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Mediation of Climate Anxiety in Doctors and Nurses: A Structural Equation Modelling Study

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Abstract: *Aims.* The goal of this meteorological psychology study is to understand the behavioral implications on the professional lives of medical professionals in one of the most polluted regions of the world with a compromised air quality index. There is a paucity of literature to explore climate ethics as to how behavioral aspects of morals may alter related to climate change. *Methods.* The study is a cross-sectional correlational quantitative study formulated through purposive sampling. Research took place during the smog season of the world's most polluted city. The research instruments of Climate anxiety, pain and distress, and cognitive failure were administered to a sample of 211 medical professionals. Confirmatory factor analysis was conducted and resulted in robust model fitness with indices between .80 and .90. Item loadings for three factors were statistically ideal of greater than. 30. Barron and Kenny's approach was applied to conduct mediation through path analysis in which climate anxiety significantly mediates between pain distress and cognitive failure (β = .51; p < .0001). Multiple regression results using bootstrap confidence showed that climate anxiety (β = .993; p < .0001), and pain distress result in cognitive failure. The independent sample t-test was carried out to explore if nurses and doctors are different in terms of experiencing climate anxiety, pain distress, and cognitive failure. *Results.* There is a strong significant association among climate anxiety, pain distress, and cognitive failure with strong to moderate correlation values, p < .001. Confirmatory factor analysis was conducted and resulted in robust model fitness with indices between .80 and .90. Item loadings for three factors were statistically ideal at .30. 102 Nurses (M = 85.216; SD = 4.94) were more painfully distressed, prone to cognitive failure, and have climate anxiety as compared to 109 doctors (M = 71.211; SD = 9.23).

Keywords: Health risk; pain; distress; hazard; smog; climate; cognition; air quality index; meteorological psychology; ecopsychology; Pakistani context.

I. Introduction

Pakistan's main metropolitan city, Lahore has been a target of smog recently, due to the presence of unregulated coal use paired with industrial mismanagement of waste

(Aoki et al. 2008) so much so, that smog is declared as the fifth season. Pakistan is deemed as the world's most polluted South Asian country after Chad and Iraq. The city of Pakistan, Lahore is deemed as the most polluted city of the world followed by Peshawar city of Pakistan. The other cities with similar air quality index are Hotan city of China, Bhiwadi, and Delhi in India (Schwela & Haq 2020). The PM 2.5 legend metric that is within a range of 0–5 is considered a healthy air quality index under World Health Organization guidelines (Janarthanan & Partheeban 2021). In Pakistan, the air quality index of 2022 exceeded 3 to five times with an index of 70.9. More than 60,000 deaths occurred and were attributed to smog in Pakistan due to fine dust matter (Shabbir et al. 2019). Exploring the effects of smog on the performance of healthcare workers is essential as weather conditions can disrupt timely action on the part of doctors and nurses reaching the hospital on time. Similarly, ambulances face hurdles during cumbersome weather situations and delays can cause fatal consequences as well as accidents.

Exposure to smog, which links ozone and amalgamation of nitrogen dioxide is the main antecedent of outcomes of respiratory ailments like asthma, obstructive pulmonary disease, and lung cancer**.** Smog consists of the tropospheric zone that consists of Sulphur oxide leaden compounds (Grzywa-Celińska et al. 2020). The pollutant of Sulphur dioxide (SO_2) is primarily owing to the waste of non-ferrous metal and oil refinery emissions. Concentration from industrial areas that include tailpipe emissions and fossil-fueled plants leads to the pollutant generation of nitric oxide (NO) and nitrogen dioxide (NO2). In addition, volatile organic compounds contribute to human-made pollution from combustion, surface coatings, and barbecue activities.

In a non-randomized controlled trial study, risk diffusion is an important measure to mitigate the risk of smog (Malcherek-Łabiak et al. 2018). In a meta-analytic study, if there are higher levels of airborne particles, there will be an exponential increment in daily mortality rates which poses an imminent health hazard (Schwartz 1994). Oxidative stress drastically increases during smog season and is manifested due to unanticipated diseases in the younger age population (Wong 2017). Moreover, cognitive capacity is reported to be negatively affected by air pollution (Chen et al. 2018). Smog leads to the intensification of poor psychopathological symptoms and adversely affects emotional well-being (Chen & Schwartz 2009). The occupational appearance of smog within Krasnoyarsk territory is seen as deteriorating urban living (Shaparev et al. 2020). The smog haze over North China contributes to white smoke from the fires of boreal forests as monitored by the AERONET networking site (Gorchakov et al. 2019).

Severe smog events that carry PM2.5 and PM10 pollutants carry soil-related microelements with allergic pathogens (Cao et al. 2014; Tokarev, Shaparev et al. 2020). To maintain the air quality equilibrium, Pakistan recently collaborated with the United Arab Emirates to induce artificial rain that covered at least 10 areas within a radius of fifteen kilometers. Climate change is mitigated through ion generation using aerosols to increase vapor density (Ma et al. 2020).

II. Pain and Distress

During smog season, healthcare staff is at an increased risk of suffering pain that may not be physical but psychological (Iannetti et al. 2013). Workers who commute from home to hospital to work diligently in smog season are at an increased risk of acute respiratory distress syndrome (Ware & Matthay 1996). The ARDS is an emergency condition and does not necessarily have underlying pulmonary complaints (Petty & Ashbaugh 1971). Heath workers who protect themselves during air pollution and smog seasons through a surgical mask complain about breathing problems, headaches, and skin allergies. It becomes a challenge to wear protective gear for safety irrespective of distress (Hines et al. 2019). The polypropylene used in masks adds to plastic waste management which leads to hazardous enduring pathogens (Windfeld & Brooks 2015).

III. Risk of Cognitive Failure

Cognitive failures constitute to human erroneous nature that includes, absent-mindedness, forgetfulness, distraction, triggering, poor performance, slips and errors of perception, traffic, and work accidents (Broadbent et al. 1982). Filter Theory of attention posits that humans can focus on limited sensory information and only one message is perceived while others cannot be contained According to perceptual load theory, three assumptions include that resources that consume attention are scarce, the task-linked stimuli are perceived before unrelated stimuli and all the resources must be consumed (Lavie 1995).

