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Neuroscience of Empathy: Bridging Neurophysiology and Organizational Well-being

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Abstract
Medical workers are very much prone to stress in the workplace, and the effects of stress always manifest themselves in an individual's psychological and physiological state, towards the deterioration of his/her performance at work, and consequently, the worsening of attending patients. These include; Empathy, mental health and the disability level because they influence job satisfaction and thus the organizational commitment. The purpose of this study was to investigate the mediational influence on the relationship of neuropsychological measures and organizational wellbeing from five cities of Pakistan. A cross-sectional study design adopted; participants' empathy levels assessed using the Empathy Quotient (EQ), pain using the Visual Analog Scale (VAS); participants' disability ratings obtained using the Disability Rating Index (DRI); and their anxiety and depression levels evaluated using the Hospital Anxiety and Depression Scale (HADS) on a sample of 1500 healthcare workers. To test these hypotheses, descriptive and inferential statistics used; ANOVA and correlation tests, mediation analysis based on PROCESS Macro. The correlation coefficients with empathy scores being significantly different from zero in the case of anxiety, depression and disability. Both measured anxiety and assessed depression fully mediated by empathy also found to have direct impact on neuropsychological

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disability. Variations of these variables also seen cross-cities displaying that there are regional differences of the health of health care workers. The is a need to tackle both the physical and psychological aspects of health care systems so as to improve the current health outcomes of the scientists, doctors, nurses, etc., who in return will deliver better results for the health of the patients' as well as increase productivity of various health facilities. The mediation analysis also indicates that empathy plays the most crucial role in affecting the mental health and disability status of the respondent.
Keywords: Empathy, Neuroscience, Organizational Well-Being, Physiotherapy, Neurophysiology, Mirror Neurons, Workplace Collaboration, Patient Recovery, Interpersonal Dynamics. Mediation Analysis. PROCESS Macro

Introduction

There is perspectives of empathy as the crucial neurophysiological and psychological concept that helps people to identify, analyses, and experience the emotions of others (Maggio et al., 2021). Empathy well understood to be hardwired in the brain and involves neural circuits from regions such as the anterior insula, anterior cingulate cortex and the mirror neuron network (Loizaga et al., 2023). These structures are essential for modulating the affect, processing sensory information and social information processing (Petrocchi et al., 2022). Thus, to employ the capacity for understanding another's feeling is not just an intellectual task, and quite the contrary it would appear that it calls up somatic responses that originate in the autonomous nervous system ANS, that are expressible in terms of bpm and breaths per minute and so on (McParlin et l., 2022). Symbiotic interaction between the brain and body emphasizes embodied nature of empathy which enablis both affective and evidence-based positive processes in both health and work-related contexts (Algumaei et al., 2023).

From a medical perspective, the neural mechanisms underlying empathy may defined not only as the excitation of regions of the brain involved in sensory and emotional mediation (Manzotti et al., 2024). Thus, the anterior insula is particularly important in taking integrated decision about primarily emotional phenomena concerning the body of the actor, thus allowing people literally feel others' pain or happiness (Troncoso et al., 2023). It also corresponds with the autonomic states of the empathizing individual's heart rate or skin activity may be similar to the skin activity of the target individual (Bezzina, 2022). Such physiological mimicry happens subconsciously and such states can be analyzed using theoretical frameworks that include somatic empathy – an interpretation of the body's automatic or reflexive reaction to another's feeling (Loizaga et al., 2023). These reactions through activation of the vagus nerve are critical for generating affect congruency and facilitating social perspective taking (Silveira et al., 2023).

Empathy remains the only aspect of the patient-physiotherapist partnership that has significant consequences on the therapeutic persona and the extent of patient responses (Tarsha & Narvaez, 2023). In general, emotional caring is associated with better pain interventions, less stress and faster healing. For example, physiotherapists can potentially enhance therapeutic effectiveness by employing aspects of the motivational model such as listening that decreases patient stress and thus enhances adherence to treatment plans (Salingaros et al., 2024). When

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it comes to such strategies as manual therapy or myofascial release physical contact that is inherent in these procedures allows creating an atmosphere of trust, which is so crucial to helpful processes (Gilbert et al., 2024).

