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CRISPR-Cas9: Revolutionizing Gene Therapy for Genetic Disorders

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Faulty or mutated genes cause multiple human disorders such as cancer, neurogenerative disorders, and cardiovascular diseases. These mutations in genes are usually inherited. Many treatments have been established to cure such diseases, but gene therapy is the most promising strategy. It's an application of biotechnology that is based on correcting and replacing the mutated gene with the healthy gene, providing the genes for the proper expression of desired proteins required for curing the disease. In clinical settings, gene therapy has proved itself as a very promising treatment but has some drawbacks. Traditionally, these methods involved viral vectors that are used to deliver correct genes and replace them with the mutated genes, in patients. These approaches have somehow potential to cure diseases but often off-target effects, limitations in the editing process, and immune responses caused by patients' immune systems are the main challenges that are the main shortcomings of this method. However, the discovery of the clustered regularly interspaced short palindromic repeats (CRISPR) and CRISPR-associated nuclease protein 9 (Cas9) genome editing system (CRISPR/Cas9) in 2012 and its development have increased the value of gene therapy in the therapeutic world [1]. CRISPR/Cas9 is a revolutionizing tool that has been in gene therapy for knocking in and out gene to correct the mutation associated with many genetic diseases. This system has evolved greatly and has many isomers using different strategies to improve both applied, basic research and its clinical application.

The ability of CRISPR-Cas9 to target various genetic diseases is one of its greatest advantages. Mutation in single gene results in monogenic diseases such as cystic fibrosis, muscular dystrophy, and sickle cell anemia, and this system has shown the potential to edit or fix the defective genes, causing these diseases. Even in the case of complex disorders caused by the mutation in multiple genes such as several types of cancer, and cardiovascular diseases, CRISPR has shown very positive results.

The application of CRISPR-Cas9 in gene therapy is very promising and has tremendous potential to give cures for many complex disorders. The ethical issue regarding the editing of human DNA and the inheritance of modified DNA into the next generation is still under discussion and causing hurdles in uncovering the full potential of this system. Researchers are working to increase its efficiency and specificity to reduce the off-target sequences so that only targeted modification can be achieved. Moreover, they are trying to give possible results to reduce ethical concerns.

CRISPR has evolved greatly and has many isomers using different strategies to improve both applied, basic research and its clinical application in the future.

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Original Article

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Knowledge and Attitude Regarding Needle Stick Injury among Undergraduate Nursing Students

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ABSTRACT

Needle stick injuries pose a significant risk to undergraduate nursing students, potentially exposing them to serious infections. Understanding their knowledge and attitudes towards needle stick injury prevention is essential for enhancing safety protocols and education. **Objective:** To assess the level of knowledge and attitudes of nursing students regarding needle stick injuries. **Methods:** A cross-sectional study design was used to assess the knowledge and attitudes of undergraduate nursing students regarding needle stick injury. This study was conducted among 145 undergraduate nursing students at a private institute in Karachi Pakistan were included which was assessed by an online survey. **Results:** The students show a good knowledge score with a mean of 5.724 (SD=1.45). The range of accurate answers to each question ranges from 21.4% to 89.7%. 62.1% (n=90) show good knowledge. The students had a positive attitude toward needle stick injuries with a mean of 19.66 and SD=3.16. The students showed a positive attitude regarding needle stick injuries was 64.2% (n=93). **Conclusions:** It was concluded that students show good knowledge and a positive attitude towards needle stick injury. According to this study after performing nursing interventions recap of the syringe is recommended to decrease the risk of needle stick injury remains challenging, but overall knowledge was good and positive attitude of the students towards needle stick injury.

INTRODUCTION

Majority of the nursing students encounter certain side effects/challenges during clinical or training sites that compromise their safety or the safety of the client. One main challenge nursing students face is needle stick injury [1]. A penetrating/cut wound in the skin caused by a needle or sharp instrument in a healthcare setting is called a needle stick injury (NSI) [2]. NSIs are far more common in underdeveloped nations. In Pakistan, India, Nepal, and Nigeria, the yearly incidence of NSIs is typically more than 50% [3]. In India, the overall prevalence of needle stick injury among nursing college students was 16%. The majority of the students were aware of universal precaution guidelines, and 57% of students were aware of the diseases transmitted by NSI [4]. Globally the prevalence of NSIs reported among nursing students, the prevalence of NSI has ranged from 8.7 to 71% [5]. The frequency of NSIs among nursing students in Asia remains high. Approximately 60% of nursing students in China report experiencing at least one NSI while completing their clinical rotations [6]. The Italian Study on Human Immunodeficiency Virus (HIV) Occupational Risk stated that injuries due to occupational exposure to biological risks are the most common type of injury for healthcare workers, including both trainees and nursing students, and account for 41% of the total number of notifications. It is noted that two-thirds of these are related to needle stick injuries [7]. NSIs are a major problem for nursing students, like other healthcare providers, nursing students are not protected from sharp injuries because of their lack of knowledge and experience [8]. Pathogens such as HIV, Hepatitis B and C with post-exposure transmission rates of 0.4%, 30%, and 5–10, respectively, may be present in