Norman Action Theory postulates that human error increases in the presence of poor planning and weak execution of plans (Norman 1981). Cognitive processes in health care workers in terms of vigilance and efficacy can be adversely impacted if climate anxiety moderates (Swee et al. 2021). Emotion regulation theory includes behavioral avoidance techniques to avoid climate anxiety (Newman & Llera 2011).

IV. Climate Anxiety

Climate anxiety is the persistent fear of the season that can destroy humans as they are dependent on natural resources (Boyd et al. 2023). Climate anxiety is further defined as difficult apprehensiveness regarding climate change that adversely affects mental health (Coffey et al. 2021). Building onto the operational definition, even worrying about climate change can trigger anxiety (Clayton 2020).

The model of climate anxiety includes cognitive-emotional impairment, functional impairment, and personal experience of climate change and behavior engagement (Clayton & Karazsia 2020). Social identity theory takes into account how climate distress is combated through social cognition and collective environmental action to actively participate in groups for greater welfare (Teesser & Schwarz 2008). Doctors report that they have a lack of time to address climate change actively. They may seem out of capacity to work on climate change and remain aware of environmental changes despite being anxious (Kotcher et al. 2021). Medical personnel are encouraged to use fewer disposal devices and awareness campaigns continue to promote professional travel (Kuvadia et al. 2020). Healthcare professionals experience climate anxiety which is a normal response rather than a mental disorder. However, extreme levels of climate anxiety can lead to potential psychological health risks (Bingley et al. 2022).

V. Research Aim

The specific aspect of the aim is to measure the pain and distress felt by healthcare staff, primarily doctors and nurses engaged in hospitals during smog season. The measurability of the goal includes recording the responses of the healthcare staff administered, collected, and collated during peak smog season in Lahore city of Pakistan. The goal was achievable yet it was challenging to involve doctors and nurses who are working in their demanding professions. The study took four months to complete as smog emerged and eventually subsided over time so the accuracy of the results could be reported.

There is a paucity and lack of literature and studies conducted that take into account the psychological and physical well-being of healthcare workers during smog. Meteorological psychology and psyecology are integral to study in Asian regions. The research aim was to evaluate as to whether doctors and nurses respond contrarily to the smog seasonal changes and if it impacts their cognition to perform optimal work in Lahore city hospitals within a Pakistani context.

VI. Research Design, Data and Methods

The cross-sectional correlational quantitative study was conducted through the distribution of valid and reliable instruments after obtaining formal consent from the authors. A formal consent from a 670-bed tertiary hospital's head was taken to conduct the study from Avicenna Medical Hospital, Lahore (Pakistan). The final total sample resulted in 129 respondents. Two main administrative personnel's appointment was taken and questionnaires were distributed to them. Initially, 254 doctors and nurses were reached through purposive sampling from which 24 remained work engaged, 12 were on medical training leave and 7 were reported to have not worked during smog season. The response rate constituted to 83%. According to G Power (see Figure 1) analysis, a minimum sample size of 198 is sufficient to produce meaningful results with two sample groups within biomedical sciences (Faul et al. 2007) See Appendix 1. Respondents were asked to rate the survey who freshly worked through the smog season. The paper questionnaires were collected and coded in SPSS v.25. AMOS analysis was opted for structural equation modeling.

The inclusion criteria reported only those nursing and doctor personnel proficient in the English Language. English is the official language of Pakistan and medical staff work in white white-collar tertiary sector, educated and trained in the English Language. The professionals who continuously worked through the smog season; whereby air is heavily laden with the carbon-generated mixture of smoke and mist (Hussain et al. 2024), beginning in November 2023 and lasting till the first week of February 2024.

The Pearson product-moment correlation was conducted for normalized distributed variables for associated relationships. Confirmatory factor analysis (CFA) was conducted to validate cause and effect. The structural equation modeling (SEM) was fitted for the sample variances and covariance. Data showed normal distributions and was followed by generalized least square and maximum likelihood parameters. Chi-square and degree of freedom signified model fitness. A predictive matrix was formed using normed fit, relative fit, and incremental fit. Tucker-Lewis coefficient, comparative fit index, and goodness-of-fit indices with root mean square error of approximation. NFI, RFL, IFI, TLI, and CFA greater than .85 values are considered adequate. RMSEA values of less than .08 were considered moderately adequate whilst less than .03 was considered perfect (Hair et al. 2021).

For path analysis, structural equation modeling (SEM) was used. Similarly, mediation was calculated using estimated bootstrap standard errors and bootstrap confidence. Independent sample t-tests were used to compare means for groups of doctors and nurses on three constructs.

VII. Hypotheses

Our hypotheses are as follows:

H1: There is a significant association among climate anxiety, cognitive failures, pain, and distress.

H2: Climate anxiety, pain, and distress have a significant effect on cognitive failure.

H3: Climate anxiety mediates significantly between pain, distress, and cognitive failure.

H4: The groups of nurses and doctors show significant mean differences for pain, dress, cognitive failures, and climate anxiety.

VIII. Instruments

Pain and Distress Scale by Zung (Zung 1983)

The scale consists of 20 items and is scored from 1 (none) of the time to (4) most or all of the time. Cronbach alpha is .89.

Risk of Cognitive Failure (Broadbent et al. 1982)

The scale consists of 25 items on a 4-point Likert scale, from 0 (never) to 4 (very often). Cronbach alpha is .71.

Climate Anxiety by (Clayton & Karazsia 2020)

The scale consists of 22 items on a 5-point Likert scale from 1 (never) to 5 (almost always). The scale has four subscales, cognitive-emotional impairment, functional impairment, personal experience of climate change, and behavioral engagement. Cronbach alpha is.84.