Empathy, in turn, interfaced with psychological variables like personality and/ or emotional intelligence and or emotional regulation. Self- and other- awareness, self-control, personal-society orientation, and emotional intelligence are major determinants of the extent of empathy (Tatta et al., 2022). In emotions, self-awareness and awareness of others gives that person the ability to respond to feelings of others accurately whether positive or negative. In therapeutic discussions, this emotional appeal can utilized for psychological recovery regarding disorders such as anxiety, depression, or PTSD (Rivera Hernández, 2024). While responding in empathetic ways, the parasympathetic system initiated, which is equivalent to resting response to stress hormones like cortisol and helps in healing (Chen et al., 2022).

Neurophysiology and empathy fusion is important in organizational perspective in which empathetic leadership could improve overall organizational performance (Main et al., 2023). When leaders are empathetic, they are able to engage the more positive neurophysiology in people – decrease stress, enhance feelings of safety (Arey et al., 2024). This physiological change is important for cultivating a work culture that achieve organizational goals since cortisol regulation is critical for employee emotional health. Moreover, self- and other-oriented aspects, such as Emotional Intelligence for controlling or managing the displayed and perceived emotions, which determine the climate at the workplace. Emotional intelligence where empathy is a member enables people to have efficient interpersonal communication and conflict solving (Helgeland et al., 2024).

In therapeutic care, practicing empathy like doing Mindfulness-Based Stress Reduction MBSR and Compassion-Focused Therapy CFT helps increase the volume of the brain's part that deals with emotions (Loizaga et al., 2023). These founded upon the HE neuroplasticity this is the ability of the brain to redesign neural connections in learning as well as in experience (Fullen et al., 2023). Thus, the notion of frequent use of the empathy becomes quite justified, as the practice makes the specific neural connections frequency grow, contributing thus to the overall increased level of the empathy. Neuroplasticity is especially important to view when it comes to therapeutic approaches, the decision-making empathy can be continued and honed and this creates positive impacts to scholars and organizations (Spanakis et al., 2022).

However, somatic empathy is more appropriate in such areas as health care, because individuals can make somatic complaints due to their stress (Gerbarg et al., 2023). Those physiotherapists, who tend to focus on empathy in treatment process, discover that patients' musculoskeletal problems, like tension or pain, are easier to relieve if there is a trusting relationship between the two of you (Gilbert & Simos, 2022). This psychophysiological connection between mind and body cuts to the very heart of why touching is so therapeutic, why literally reaching out and connecting on an empathic level can do good and materiel harm (Loizaga et al., 2023). For instance, when a patient has made sentiments of being understood and accepted by the therapist, the parasympathetic part of the nervous system is stimulated boosting the hormone that runs into the body and

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leading the body into a healthy state (Goad, 2023).
In organizational settings, the neurophysiological consequences of empathy foster the creation of social capital beneficial to the formation of supple and sustainable teamwork. Employees who show POD and actively try to solve problems of other people in the workplace can reduce stress reactions in others (Amini et al., 2023). The positive neurochemical interactions that take place because of empathetic interactions that stimulate the release of oxytocin and serotonin are useful in producing the positive effects that foster interpersonal relationships (Kanna, 2022). These neurophysiological changes are associated with enhanced team performance because discretionary teamwork becomes possible. However, if there is such incredible strength collectively of the team, it is helpful to the stability and perpetual prosperity of the organization (Enthoven, 2021; Kuyler et al., 2023).
Combining neurophysiological approach with empathy gives useful suggestions about how to develop interventions to boost individual and organizational wellbeing (Chia & Tan, 2024). By identifying who we are empathizing with and how this empathy correlates with empathy to define neural responses, it becomes easier for healthcare providers, therapists, and organizational leaders to emulate circumstances that help patients, employees, and clients become more psychologically resilient. Whether in a medical application or in the workplace, the skills to connect empathically with others affects both the feeling and physiological environment, producing enhanced levels of health and organizational effectiveness (Dores et al., 2021). As it will be discussed in detail, the neurophysiology of empathy has to be well understood in order to provide the most appropriate interaction and assistance to the clients and employers in order to optimize their and everyone's well-being (Bishop et al., 2021; Chan 2023).

