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ORIGINAL ARTICLE

Strategic training and workforce readiness in healthcare organizations: Evidence from COVID-19 in Tamil Nadu

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ABSTRACT
Public health emergencies such as the COVID-19 pandemic have underscored the critical importance of a well prepared healthcare workforce. This study examines the readiness of healthcare sector employees in Tamil Nadu to manage future public health crises, with a specific focus on the role of continuous training initiatives. Using a descriptive and analytical research design, primary data were collected from 403 healthcare professionals working in multispecialty hospitals across the state. The study assessed perceptions of COVID-19 training effectiveness and analyzed differences based on educational qualification and work experience using non-parametric statistical techniques. The findings reveal that structured and need-based training significantly enhanced workforce preparedness, confidence, and adaptability. While training effectiveness did not vary significantly across qualification levels, notable differences were observed across experience groups, with early-career professionals reporting greater benefits. The study emphasizes the necessity of integrating continuous, context specific training programs into routine healthcare operations to strengthen resilience and improve responses to future public health emergencies.
Keywords: *Health system resilience, Healthcare employee training, Continuous training; Public health emergencies; COVID-19 response*

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INTRODUCTION

Public health emergencies pose profound challenges to healthcare systems, exposing structural weaknesses while simultaneously testing the preparedness and resilience of healthcare professionals. The COVID-19 pandemic, which emerged in late 2019, rapidly evolved into a global crisis that overwhelmed health systems, disrupted service delivery, and placed extraordinary demands on healthcare workers across all levels of care [14]. Hospitals and healthcare institutions were compelled to respond to rapidly changing clinical protocols, surges in patient volumes, shortages of critical resources, and heightened occupational risks. These circumstances highlighted the crucial role of healthcare workforce preparedness in ensuring continuity of care and effective crisis response. Healthcare employees serve as the backbone of emergency response during public health crises. Their ability to adapt to unfamiliar clinical situations, comply with evolving safety guidelines, and manage increased workloads directly influences patient outcomes and system performance [12]. However, the COVID-19 pandemic revealed that many healthcare systems were insufficiently prepared to support their workforce during prolonged emergencies. Gaps were observed in infection control training, emergency protocols, use of personal protective equipment, and psychological preparedness, resulting in stress, burnout, and reduced workforce efficiency [10].

Preparedness in healthcare extends beyond infrastructure and medical supplies; it encompasses the knowledge, skills, attitudes, and competencies of healthcare employees to respond effectively under crisis conditions [9]. Workforce preparedness is closely linked to continuous training and capacity-building

initiatives that equip healthcare professionals with up-to-date clinical knowledge, emergency response skills, and situational awareness. Training programs play a critical role in enhancing adaptability, decision-making, teamwork, and confidence during emergencies, thereby strengthening overall health system resilience [2]. Continuous training has been widely recognized as a strategic tool for improving emergency preparedness in healthcare settings. Simulation-based training, infection prevention workshops, disaster drills, and digital learning platforms have been shown to improve clinical competence and readiness for crisis scenarios [13]. During the COVID-19 pandemic, healthcare institutions that had invested in regular training programs were better positioned to implement new protocols, redeploy staff across departments, and maintain service quality despite operational disruptions [3]. Conversely, inadequate training was associated with higher levels of anxiety, reduced compliance with safety measures, and increased vulnerability among healthcare workers.

In developing regions, including India, challenges related to workforce preparedness were particularly pronounced due to high patient loads, uneven distribution of healthcare resources, and limited access to structured training programs. The scale and diversity of the Indian healthcare system posed significant obstacles to standardized emergency preparedness initiatives [11]. Healthcare professionals, especially those working in multispecialty and tertiary hospitals, were required to manage complex clinical demands while adapting to rapidly changing guidelines. These circumstances underscored the importance of context-specific training strategies that address local healthcare needs and constraints. Tamil Nadu, one of India's leading states in healthcare delivery, experienced significant pressure on its healthcare workforce during the COVID-19 pandemic. Despite having relatively strong health indicators, hospitals across the state faced shortages of trained personnel, increased workload intensity, and challenges in maintaining workforce morale [4]. The experience highlighted the need to strengthen employee preparedness through systematic and continuous training interventions that can enhance both clinical and non-clinical competencies.