IX. Ethics

The study complies with all the ethical requirements described in the Helsinki Declaration and Resolution 8430, which establishes the norms for health research, according to which this study would be classified as without risk (Ministry of Health 1993, article 11). The official covering letter with the round stamp was taken from the Hospital X (name redacted, known to Editorial Team). All persons participated based on their free consent. Additionally, a protocol was established with risk minimization actions. This study complies with the research rules of the Psychology Department of Hazara University.

X. Results

	Frequency	Percent
Gender		
Female	138	65.4
Male	73	34.6
Age		
18–30	24	11.4
31–40	49	23.2
41–50	41	19.4
51–60	65	30.8
Above 60	31	15.6
Education		
CNS	20	9.5
BSN	66	31.3
MPH/MSN	28	13.3
BS MEDICINE	47	22.3
MD/MSPHIL/Specialization	41	19.4

Doctorate	9	4.3
Medical Staff		
Nurses	102	48.3
Doctors	109	51.7

Table 1: Demographics. Note: CNS = Certificate of Nursing (2years); BSN = Bachelors of nursing (4 years); MPH = Masters of Public Health; MSN = Masters of Nursing; BS Medicine = MBBS or Bachelors of Medicine (5 years).

Variables	***K***	***α***	***M(SD)***	***Skewness***	***Kurtosis***
Cognitive Failure	25	.933	68.24(14.23)	-.545	-1.170
Pain and Distress	18	.589	50.81(4.09)	.-313	1.771
Climate Anxiety	22	.788	77.98(10.24)	.167	-.634
Cognitive-Emotional Impairment	8	.667	29.75(3.28)	-.855	1.409
Functional Impairment	5	.720	18.17(2.61)	-.346	.326
Personal Impairment	3	.796	11.01(2.09)	-.313	-.755
Behavioral Impairment	6	.799	19.04(5.62)	-.234	-1.46

Table 2: Psychometric Properties. K = no. of item; α = Cronbach alpha.

Variables	**1**	**2**	**3**	**4**	**5**	**6**	**7**
1. Cognitive Failure	-	.789**	.512**	.516**	.386**	.376**	.816**
2. Climate Anxiety		-	.512**	.708**	.593**	.630**	.897**
3. Pain and Distress			-	.364**	.277**	.326**	.470**
4. Cognitive Emotional Impairment				-	.231**	.369**	.460**
5. Functional Impairment					-	.193**	.408**
6. Personal impairment						-	.470**
7. Behavioral Impairment							-

*Table 3: Correlation Table; p < .-01**; p < .05*.*

The CFA analysis conducted prior to testing SEM model:

Goodness-of-fit indices	*χ2 /df*	*χ2 /df*	*GFI*	*P*	*AGFI*	*CFI*	*IFI*	*RMSEA*
Model	2020/840	2.40	.738	.000	.713	.750	.753	.071

Table 4: Confirmatory Factor Analysis / Goodness of Fit-Indices.

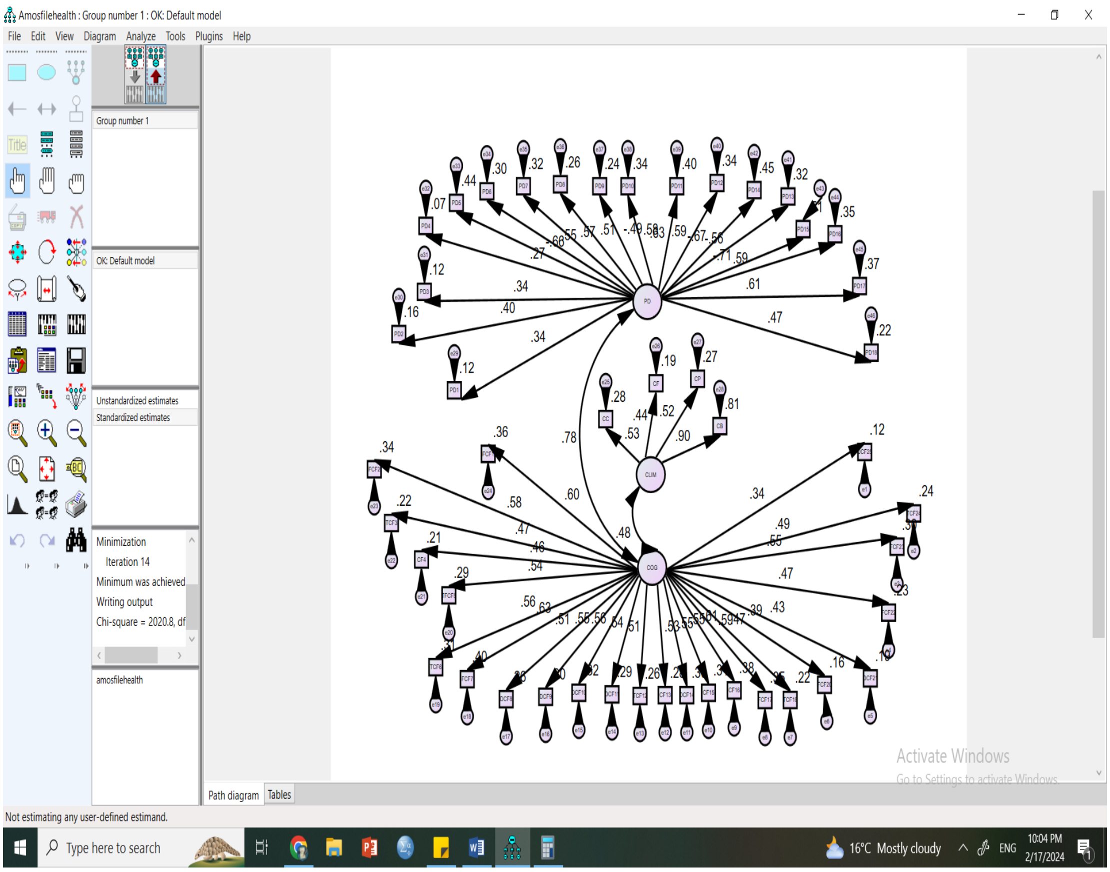

Figure 1: Factor Loadings.