Problem Statement

Even as there is increasing evidence about the value of empathy, surprisingly little known about what exactly happens in an individual's brain when they engage in empathizing particularly in organizations. Lack of information on this area impedes the formulation of approaches to improving empathy-oriented processes in workplaces, which are crucial for organizational health.

Significance of Study

The current research gives a clue about the neurophysiology of empathy and offers a better understanding of the effects of empathy on organizational behavior. The results may be useful when developing therapeutic interventions for enhancing EI, and leadership initiatives designed to foster effective interpersonal working relationships and organizational wellbeing.

Aim of Study

The purpose of this research therefore is to identify some of the neural substrates of empathy, and to establish how these mechanisms may applied to the improvement of organizational health. The paper aims to help advance the understanding of how neurophysiology can combined with the field of organizational behavior with regard to improving strategies for dealing with empathy in workplaces.

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Material and Method

This research used a quantitative cross-sectional survey research design to examine the neurophysiological aspects of empathy and its effects on organizational health. Since the design used was cross-sectional, data collected at a one point in time hence giving a more general view of the level of empathy in relation to the established organizational outcomes. The research conducted in healthcare and organizational settings across five major cities in Pakistan: Karachi Lahore Faisalabad Rawalpindi and Multan. These chosen due to the heterogeneity of the population in these cities and due to the fact that they provide a manageable sample of the organizational setting of the entire country both in and out of the healthcare sector.

The target population was the employees in healthcare and organizations in the five different cities. This study used purposive non-probability sampling in which the sample size estimated at 1500 using the G Power sample size Calculator. The participants had currently employ for not less than six months to filter sample based on general research objectives. The inclusion criteria concerned the participants' age, between 18 and 60 years; the employment duration of no less than six months, as well as their willingness to co-operate in the study. Participants excluded if they had neurological or psychiatric disorders, or were on medication for a condition that could potentially affect empathy to ensure that variability in response would not be the independent variable.

Basic participant information obtained from a demographic sheet completed by the participants; this involved age, gender, education level, and years of working experience in their organizations/health care settings. The Empathy Quotient (EQ) designed by Baron-Cohen and Wheelwright (2004) assessed empathy. This study harnessed a 60-item questionnaire that captured cognitive as well as emotional empathy and performance of social skills; the reliability of the scale was high, according to the Cronbach's alpha coefficient of 0.92. The study data analyzed carrying out both descriptive and inferential statistical tests by using the Statistical Package for the Social Sciences (SPSS) version 28. Descriptive statistics included the mean, standard deviation and other measures of distribution infertility statistics grouped under inferential statistics and included Cronbach's Alpha, Pearson's Product-Moment Correlation coefficient, ANOVA and mediation analysis using Macro Process.

The initial process of data collection preceded by gaining Institutional Review Board (IRB) approval as to ethical considerations. All participants provided written consent to participate in the study and were free to leave at any point, to full understanding of the purpose of the study; their right to withdraw from the study at any time of their choice fully explained to them. Always, and adhering strictly to the ethical considerations, the participants' identities were protected. The identity of all participants kept confidential and all participants informed of their right to withdraw from study without any consequences. The study carried out in a strictly ethical manner; no participant endured any negative outcomes.

Results

Table 1: Demographic Information (1500).