In this regard, the present study investigates the preparedness of healthcare employees in Tamil Nadu for future public health emergencies, with a specific focus on the role of continuous training programs. By examining training practices, perceived preparedness, and workforce adaptability, the study aims to contribute to the growing body of literature on healthcare resilience. The findings are expected to provide practical insights for hospital administrators, policymakers, and healthcare educators in strengthening workforce preparedness and ensuring more effective responses to future public health crises.

MATERIAL AND METHODS

Research design

The present study adopted a descriptive and analytical research design to examine the preparedness of healthcare employees in Tamil Nadu for managing future public health crises, with particular emphasis on the effectiveness of COVID-19–related training initiatives. The design was selected to systematically capture variations in training practices, preparedness levels, and perceptions across healthcare professionals with differing qualifications and work experience. Both quantitative and qualitative elements were incorporated to ensure a comprehensive assessment of workforce readiness and training outcomes.

Sources of data

The study utilized both primary and secondary data sources. Primary data were collected directly from healthcare employees through structured questionnaires and limited interviews. Secondary data were gathered from policy documents, government training manuals, institutional reports, and published research related to healthcare preparedness, emergency training, and pandemic response. The integration of these sources enhanced contextual understanding and strengthened the interpretation of empirical findings.

Sampling design and sample size

A cluster sampling technique was employed to ensure adequate representation across different categories of healthcare institutions. Multispecialty hospitals across various districts of Tamil Nadu were identified as clusters. Within each cluster, respondents were selected randomly to capture diversity in educational qualifications and years of work experience. A total of 403 healthcare employees voluntarily participated in the study, exceeding the initially proposed sample size of 400 and thereby enhancing the robustness of statistical analysis.

Data collection instrument

Primary data were collected using a structured questionnaire developed based on an extensive review of literature and existing training evaluation frameworks. The questionnaire consisted of four sections. The first section captured demographic details such as educational qualification and work experience. The

second section assessed exposure to COVID-19–specific training programs. The third section measured perceptions of training effectiveness and preparedness using multiple statements related to skill development, adherence to standard operating procedures, and workplace safety. The final section examined overall attitudes toward on-the-job training during the pandemic. Responses were recorded on a five-point Likert scale ranging from strongly disagree (1) to strongly agree (5).

Measurement of variables

Training effectiveness was treated as the primary dependent variable, operationalized through multiple observed indicators related to COVID-19 training practices. Educational qualification and work experience were treated as independent variables. Preparedness was assessed indirectly through respondents' agreement with statements reflecting confidence, adaptability, and operational readiness during the pandemic. The mean score for training effectiveness was calculated using the formula:

$$\bar{X} = \frac{\sum X_i}{N}$$

where *Xi* represents individual responses and *N* denotes the total number of respondents. Standard deviation was computed to assess variability in responses.

Data analysis techniques

Data analysis was carried out using statistical software. Descriptive statistics such as frequency, percentage, mean, standard deviation, skewness, and kurtosis were used to summarize respondent characteristics and training perceptions. Tables were employed to present distributions of educational qualifications and work experience (Table 1), providing an overview of respondent diversity.

Inferential analysis was conducted to test the proposed hypotheses. Since the data did not strictly satisfy normality assumptions, non-parametric tests were applied. The Kruskal–Wallis H test was used to examine differences in training effectiveness across groups based on educational qualification and work experience. The test statistic was calculated using the formula:

$$H = \frac{12}{N(N+1)} \sum \frac{R_i^2}{n_i} - 3(N+1)$$

where *Ri* is the sum of ranks for each group, *ni* is the sample size of each group, and *N* is the total sample size. Statistical significance was evaluated at the 5 percent level.