Source variable			**Estimate**	***S.E.***	***C.R.***	***P***
CF25	<---	COFGTO	1.000			
CF24	<---	COFGTO	1.381	.327	4.218	***
CF23	<---	COFGTO	1.539	.350	4.397	***
CF22	<---	COFGTO	1.395	.334	4.178	***
CF21	<---	COFGTO	1.315	.327	4.023	***
CF20	<---	COFGTO	1.136	.295	3.847	***
CF18	<---	COFGTO	1.517	.364	4.166	***
CF17	<---	COFGTO	1.919	.425	4.518	***
CF16	<---	COFGTO	1.751	.384	4.559	***
CF15	<---	COFGTO	1.747	.395	4.421	***
CF14	<---	COFGTO	1.485	.337	4.405	***
CF13	<---	COFGTO	1.721	.396	4.342	***
CF12	<---	COFGTO	1.719	.399	4.305	***
CF11	<---	COFGTO	1.681	.384	4.376	***

Source variable			Estimate	S.E.	C.R.	P
CF10	<---	COFGTO	1.673	.376	4.445	***
CF9	<---	COFGTO	1.753	.397	4.410	***
CF8	<---	COFGTO	1.546	.360	4.289	***
CF7	<---	COFGTO	2.149	.468	4.594	***
CF6	<---	COFGTO	1.791	.404	4.429	***
CF5	<---	COFGTO	1.642	.375	4.382	***
CF4	<---	COFGTO	1.262	.307	4.109	***
CF3	<---	COFGTO	1.235	.297	4.164	***
CF2	<---	COFGTO	1.818	.406	4.482	***
CF1	<---	COFGTO	2.038	.450	4.527	***
CC	<---	CLIM	1.000			
CLF	<---	CLIM	.657	.128	5.149	***
CP	<---	CLIM	.622	.107	5.807	***
PD2	<---	PD	1.004	.260	3.864	***
PD3	<---	PD	.879	.247	3.559	***
PD4	<---	PD	.762	.246	3.095	.002
PD5	<---	PD	-2.120	.455	-4.658	***
PD6	<---	PD	1.463	.333	4.393	***
PD7	<---	PD	1.402	.315	4.454	***
PD8	<---	PD	1.241	.290	4.285	***
PD9	<---	PD	-1.480	.351	-4.210	***
PD10	<---	PD	1.661	.370	4.493	***
PD11	<---	PD	1.597	.348	4.592	***
PD12	<---	PD	1.555	.346	4.496	***
PD13	<---	PD	-1.750	.394	-4.441	***
PD14	<---	PD	-2.135	.457	-4.673	***
PD15	<---	PD	-2.422	.511	-4.737	***
PD16	<---	PD	1.628	.360	4.517	***
PD17	<---	PD	1.471	.324	4.542	***
PD18	<---	PD	1.134	.274	4.146	***
PD1	<---	PD	1.000			
CB	<---	CLIM	2.888	.410	7.050	***

*Table 5: Analysis of Estimated Parameters Significance. Note: SE = standard error; CR = Composite Reliability; p = ***<.0001 = level of significance. Items CF = cognitive failure; PD = Pain and Distress; CC = Cognitive Emotional Impairment; CLF = Functional Impairment; CP = Personal Impairment, CB = Behavioral Impairment.*

			Estimate	S.E.	C.R.	P
Climate Anxiety	<---	Pain and Distress	1.283	.148	8.648	***
Cognitive Failure	<---	Pain and Distress	.507	.168	3.014	.003
Cognitive Failure	<---	Climate Anxiety	.993	.067	14.784	***

Table 5a: Regression weights.

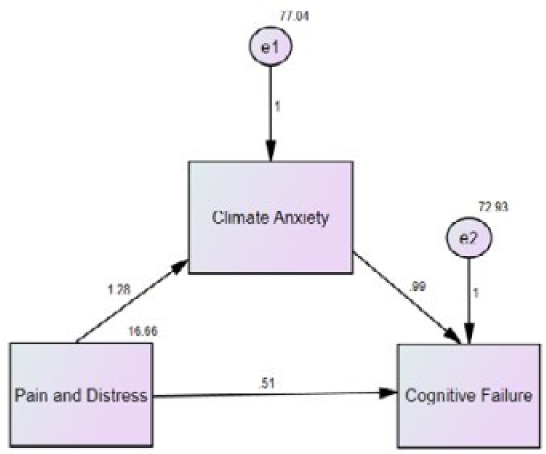

Figure 2: Path Analysis.

Hypothesis	Direct Effects	Indirect Effects	Total Effects	Remarks
H2	1.28**	3.66***	.512***	Climate Anxiety, Pain and Distress have a significant effect on cognitive failure
H3	.507***	.366***	.993***	Climate Anxiety significantly mediates between Pain, Distress, and Cognitive Failure

Table 6: Mediation analysis.

	Nurses (n=102)		Doctors (n=109)					95% CI		
Variables	M	SD	M	SD	t	df	p	LL	UL	Cohen's *d*
Pain and Distress	52.22	2.49	49.95	4.80	5.127	209	.000	1.68	3.79	.5936
Cognitive Failure	78.89	4.55	58.28	12.94	15.227	209	.000	17.9	23.2	.2123
Cognitive emotional impairment	31.06	2.44	28.52	3.50	6.081	209	.001	1.72	3.37	.8419
Functional impairment	19.03	2.24	17.36	2.68	4.895	209	.000	.998	2.35	.6761
Personal impairment	11.77	1.90	10.30	2.02	5.431	209	.000	.938	2.00	.7496
Behavioral impairment	23.33	2.43	15.01	4.73	15.903	209	.000	7.28	9.34	.2124

Climate anxiety	85.21	4.94	71.21	9.25	13.582	209	.000	11.97	16.03	.1898
Pain and	52.22	2.49	49.95	4.80	5.127	209	.000	1.68	3.79	.5936

Table 7: Independent samples t-test for groups. P = Significance Level; CI = Confidence Interval; LL = Lower Limit; UL = Upper Limit; M = Mean; SD = Standard Deviation; df = degree of freedom.