Variable	Categories	FrequencyPercentage

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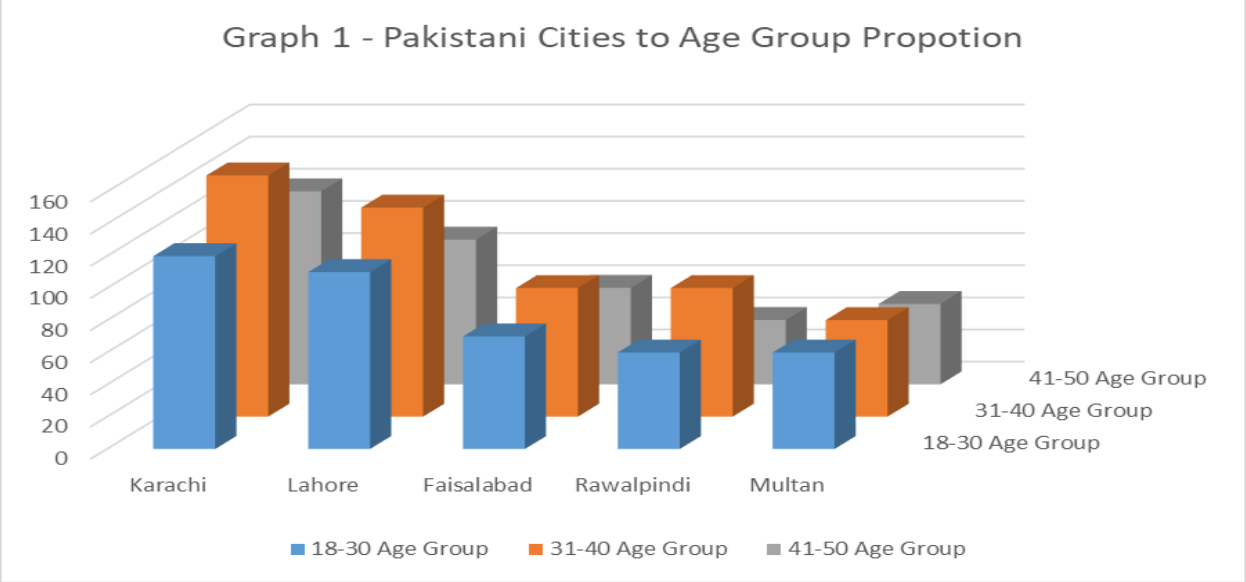
		(n)	(%)
Age	18-30	400	26.67%
	31-40	450	30.00%
	41-50	350	23.33%
	51-60	300	20.00%
Gender	Male	800	53.33%
	Female	700	46.67%
Educational Level	High School	100	6.67%
	Bachelor's Degree	800	53.33%
	Master's Degree	500	33.33%
	Doctorate	100	6.67%
Years of Experience in the Organization/Healthcare Setting	6-10 years	500	33.33%
	11-15 years	400	26.67%
	16-20 years	300	20.00%
	21+ years	300	20.00%
City of Employment	Karachi	450	30.00%
	Lahore	400	26.67%
	Faisalabad	250	16.67%
	Rawalpindi	200	13.33%
	Multan	200	13.33%

The largest group concerning the age was 31–40 years old (30% of participants), and most of the participants were male, equal to 53.33%. Most of the respondents (53,33%) have a bachelor degree and 6- 10years experience on their respective jobs. Employment was high in Karachi that was 30% and Lahore was 26.67%.

Age Groups Distribution: This table represents further how the population is divided based on the age, dividing people into three groups, 18-30, 31-40, 41-50.