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individuals harmed by contaminated needle exposure [1]. The majority of the students have poor knowledge about safe injection techniques and NSIs, and they also engage in unsafe practices [9]. Nursing students must be taught about the details of NSI and how to prevent its effects. Literature is scarce on NSIs, especially with nursing students from developing countries like Pakistan [10]. The student nurses of Oman show the average score for all knowledge was 6.6 out of 10 (SD=2.1) and 18.2% (n=32) of the students sustained injuries from needle sticks, they reported that recapping needles was the primary cause of NSI (59%, n=19) [11].

The study aims to uncover knowledge gaps and attitudes that may increase the risk of NSIs by assessing these students' existing knowledge and attitudes. The study's ultimate goal is to improve nursing students' safety in clinical settings by encouraging improved preventive measures and a more knowledgeable and cautious handling of needles and sharp instruments.

METHODS

A descriptive cross-sectional study was conducted at a private nursing institute in Karachi Pakistan among undergraduate nursing students. All the enrolled nursing students were approached, while passed out students and those who didn't respond to the online survey or who gave incomplete information were excluded from the study. The simple random sampling technique was utilized for the study and sample size was calculated by OpenEpi by taking a 14.1% prevalence of NSI from the previous study [1] 95% confidence level and 5% confidence limit. The calculated sample size was n=145 by specifying the population of 600. Open accessed, structured and validated tools were used for assessing the knowledge and attitude of undergraduate nursing students [1]. The questionnaire consists of 12 questions, and consists of two parts, in the part first researcher asked for demographic data like gender, study year, and previous knowledge of NSI, and the second part had seven knowledge questions related to general knowledge of NSI, just like definitions of NSI, information about blood-borne diseases, and maximum capacity of sharps containers. Each question had two choices. The incorrect answer was worth 0; the correct answer was worth 1, the knowledge levels have been categorized into three tiers, namely poor, fair, and good. Therefore, percentage ranges less than 50% indicated poor knowledge, 50-75% represented fair knowledge, and greater than 75% signified good knowledge. The second section consisted of five statements about attitudes toward NSI. Responses fell between 1 and 5, using a Likert-type scale with five points: "Strongly Agree 5," to "Strongly Disagree 1"). Classifying into three attitude levels based on score ranges: a score of 12 or less indicated poor attitude, scores from 13 to 18 represented fair attitude, and scores from 19 to 25 signified good attitude. After the approval was held from the ethical review committee at the Institute of Nursing and Allied Health Sciences where the study was conducted, with approval number (HSNHS/2024/098). Students were provided with a Google Forms study that was administered via WhatsApp. Information about the study with its aims was sent together with guidelines and instruments for participants' guidance in answering the questionnaire. By submitting the completed online questionnaire, the participants gave consent to take part in the research. These surveys were sent several times to prompt the students to complete them. The research study was conducted in two months from August to September 2024. To avoid a repeat of the survey, there was a restriction on the number of times a participant can take the survey. Data were analyzed by using SPSS version 22.0. For descriptive analysis, mean (S.D) was used for parametric data and non-parametric data, and median IQR was viewed. For the categorical variable, frequency and percentages have been calculated. To determine the association with demographic variables Chi-square or Fisher's exact test has been applied.

RESULTS

A total of 145 (n=145) students filled out the online Google form in which 30.3% (n=44), 32.4% (n=47) and 37.2% (n=54) 2nd year, 3rd year and 4th-year students were assessed respectively. Most of the students were male students 74.5% (n=108) and female students were 25.5% (n=37). Regarding previous education most of the students 56.6% (n=82) have received formal training on NSI prevention and management and the other 43.4% (n=63) did not receive any formal training on NSI prevention and management (Table 1).

Table 1: Demographic Characteristics of Study Participants

Category	n (%)
Total Students	145 (100)
Year of Study	
2nd Year	44 (30.3)
3rd Year	47 (32.4)
4nd Year	54 (37.2)
Gender	
Male	108 (74.5)
Female	37 (25.5)
Previous Education on NSI Prevention	
Received Formal Training	82 (56.6)
Did Not Received Formal Training	63 (43.4)

The total NSI knowledge ranged from 1 to 7 with a mean of 5.724 (SD=1.45). The range of accurate answers to each question ranges from 21.4% to 89.7%. "NSI is defined as wounds caused by needles that accidentally puncture the skin" received the highest accurate answer percentage 89.7% (n=130). The lowest accurate answer percentage 21.4% (n=31) was for the question "Recap of the syringe

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upon completion of nursing care should be performed to reduce the possibility of a needle stick injury". Majority of the students showed good knowledge regarding NSI 62.1% (n=90), 29% (n=42) students had fair knowledge about NSI and only 9% (n=13) students had poor knowledge about NSI (Table 2).