XI. Discussion

Table 1 enlists the demographic characteristics of the study. Followed by Table 2, shows psychometric properties and scale reliability coefficients for the three constructs for the normalized distributed data. In Table 3, robust highly significant correlations are reported for cognitive failure, pain and distress, climate anxiety subscales of cognitive impairment, functional impairment, personal impairment, and behavioral impairment. There is a strong significant positive correlation of cognitive failure with climate anxiety (r = .789; $p < .01$), pain and distress (r = .512; $p < .01$), and cognitive-emotional impairment (r = .516; p <. 01). Moderately strong positive association of cognitive failure with functional impairment (r = .376; $p < .01$). Strongest positive and significant association of cognitive failure with behavioral impairment (r = .86; p < .01). Consistent with the Norman Action Theory that there is increase in human error with execution of plans are unanticipated. It is important to understand if this feature leads to a compromise of ethics attributed to climate change in the medical field. Impairment in physiological and psychological facets occurs through smog, especially in cognition (Yao et al. 2023). Climate anxiety paired with pain and distress further increases the risk of cognitive failure. Climate anxiety also mediates pain distress and cognitive failure. As nurses and doctors commute to work through the polluted atmosphere are at a higher risk of incidental lung cancer if exposed to smog in the long term (Puett et al. 2014; Pun et al. 2015).

According to independent t-tests, nurses face greater distress and climate anxiety as confirmed by an observational cohort study (Power et al. 2015). Supported by the findings, there is a need to incorporate a satisfactory indoor environment for healthcare workers as they are faced with crucial circumstances outdoors (Shen et al. 2023).

Confirmatory factor analysis was conducted before testing the regression path analysis to test mediation. The diagram in Figure 1 shows almost all of the factor loadings greater than .03 as statistically fit (JR 1963) (Tavakol & Wetzel 2020).

According to Baron and Kenny (Baron & Kenny 1986), the classical approach of mediation analysis is used to test causal models (Kim et al. 2001). Preventive measures and awareness of precautions related to precision intervention are important to protect citizens from the toxic impact of smog. Hybrid and green technology-embedded vehicles must be incorporated into the infrastructure of Pakistan (Sajjad et al. 2020). Smog alert systems are lacking in hospitals that can navigate air quality (Elsom 1996).

In a multiple cohort study, cognition tests were administered to investigate the impact of seasons (Lim et al. 2019). Cognitive function was reported to be higher with a difference of increase in 4.8 years of life in the clear summer season as compared to mild cognitive impairment in polluted regions. However, there is a lack of studies in investigating cognitive failure due to smog by healthcare professionals.

Cognitive function along with physiological factors of bodily distress takes place due to seasonality and air pollution but must be supported by temperature and hazardous pollutant-induced weather effects (Kent et al. 2009). Smog causes cold temperatures, yet a lack of studies poses the generalizability of results. Studies about colder seasons report that colder temperatures worsen mood and cognitive function can exacerbate confusion and bewilderment and impair manual dexterity (Sun et al. 2022). Smog is the most detrimental to the age group of young children up to 18 years of age in a study conducted in the Republic of Sakha, Russia (Narita et al. 2021).

There are mixed results on the winter and summer seasons' effect on reaction times, memory, physiological processes, vigilance, and reasoning (Dai et al. 2016). In an observational study in Germany, smog caused devastating pressures causing cardiovascular diseases (Wichmann et al. 1989). In North America, smog was the main reason for increased admissions to cardiac units (Schwartz & Morris 1995). London was once targeted by smog that led to hazardous health risk concerns of high pneumonia deaths but was combated timely (Knox 2008). Towards the eastern regions, Delhi faces photochemical smog that leads to murky cloud occurrence (Sehrawat & Chauhan 2023). Urgent actions have been taken by China, as a study suggested that smog particles destroy the alveolar wall and weaken the lungs (Xing et al. 2016). If nations do not have autonomy for dealing with climatic affairs, resources about climate action and multi-level coordination backed by potential stakeholders can lead to worsened climatic conditions (Efimova & Rukavishnikov 2021).

Participation sensing strategies are recommended as an intervention in which citizens are allowed to interact related to information dissemination regarding air pollutants. The strategy empowers citizens to use sensors such as GPS and motion sensors to collect data related to traffic and health. Participatory sensing projects are absent in the region of study and must be added with increased popularity in recent years (Aoki et al. 2008; Mendez et al. 2018; Rebeiro-Hargrave 2021). Using sensors can motivate citizens to spread awareness of the health adverse effects of air pollution. Yet citizen sensing projects are challenging (Jordan et al. 2011). Implementation of a carbon footprint can help citizens realize the amount of carbon dioxide that a person is liable for to be curtailed at the personal level. If the carbon tax is levied can also reinforce behavior that adds to the pollutants. Tree plantation and upscale the efforts in air pollution minimization. Sequestration can also aid as a combat process (Sedjo et al. 2012).

The projects that are powered by renewable energy must be used. In a recent study, to lower CO2 emissions, it is important to rely on wind renewable energy which is a high efficiency demand side measure that is not common in Pakistan. Currently, reliance on solar power is imminent in Pakistan however as speculated by 2050, this form of renewable energy will not be sufficient to reduce the harmful impact of emissions. The best method is the effective use of nuclear energy as presently the country owns five nuclear power generation stations. As compared with renewables (e.g., hydropower = 39.1%; wind = 34.8%; solar = 24.5%; nuclear power plants have the highest capacity factor of over 80% (Qudrat-Ullah 2022). Furthermore, effective methods include processes of thermochemical and photochemical nature (Trashko et al. 2022). To boost a sustainable environment, the reduction of carbon dioxide emissions is incumbent (Goeppert et al. 2014).

References

Aoki P. M., Honicky R. J., Mainwaring A., Myers C., Paulos E., Subramanian S., & Woodruff A. 2008. "Common Sense: Mobile Environmental Sensing Platforms to Support Community Action and Citizen Science," *Proceedings of UBICOMP 2008 Adjunct Program* (pp. 59–60). Seoul.