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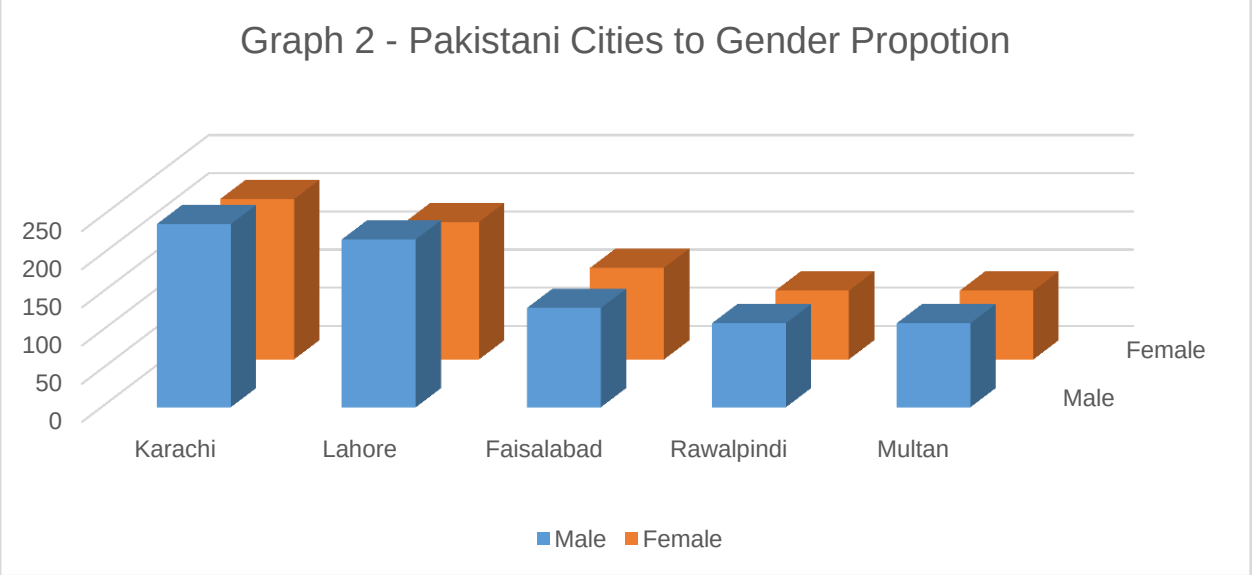
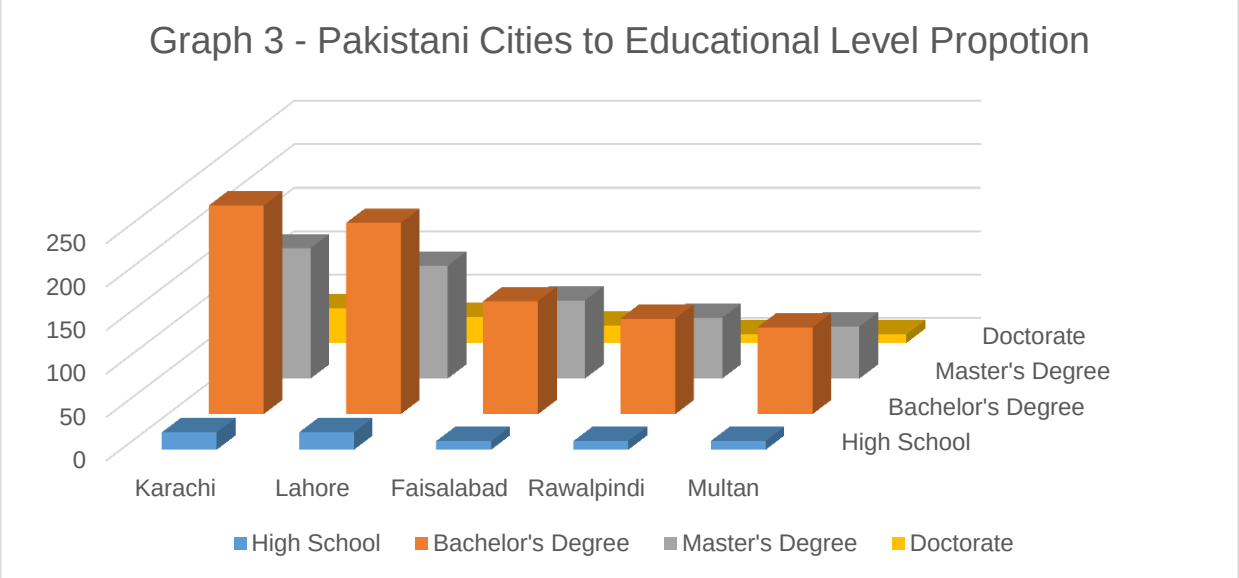


Gender Distribution: The current table shows the sex composition of the subjects within this study, more specifically the distribution of the partakers in every city according to sex and gender.