Confirmatory factor analysis

Confirmatory factor analysis (CFA) was employed to validate the construct of COVID-19 training. The model assessed the relationship between observed variables and the latent construct of pandemic training. Model fit was evaluated using indices such as Chi-square/df, Goodness of Fit Index, Adjusted Goodness of Fit Index, Normed Fit Index, Comparative Fit Index, Tucker–Lewis Index, Root Mean Square Error of Approximation, and P-close values (Table 4). These indices were compared against established threshold values to determine adequacy of model fit.

Regression Analysis

Structural regression estimates were examined to assess the contribution of each observed variable to the latent construct of pandemic training (Table 5). The regression model followed the general form:

$$Y = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \cdots + \beta_n X_n + \varepsilon$$

where *Y* represents pandemic training effectiveness, *Xn* represents observed indicators, *βn* denotes regression coefficients, and ε is the error term. Significance was determined based on critical ratios and p-values.

Validity and Reliability

Content validity was ensured through expert review of the questionnaire. Construct validity was established using CFA results, which demonstrated strong model fit. Reliability was assessed through internal consistency measures, indicating acceptable reliability levels for all training-related constructs.

Ethical Considerations

Ethical standards were strictly followed throughout the study. Participation was voluntary, informed consent was obtained from all respondents, and confidentiality was assured. The data collected were used solely for academic purposes, ensuring compliance with ethical norms in healthcare research.

RESULTS

This result presents the empirical findings of the study based on primary data collected from 403 healthcare employees working in multispecialty hospitals across Tamil Nadu. The results are organized using descriptive and inferential statistics to examine respondent characteristics, perceptions of COVID-

19 training effectiveness, and the influence of educational qualification and work experience on training outcomes.

Profile of Respondents

Table 1 summarizes the educational qualifications and work experience of the respondents. The sample is predominantly composed of highly qualified healthcare professionals, with postgraduates (36.5%) and those holding qualifications above the postgraduate or MD-equivalent level (20.1%) forming the majority. The inclusion of undergraduate medical professionals, diploma holders, and respondents with secondary and higher secondary education ensures adequate academic diversity. In terms of work experience, most respondents reported 11–20 years of professional service, indicating substantial clinical exposure. The presence of both early-career and highly experienced employees enables meaningful comparison of training perceptions across experience levels.

Table 1. Profile of respondents by educational qualification and work experience

Category	Frequency	Percentage		Category	Frequency	Percentage
Educational Qualification				**Work Experience**		
SSLC	20	5.0		0–5 Years	25	6.2
HSC	24	6.0		6–10 Years	41	10.2
Diploma in Pharmaceutical Courses	70	17.4		11–15 Years	106	26.3
UG with Medical Courses	61	15.1		16–20 Years	122	30.3
Above PG / MD Equivalent	81	20.1		21–25 Years	90	22.3
Post Graduate	147	36.5		Above 25 Years	19	4.7
Total	403	100.0		**Total**	403	100.0

Descriptive Statistics for COVID-19 Training Practices

Table 2 summarizes respondents' perceptions of COVID-19 training initiatives using descriptive statistics. The mean scores indicate moderate agreement with statements related to training need identification, development of COVID-specific modules, alignment with government standard operating procedures, and workplace safety guidance. The relatively consistent standard deviations suggest balanced variation in responses. Overall, the table highlights that structured training, particularly need-based and on-the-job learning, was viewed as an important support mechanism during the pandemic, although some gaps remained in addressing operational difficulties.