Baron R. M. & Kenny D. A. 1986. "The Moderator-Mediator Variable Distinction in Social Psychological Research: Conceptual, Strategic, and Statistical Considerations," *Journal of Personality and Social Psychology* 51(6):1173–1182.

Boyd C., Parr H., & Philo C. 2023. "Climate Anxiety as Posthuman Knowledge," *Wellbeing, Space and Society* 4, article no. 100120. https://doi.org/10.1016/j.wss.2022.100120

Broadbent D. E., Cooper P. F., FitzGerald P., & Parkes K. R. 1982. "The Cognitive Failures Questionnaire (CFQ) and Its Correlates," *British Journal of Clinical Psychology* 21(1):1–16. https://doi.org/10.1111/j.2044-8260.1982.tb01421.x

Bingley W. J., Tran A., Boyd C. P., Gibson K., Kalokerinos E. K., Koval P., Kashima Y., McDonald D., & Greenaway K. H. 2022. "A Multiple Needs Framework for Climate Change Anxiety Interventions," *American Psychologist* 77(7):812–821. https://doi.org/10.1037/amp0001012

Cao C., Jiang W., Wang B., Fang J., Lang J., Tian G., Jiang J., & Zhu T. 2014. "Inhalable Microorganisms in Beijing's PM2.5 and PM10 Pollutants during a Severe Smog Event," *Environmental Science & Technology* 48:1499–1507. https://doi.org/10.1021/es4048472

Chen S., Kong J., Yu F., & Peng K. 2018. "Psychopathological Symptoms under Smog: The Role of Emotion Regulation," *Frontiers in Psychology* 8, article no. 2274. https://doi.org/10.3389/fpsyg.2017.02274

Chen J. C. & Schwartz J. 2009. "Neurobehavioral Effects of Ambient Air Pollution on Cognitive Performance in US Adults," *Neurotoxicology* 30:231–239. https://doi.org/10.1016/j.neuro.2008.12.011

Clayton S. & Karazsia B. T. 2020. "Development and Validation of a Measure of Climate Change Anxiety," *Journal of Environmental Psychology* 69, article no. 101434. https://doi.org/10.1016/j.jenvp.2020.101434

Coffey Y., Bhullar N., Durkin J., Islam M. S., & Usher K. 2021. "Understanding Eco-Anxiety: A Systematic Scoping Review of Current Literature and Identified Knowledge Gaps," *The Journal of Climate Change and Health* 3, article no. 100047. https://doi.org/10.1016/j.joclim.2021.100047

Dai L., Kloog I., Coull B. A., Sparrow D., Spiro III A., Vokonas P. S., & Schwartz J. D. 2016. "Cognitive Function and Short-Term Exposure to Residential Air Temperature: A Repeated Measures Study Based on Spatiotemporal Estimates of Temperature," *Environmental Research* 150:446–451. https://doi.org/10.1016/j.envres.2016.06.036

Efimova N. V. & Rukavishnikov V. S. 2021. "Assessment of Smoke Pollution Caused by Wildfires in the Baikal Region (Russia)," *Atmosphere* 12(12), article no. 1542. https://doi.org/10.3390/atmos12121542

Elsom D. 1996. *Smog Alert: Managing Urban Air Quality.* London: Routledge. https://doi.org/10.4324/9781315070469

Faul F., Erdfelder E., Lang A. G., & Buchner A. 2007. "G* Power 3: A Flexible Statistical Power Analysis Program for the Social, Behavioral, and Biomedical Sciences," *Behavior Research Methods* 39(2):175–191. https://doi.org/10.3758/BF03193146

Goeppert A., Czaun M., Jones J. P., Prakash G. S., & Olah G. A. 2014. "Recycling of Carbon Dioxide to Methanol and Derived Products – Closing the Loop," *Chemical Society Reviews* 43(23):7995–8048. https://doi.org/10.1039/C4CS00122B

Gorchakov G. I., Karpov A. V., Gorchakova I. A., Gushchin R. A., & Datsenko O. I. 2019. "Smog and Smoke Haze over the North China Plain in June 2007," *Atmospheric and Oceanic Optics* 32:643–649. https://doi.org/10.1134/S102485601906006X

Grzywa-Celińska A., Krusiński A., & Milanowski J. 2020. "'Smoging Kills' – Effects of Air Pollution on Human Respiratory System," *Annals of Agricultural and Environmental Medicine* 27(1):1–5. https://doi.org.10.26444/AAEM/110477

Hardy J. D. 1956. "The Nature of Pain," *Journal of Chronic Diseases* 4(1):22–51. https://doi.org/10.1016/0021-9681(56)90005-4

Hair Jr J. F., Hult G. T. M., Ringle C. M., Sarstedt M., Danks N. P., & Ray S. 2021. An Introduction *to Partial Least Squares Structural Equation Modeling (PLS-SEM) Using R*: *A Workbook. a Workbook* (pp. 1–29). Springer.

Hines S. E., Brown C., Oliver M., Gucer P., Frisch M., Hogan R., ... & McDiarmid M. 2019. "User Acceptance of Reusable Respirators in Health Care," *American Journal of Infection Control* 47(6):648–655. https://doi.org/10.1016/j.ajic.2018.11.021

Hussain N., Khan B. N., Bashir A., Ali R. M., Mukhtar M. T., & Awan E. A. 2024. "Public Awareness and Behavioral Patterns During Smog: Public Awareness During Smog," *Pakistan BioMedical Journal* 07(2):45–50. https://doi.org/10.54393/pbmj.v7i02.1043

Janarthanan R. P., Partheeban K. Somasundaram, & Navin Elamparithi P. 2021. "A Deep Learning Approach for Prediction of Air Quality Index in a Metropolitan City," *Sustainable Cities and Society* 67: article no. 102720. https://doi.org/10.1016/j.scs.2021.102720

Iannetti G., Salomons T., Moayedi M., Mouraux A., & Davis K. 2013. "Beyond Metaphor: Contrasting Mechanisms of Social and Physical Pain," *Trends in Cognitive Sciences* 17:371–378. https://doi.org/10.1016/j.tics.2013.06.002