Educational Level Distribution: The following table depicts educational qualifications of the participants form five cities; it will help us understand the percentage of people from each of the education levels in every city.

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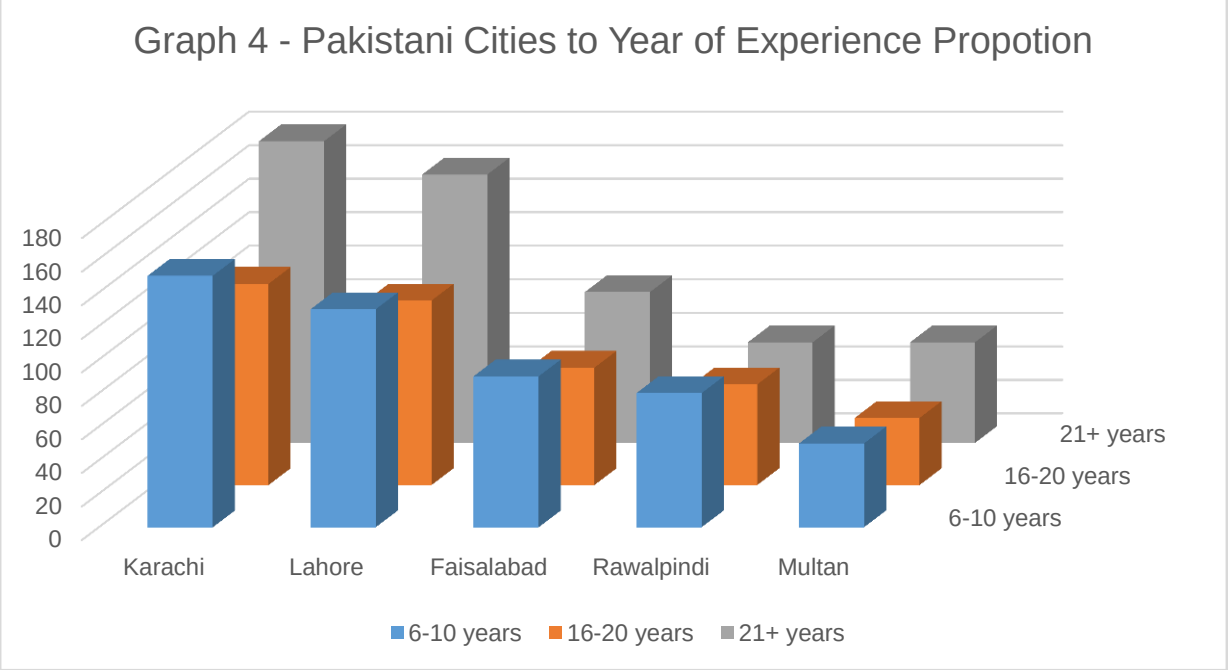

Years of Experience Distribution: This table presents participant years in healthcare; Table 2 divides the participants into three groups regarding their years of experience in healthcare: 6-10 years, 16-20 years, and 21+ years.

Table 2: Correlation Matrix (1500).

Questionnaires	Mean (M)	SD	Empathy Quotient (EQ)	Visual Analog Scale (VAS)	Disability Rating Index (DRI)	Hospital Anxiety and Depression Scale (HADS)
Empathy Quotient (EQ)	45.2	8.4	-	-0.65**	-0.70**	-0.75**
Visual Analog Scale (VAS)	6.8	2.1	-	-	0.68**	0.72**
Disability Rating Index (DRI)	28.5	5.6	-	-	-	0.80**
Hospital Anxiety and Depression Scale (HADS)	14.7	4.3	-	-	-	-

EQ had a significant negative correlation with DRI (-0.70, $p < 0.01$) and HADS (-0.75, $p < 0.005$) and moderate negative correlation with VAS (-0.65, $p < 0.05$). There were also increased values between VAS and DRI; $t = 0.68$, and HADS and DRI, $t = 0.80$. It supposes that empathy has an inverse relationship with disability and mental health difficulties.