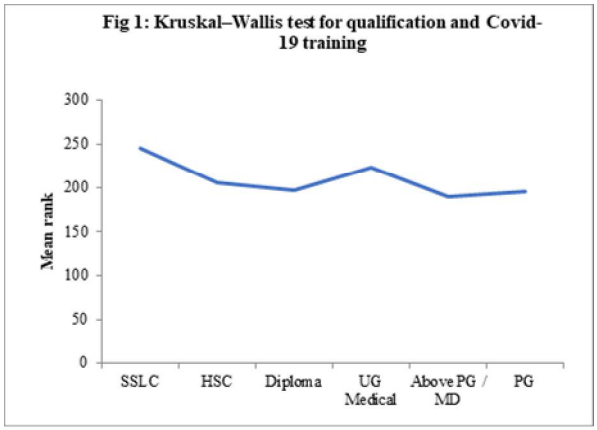
Table 2. Descriptive statistics for COVID-19 training

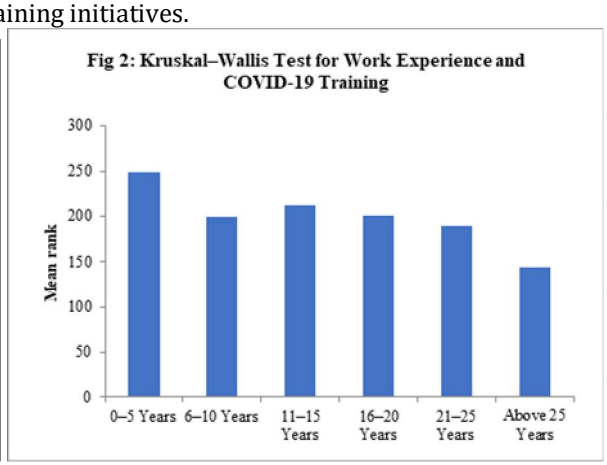
Training Statements	Respondents' perceptions
Identification of employee training needs	2.831 ± 1.1069
Routine implementation of training procedures	2.811 ± 1.0901
Development of COVID-specific training modules	2.814 ± 1.0939
Alignment of training with government SOPs	2.806 ± 1.0892
Safety-focused training programs	2.819 ± 1.1060
Training inadequacy in addressing operational difficulties	2.794 ± 1.1151
Value of on-the-job training	2.819 ± 1.1217

Kruskal–Wallis Test for Educational Qualification and Work Experience and COVID-19 Training

Figures 1 and 2 present the results of the Kruskal–Wallis tests examining differences in perceived COVID-19 training effectiveness across educational qualification and work experience groups. The analysis across educational qualification categories indicates some variation in mean ranks; however, the differences are not statistically significant, suggesting that training initiatives were perceived similarly irrespective of respondents' academic background. This reflects the broad accessibility and relevance of COVID-19 training programs across diverse qualification levels, supporting uniform preparedness among healthcare employees. In contrast, the analysis based on work experience reveals a statistically significant

difference in training perceptions. Respondents with fewer years of experience reported higher mean ranks, indicating greater perceived benefits from training initiatives.





Model Fit Indices for COVID-19 Training (CFA)

Table 4 displays the goodness-of-fit indices derived from confirmatory factor analysis for the COVID-19 training construct. All indices exceed recommended threshold values, indicating an excellent model fit. The low Chi-square/df ratio and RMSEA value confirm minimal discrepancy between the proposed model and observed data. These results validate that the selected indicators effectively measure the underlying construct of pandemic training, confirming the reliability and structural soundness of the measurement model used in the study.

Table 4. Model Fit Indices for COVID-19 Training

Fit Index	Value
Chi-square/df	1.599
GFI	0.998
AGFI	0.968
NFI	0.999
CFI	0.999
TLI	0.998
RMSEA	0.039
P CLOSE	0.488

Regression Estimates for Pandemic Training

Table 5 presents the regression estimates linking observed training indicators to the latent construct of pandemic training. All indicators show statistically significant estimates with high critical ratios, demonstrating strong predictive relationships. This confirms that elements such as need-based training, SOP-aligned modules, workplace safety guidance, and on-the-job learning are integral components of effective COVID-19 training. The results reinforce the conceptual framework of the study and highlight the multidimensional nature of training required to enhance healthcare workforce preparedness during public health crises.