Jordan R. C., Gray S. A., Howe D. V., Brooks W. R., & Ehrenfeld J. G. 2011. "Knowledge Gain and Behavioral Change in Citizen-Science Programs," *Conservation Biology* 25(6):1148–1154. https://doi.org/10.1111/j.1523-1739.2011.01745.x

Kent S. T., McClure L. A., Crosson W. L., Arnett D. K., Wadley V. G., & Sathiakumar N. 2009. "Effect of Sunlight Exposure on Cognitive Function among Depressed and Non-depressed Participants: A REGARDS Cross-sectional Study," *Environmental Health* 8(1):1–14. https://doi.org/10.1186/1476-069X-8-34

Kotcher J., Maibach E., Miller J., Campbell E., Alqodmani L., Maiero M., & Wyns A. 2021. "Views of Health Professionals on Climate Change and Health: A Multinational Survey Study," *The Lancet Planetary Health* 5(5), e316-e323. https://doi.org/10.1016/S2542-5196(21)00053-X

Kuvadia M., Cummis C. E., Liguori G., & Wu C. L. 2020. "'Green-gional' Anesthesia: The Non-Polluting Benefits of Regional Anesthesia to Decrease Greenhouse Gases and Attenuate Climate Change," *Regional Anesthesia and Pain Medicine* 45(9):744–745. https://doi.org/10.52211/asra050123.006

Knox E. 2008. "Atmospheric Pollutants and Mortalities in English Local Authority Areas," *Journal of Epidemiology & Community Health* 62:442–447. https://doi.org/10.1136/jech.2007.065862

Kim J. S., Kaye J., & Wright L. K. 2001. "Moderating and Mediating Effects in Causal Models," *Issues in Mental Health Nursing* 22(1):63–75. https://doi.org/10.1080/01612840121087

Lavie N. 1995. "Perceptual Load as a Necessary Condition for Selective Attention," *Journal of Experimental Psychology: Human Perception and Performance* 21(3):451–468. https://psycnet.apa.org/doi/10.1037/0096-1523.21.3.451

Lim A. S. P., Gaiteri C., Yu L., Sohail S., Swardfager W., Tasaki S., & Black S. E. 2018. "Seasonal Plasticity of Cognition and Related Biological Measures in Adults with and without Alzheimer Disease: Analysis of Multiple Cohorts," *PLoS Med.* 15, e1002647. https://doi.org/10.1371/journal.pmed.1002647

Ma S., Cheng H., Li J., Xu M., Liu D., & Ostrikov K. 2020. "Large-scale Ion Generation for Precipitation of Atmospheric Aerosols," *Atmospheric Chemistry and Physics* 20(20):11717–11727. https://doi.org/10.5194/acp-2020-23

Malcherek-Łabiak J., Olszewska A., & Sobków A. 2018. „W jaki sposób komunikować ryzyko związane ze smogiem? Wpływ formatu oraz treści komunikatu na percepcję ryzyka oraz działań zapobiegawczych," *Psychologia Ekonomiczna* 13:49–65. https://doi.org/10.15678/pjoep.2018.13.04

Mendez D., Colorado J., Rodriguez L., Chacon A., & Hernandez M. 2018. "Monitoring Air Pollution by Combining a Static Infrastructure with a Participatory Sensing Approach: Design and Performance Evaluation," *International Journal of Sustainable Development and Planning* 13(4):638–652.

Narita D., Gavrilyeva T., & Isaev A. 2021. "Impacts and Management of Forest Fires in the Republic of Sakha, Russia: A Local Perspective for a Global Problem," *Polar Science* 27, article no. 100573. https://doi.org/10.1016/j.polar.2020.100573

Norman D. A. 1981. "Categorization of Action Slips," *Psychological Review* 88(1):1–15. https://psycnet.apa.org/doi/10.1037/0033-295X.88.1.1

Newman M. G. & Llera S. J. 2011. "A Novel Theory of Experiential Avoidance in Generalized Anxiety Disorder: A Review and Synthesis of Research Supporting a Contrast Avoidance Model of Worry," *Clinical Psychology Review* 31(3):371–382. https://doi.org/10.1016/j.cpr.2011.01.008

Petty T. & Ashbaugh D. 1971. "The Adult Respiratory Distress Syndrome. Clinical Features, Factors Influencing Prognosis and Principles of Management," *Chest* 60(3):233–239. https://doi.org/10.1378/CHEST.60.3.233

Puett R. C., Hart J. E., Yanosky J. D., Spiegelman D., Wang M., Fisher J. A., ... & Laden F. 2014. "Particulate Matter Air Pollution Exposure, Distance to Road, and Incident Lung Cancer in the Nurses' Health Study Cohort," *Environmental Health Perspectives* 122(9):926–932. https://doi.org/10.1289/ehp.1307490

Pun V. C., Hart J. E., Kabrhel C., Camargo Jr C. A., Baccarelli A. A., & Laden F. 2015. "Prospective Study of Ambient Particulate Matter Exposure and Risk of Pulmonary Embolism in the Nurses' Health Study Cohort," *Environmental Health Perspectives* 123(12):1265–1270. https://doi.org/10.1289/ehp.1408927

Power M. C., Kioumourtzoglou M. A., Hart J. E., Okereke O. I., Laden F., & Weisskopf M. G. 2015. "The Relation between Past Exposure to Fine Particulate Air Pollution and Prevalent Anxiety: Observational Cohort Study," *BMJ* 350, article no. h1111. https://doi.org/10.1136/bmj.h1111

Qudrat-Ullah H. 2022. "A Review and Analysis of Renewable Energy Policies and CO2 Emissions of Pakistan," *Energy* 238, article no. 121849. https://doi.org/10.1016/j.energy.2021.121849

Rebeiro-Hargrave A., Fung P. L., Varjonen S., Huertas A., Sillanpää S., Luoma K., ... & Tarkoma S. 2021. "City Wide Participatory Sensing of Air Quality," *Frontiers in Environmental Science* 9, article no. 773778. https://doi.org/10.3389/fenvs.2021.773778

Royce J. R. 1963. "Factors as Theoretical Constructs," *American Psychologist 18*(8):522–528. https://doi.org/10.1037/h0044493

Sajjad A., Chu J., Anwar M., & Asmi F. 2020. "Between Green and Gray: Smog Risk and Rationale Behind Vehicle Switching," *Journal of Cleaner Production* 244, article no. 118674. https://doi.org/10.1016/j.jclepro.2019.118674

Schwela D. H. & Haq G. 2020. "Strengths and Weaknesses of the WHO Urban Air Pollutant Database," *Aerosol and Air Quality Research* 20(5):1026–1037. https://doi.org/10.4209/aaqr.2019.11.0605

Schwartz J. & Morris R. 1995. "Air Pollution and Hospital Admissions for Cardiovascular Disease in Detroit, Michigan," *American Journal of Epidemiology* 142(1):25–35.