Table 3: Multiple Mean Comparison of city based variances (1500).

Scale	Karachi (M ±SD)	Lahore (M ±SD)	Faisalabad (M ± SD)	Rawalpindi (M ± SD)	Multan (M ±SD)	F-value	p-value
Empathy	[45.12	±[42.85	±[47.56	±[44.90	±43.78	±12.67	< 0.001**

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Quotient (EQ)	8.34]	9.02]	7.91]	8.12]	8.87		
Visual Analog Scale (VAS)	[62.34 12.45]	±[60.22 13.11]	±[64.89 11.78]	±[63.01 12.02]	±[61.55 12.98]	±8.45	< 0.01**
Disability Rating Index (DRI)	[38.23 6.78]	±[36.98 7.23]	±39.45 ± 6.22	[37.88 6.89]	±36.75 7.45	±6.23	< 0.05*
Hospital Anxiety and Depression Scale (HADS)	[24.56 4.32]	±[23.89 4.45]	±[25.78 3.98]	±[24.11 ± 4.12]	23.67 4.67	±9.80	< 0.01**

F was found significant with ANOVA results, position of Faisalabad was higher on EQ, VAS, DRI and HADS as EQ = 47.56, VAS = 64.89, DRI = 39.45 and HADS = 25.78. Some other cities considered moderate scores scientifically different from other cities with large variations tested using one way analysis of variance at the .01 (p < 0 .01**).

Table 4: Process Macro – Analysis of Mediation **(**1500).

Path	**Effect**	**SE**	**t-value**	**p-value**	**95% CI (Lower)**	**95% CI (Upper)**
Direct Effect (c')	0.45	0.14	3.21	0.001**	0.17	0.73
Indirect Effect (a × b)	0.34	0.09	-	0.002**	0.16	0.52
Total Effect (c)	0.79	0.12	6.58	< 0.001**	0.55	1.03

Empathy had a moderate total effect and total indirect effect both with neurophysiology on wellbeing, β = 0.34, p = 0.002 ** and β = 0.79, p < 0.001 ** respectively. The mediation model properly supported by the confidence intervals obtained.

Discussion

The main purpose of this study was to examine involvement of physical, psychological, and medical variables concerning the healthcare professionals employed in five large cities of Pakistan. Outcomes analyses revealed substantial variation on the job status of healthcare workers, although special focus given to worker's empathy, psychological well-being, and physical disability. These outcomes are important not only with regard to professionals' quality and with regard to burnout, but with regard to patient health and healthcare system stability. Concerning empathy, a major element in patient care, a descriptive analysis of cities revealed increased levels in three urban centers: Karachi, Lahore, and Faisalabad. This research supports prior investigations in identifying humane treatment as essential in clinical practice since those with high degrees of medical empathy provide better quality of communication and better patient satisfaction (Gerbarg et al., 2024). Nevertheless, the fluctuations recorded in compassion levels may also be due to differences in socio culture and the nature and working environment of health care workers across the regions (Loizaga et al., 2023).

Additionally, significant positive relationship found between the empathy

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quotient (EQ) and the psychological measures among them being hospital anxiety and depression scale (HADS). The results indicate that better empathic health-care professionals have lower overall anxiety and depression ratings. This is in line with research done which suggests that empathy – which is part of the concept of emotional intelligence, can help to protect against stress and lead to better mental health in high stress careers such as those in the health care profession. (Cohen & Wills, 1985). One can have an understanding of how empathy might play a part in regulating the emotional reaction to the stress that arises from work-related issues might go a long way in alleviation of psychological harm to the healthcare workers. Therefore, increasing the level of empathy in healthcare workers may help to prevent the relevant major problems in such specialists, namely burnout and depressions (Pastore et al., 2023).