Table 5. Regression Estimates for Pandemic Training

Training Indicators	Estimate	CR	p-value
Training need identification	0.999	50.729	0.000
Routine training procedures	0.970	50.478	0.000
COVID-specific modules	1.003	59.041	0.000
SOP-aligned training	0.973	47.708	0.000
Workplace safety training	0.996	51.672	0.000
Addressing operational difficulties	0.953	37.790	0.000
On-the job training value	1.031	59.389	0.000

DISCUSSION

The findings of the present study reaffirm the critical role of continuous training initiatives in enhancing the preparedness of healthcare employees to manage future public health emergencies. Training programs play a vital role in strengthening adaptability, decision-making, teamwork, and professional confidence during crisis situations, thereby contributing to overall health system resilience [2]. During

the COVID-19 pandemic, healthcare workers were required to rapidly adjust to evolving clinical protocols and operational demands, making structured and responsive training essential for effective performance.

The educational composition of the respondents indicates a workforce with strong academic foundations, predominantly comprising postgraduate and medically qualified professionals. The absence of statistically significant differences in training effectiveness across educational qualification levels suggests that pandemic training initiatives were largely practical and skills-oriented rather than theory-driven. This finding aligns with evidence that competency-based training approaches reduce knowledge gaps and promote standardized practices across professional hierarchies during emergencies [1]. By focusing on infection control, patient safety, and operational procedures, training programs ensured that healthcare workers, regardless of academic background, were equipped to respond effectively.

Work experience emerged as a significant factor influencing perceptions of training effectiveness. Employees with fewer years of experience reported greater benefits from COVID-19 training initiatives, highlighting the supportive role of structured learning for early-career professionals. Previous research indicates that less experienced healthcare workers often experience higher stress and uncertainty during crises and therefore rely more heavily on formal training to build confidence and competence [7]. Conversely, highly experienced professionals may depend more on prior clinical exposure, which can moderate the perceived impact of additional training.

The descriptive analysis of training practices demonstrates that respondents generally acknowledged institutional efforts to identify training needs, develop pandemic-specific modules, and align training with government-issued standard operating procedures. Aligning training with national and international guidelines has been shown to improve consistency, safety, and compliance during public health emergencies [6]. However, the moderate agreement levels observed in this study suggest that training programs could be further strengthened to address operational challenges that were not fully anticipated during the prolonged phases of the pandemic.

The confirmatory factor analysis results validate the multidimensional nature of pandemic training. Components such as need-based training, safety-focused instruction, and on-the-job learning were all found to significantly contribute to overall training effectiveness. Experiential learning approaches, particularly on-the-job training, have been widely recognized for their ability to translate theoretical knowledge into practical competence under real-world conditions [8]. Such approaches enhance situational awareness and enable healthcare workers to respond more confidently to rapidly changing environments.

From an organizational perspective, the findings underscore the importance of leadership support and institutional commitment in sustaining effective training systems. Regular updates to training content, clear communication, and attention to staff well-being are essential for maintaining workforce engagement and performance during crises [5]. Furthermore, the variation in perceived training effectiveness across experience levels highlights the need for differentiated training strategies tailored to the specific needs of diverse workforce segments.

CONCLUSION

The study highlights the crucial role of continuous and structured training programs in strengthening the preparedness of healthcare employees to manage future public health emergencies. The findings demonstrate that well-designed training initiatives enhance workforce confidence, adaptability, and operational effectiveness, particularly during crisis situations such as the COVID-19 pandemic. While training effectiveness was perceived consistently across educational qualification levels, differences were observed based on work experience, indicating the need for tailored training approaches that address the specific requirements of both early-career and experienced professionals. The validation of training constructs further confirms the importance of need-based, safety-oriented, and experiential learning components. Overall, the study underscores the necessity of integrating continuous training frameworks into routine healthcare operations to improve resilience, ensure coordinated responses, and strengthen the capacity of healthcare systems to withstand future health crises.

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