Schwartz J. 1994. "Air Pollution and Daily Mortality: A Review and Meta-Analysis," *Environmental Research* 64(1):36–52. https://doi.org/10.1006/ENRS.1994.1005

Sedjo R. & Sohngen B. 2012. "Carbon Sequestration in Forests and Soils," *Annual Review of Resource Economics* 4(1):127–144. http://dx.doi.org/10.1146/annurev-resource-083110-115941

Sehrawat N. & Chauhan R. 2023. "Investigatory Studies on Pattern in Enhancement in Fine Particulate Matter in the Delhi During Einters," *International Journal of Pharmaceutical and Bio-Medical Science* 3(3):98–101. https://doi.org/10.47191/ijpbms/v3-i3-02

Shabbir M., Junaid A., & Zahid J. 2019. "A Snapshot of Smog in India and Pakistan," *Sustainable Development Policy Institute SDPI*, Policy Brief 67. Available online at: https://sdpi.org/sdpiweb/publications/files/smog-atransboundary-issue-and-its-implications-in-India-and-Pakistan(PB-67).pdf

Shaparev N., Tokarev A., & Yakubailik O. 2020. "The State of the Atmosphere in the City of Krasnoyarsk (Russia) in Indicators of Sustainable Development," *International Journal of Sustainable Development & World Ecology* 27(4):349–357. https://doi.org/10.1080/13504509.2019.1699879

Shen X., Zhang H., Li Y., Qu K., Zhao L., Kong G., & Jia W. 2023. "Building a Satisfactory Indoor Environment for Healthcare Facility Occupants: A Literature Review," *Building and Environment* 228, article no. 109861. https://doi.org/10.1016/j.buildenv.2022.109861

Sun B., Wu J., Hu Z., Wang R., Gao F., & Hu X. 2022. "Human Mood and Cognitive Function After Different Extreme Cold Exposure," *International Journal of Industrial Ergonomics* 91, article no. 103336. https://doi.org/10.1016/j.ergon.2022.103336

Swee M. B., Hudson C. C., & Heimberg R. G. 2021. "Examining the Relationship between Shame and Social Anxiety Disorder: A Systematic Review," *Clinical Psychology Review* 90, article no. 102088. https://doi.org/10.1016/j.cpr.2021.102088

Tavakol M. & Wetzel A. 2020. "Factor Analysis: A Means for Theory and Instrument Development in Support of Construct Validity," *International Journal of Medical Education* 11, article no. 245. https://doi.org/10.5116%2Fijme.5f96.0f4a

Tesser A. & Schwarz N. (Eds.) 2008. *Blackwell Handbook of Social Psychology: Intraindividual Processes*. Oxford, UK: John Wiley & Sons.

Tokarev A. & Shaparev N. 2020. "The Influence of Weather Conditions on the Concentration of PM2.5 in the Surface Layer of the Atmosphere of Krasnoyarsk," *Atmospheric Physics* 11560:606–610. *Proceedings of 26th International Symposium on Atmospheric and Ocean Optics.* https://doi.org/10.1117/12.2573837

Trashko M. D., Volkova E. A., Muratchaev S. S., Gorelik A. V., & Solodkov A. V. 2022. "Development of an Environmental Monitoring System for Predicting and Preventing Photochemical Smog," in *Conference of Russian Young Researchers in Electrical and Electronic Engineering 2022 (ElConRus)* (pp. 1624–1627), IEEE.

Ware L. & Matthay M. 1996. "The Acute Respiratory Distress Syndrome," *The New England Journal of Medicine* 342(18):1334–1349. https://doi.org/10.1056/NEJM200005043421806

Windfeld E. S. & Brooks M. S. L. 2015. "Medical Waste Management – A Review," *Journal of Environmental Management* 163:98–108. https://doi.org/10.1016/j.jenvman.2015.08.013

Wichmann H., Mueller W., Allhoff P., Beckmann M., Bocter N., Csicsaky M., Jung M., Molik B., & Schoeneberg G. 1989. "Health Effects During a Smog Episode in West Germany in 1985," *Environmental Health Perspectives* 79:89–99. https://doi.org/10.1289/EHP.897989

Wong T. 2017. "Smog Induces Oxidative Stress and Microbiota Disruption," *Journal of Food and Drug Analysis* 25:235–244. https://doi.org/10.1016/j.jfda.2017.02.003

Wu Y. 2023. "Urban Smog in the Process of Industrialization-Take Xi'an, China, for Example," *Revista Internacional de Contaminación Ambiental* 38:13–19.

Xing Y., Xu Y., Shi M., & Lian Y. 2016. "The Impact of PM2.5 on the Human Respiratory System," *Journal of Thoracic Disease* 8(1):E69–E74. https://doi.org/10.3978/j.issn.2072-1439.2016.01.19

Yao H., Peng Z., & Sha X. 2023. "Association between Cognitive Function and Dusty Weather: A Propensity Score Matching Study," *BMC Geriatrics* 23(1), article no. 777. https://doi.org/10.1186/s12877-023-04466-0

Zung W. W. 1983. "A Self-Rating Pain and Distress Scale," *Psychosomatics* 24(10):887–894. https://doi.org/10.1016/S0033-3182(83)73140-3