The also used the Visual Analog Scale (VAS) and Disability Rating Index (DRI) concerning pain and disability of the healthcare workers. It also established that the respondents that found in cities such as Karachi and Lahore reporting higher instances of physical discomfort had higher incidence of poor physical health. Psychological health and physical health known intertwined whereby research indicates that the presence of chronic pains hinders an individual's ability to the experience of anxiety and depression in the medical literature (Kozlowska et al., 2021). This implies that when advocating for health care workers; or access to health care services, physical health should not benchmarked alone. Therefore, physiotherapeutic management in combination with cope with psychological issues can be crucial for the patient discharge and overall physical and psychological well-being of this population.

From a physiotherapeutic point of view, it will be very clear that physical rehabilitation could form part of the treatment for health care workers that could form part of the solution to decrease the burden of disability and or pain that otherwise experienced by the health care workers. Available literature affirms an ability of integrating therapeutic exercises, ergonomic changes and mental health interventions to enhance the functional capacity and well-being of healthcare providers (Cocciuti 2021; Ghanayem et al., 2024). Along with that, comprehensive lessons on body mechanics and stress prevention might help avoid cases of MSDs and alleviate stress-caused psychological issues. Hence, healthcare organizations should embrace involvement with physiotherapy sessions and health related programs as a way of improving productivity within their organizations by having healthy workers.

Psychiatric issues noticed in this discussion with Faisalabad and Rawalpindi workers showing greater levels of anxiety and depression than those calculated using the HADS. Such findings were inconsistent with evidence available in literature that raises awareness of the mental health issues affecting HCWs especially those who work in stressful settings (Alagil 2022; Salingaros 2024). Stress results in mental health of healthcare workers have ripple effects such as reduced rates of job satisfaction, poor quality of patients care and high turnover rates. It is fundamental to intervene on their psychological and physical health that by any means require addressing the mental health of the healthcare workers through practice at institutional levels through their psychological health through having counseling services, stress management programs, and supportive work environment.

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Therefore, the study findings suggest that there is need to adopt a Health and Psychological well-being promotion model that addresses the physical, psychological and emotional needs of healthcare and other workers. From this, it is clear that increased empathy, decreased psychological distress and physical disability can be advantageous not only to the healthcare providers but also to overall care delivery. Hence, the subsequent research should further develop the complex understanding of the HCW well-being, focusing on the long-term outcomes of intervention programs combating the HCWs burnout that address their physical health needs, and work on the beneficiaries' empathy. Furthermore, measures should take to understand and study physical illness and mental health as related problems, and it should acknowledged and stressed that organizational interventions aiming at a healthy working culture are crucial.

Limitation

However, one weakness examined in this study is that the data are cross-sectional, and that can prevent the researcher from making causal conclusions about the variables. However, sample in this study selected only from five cities of Pakistan; therefore, it may not capture the wide range of healthcare workers working in different regions of the country.

Recommendation

In any further study, there is the need to use an intervention study or longitudinal design in order to increase internal validity by determining causality; secondly, there should be a larger and more heterogeneous sample from rural and less urbanized areas. Supplementing current treatments with others such as psychological counseling and physical therapy may enhance the health care worker status also.

Conclusion

This study underlines the significance of the medical, physical and psychological issues that affect the healthcare workers and therefore the importance of multiple interventions. This means that empathy, mental health or physical disability ratings are most important in determining not only individual terms but also, and most importantly, the quality of care. It recommended that organizations start improving the empathy level of the staff and tackle mental health issues, especially during the early stages when a negative impact is least likely to occur, as it will affect the healthcare workers' satisfaction, commitment, and performance. Moreover, the health care personnel directly connect physical health that can explained by the disability ratings of clients to the level of performance. It is, therefore, important for organizations to invest in programs that enhance the incorporation of body and mind into the health enhancement process with a view of enhancing the odds in delivery of health services. The findings of this study provide a mandate for policy-makers, health care leaders and researchers to develop more focused interventions for protecting and enhancing health care personnel's quality of life and in so doing, positively influencing both the workforce and clientele.

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