Table 2: Level of Knowledge regarding NSI among study participants

Level of Knowledge	n (%)
Poor Knowledge	13 (9)
Fair Knowledge	42 (29)
Good Knowledge	90 (62.1)
Total	145

Knowledge-related statements from students were noted (Table 3).

Table 3: Knowledge-Related Statements among study participants

No	Statement	True n (%)	False n (%)
1	Needle stick injuries are wounds from needles that accidentally puncture the skin.	130 (89.7)	15 (10.3)
2	Recap of the syringe upon completion of nursing care should be performed to reduce the possibility of a needle stick injury (False*).	114 (78.6)	31 (21.4)
3	Technics and Safer devices, gloves should be worn to prevent needle stick accidents.	120 (82.8)	17 (11.7)
4	Hepatitis B & C, and HIV, are the blood-borne pathogens most f frequently exposed to by health care providers when they experience NSI	128 (88.3)	17 (11.7)
5	The maximum capacity of a sharp container is 75%.	105 (72.4)	40 (27.6)
6	Soap and water use wash area to minimize the risk of infection after having had NSI.	112 (72.2)	33 (27.6)
7	Dispose in a sharp container practice minimizes injury risk.	121 (83.4)	24 (16.6)

The level of attitude was recorded (Table 4).

Table 4: Level of Attitude towards NSI among study participants

Level of Attitude	N (%)
Poor Knowledge	4 (2.8)
Fair Knowledge	48 (33.1)
Good Knowledge	93 (64.1)
Total	145

In general, the students show a positive attitude regarding NSI the mean score is 19.66, the range is 16.00, and SD=3.16. likewise, 64.1% (n=93) students showed a good attitude toward NSI, some students 33.1% (n=48) had a fair attitude toward NSI and just 2.4% (n=4) students had a poor attitude regarding NSI. More than half 82(56.6%) of the study participants agreed to report NSI immediately 36.6% (n=53) strongly agreed that NSI is the most common event and 40.7% (n=59) agreed that NSI is the most common event and 44.8 (n=65) were believed (Table 5).

Table 5: Attitude-Related Statements among study participants

No	Attitude Statements	Strongly Agreen (%)	Agreen n (%)	Neutral n (%)	Disagree n (%)	Strongly Disagree n (%)
1	Report NSI Immediately	82 (56.6)	45 (31.0)	9 (6.2)	5 (3.4)	4 (2.8)
2	I Am Worry About NSI	48 (33.1)	51 (35.2)	19 (13.1)	12 (8.3)	15 (10.3)
3	NSI Is a Common Event	53 (36.6)	59 (40.7)	21 (14.5)	10 (6.9)	2 (1.4)
4	NSI Is Neglected	25 (17.2)	43 (29.7)	21 (14.5)	44 (30.3)	11 (7.6)
5	I Think NSI Is Preventable	65 (44.8)	57 (39.3)	15 (10.3)	6 (4.1)	2 (1.4)

DISCUSSION

The knowledge and attitudes of nursing students regarding NSIs are thoroughly examined in this study, which also identifies areas of strength and potential improvement in NSI management and prevention. Upon juxtaposing these results with global research, several revelations become apparent. The highest risk to nursing students during clinical trials is NSIs because they result from unintentional contact with contaminated blood and bodily fluids can compromise patient safety [1]. The current study showed remarkable findings about nursing students' knowledge regarding NSIs. The knowledge level among nursing students in this study, with a mean score of 5.724 (SD=1.45), is relatively high. This is consistent with findings from other studies conducted in different countries. The low accuracy of 21.4% for the question on syringe recapping contrasts with findings from international studies such as those by [12] in Pakistan, where 80% of participants correctly identified that recapping syringes is not recommended. In addition, students have enough knowledge about NSI. This finding is consistent with a study done in Saudi Arabia where participants also had sufficient knowledge regarding NSI [1] and contrasted with global investigations indicating students' insufficient knowledge about NSI [13-15]. A notable proportion of nursing students has prior knowledge of and understanding of NSIs which points out that they have been in contact with the causes as well as the risk factors of these practices. Moreover, nursing students are at high risk of blood-borne pathogens transmitted via NSI [16]. This can be attributed to the fact that senior nursing students had taken more courses and spent more time learning and practicing infection control techniques making them better than their junior colleagues. This finding bridged the gap between the need for an extra year to prepare students for infection control and the other factors affecting their performance in clinical practices. As for NSI management, a favourable perception was recorded with a mean score of 19.66 (SD=3.16). This

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favourable perception is consistent with other studies. For instance, one study reported that a large proportion of registered nurse students in Turkey were willing to prevent NSIs [17], displaying an inclination that was also evident in our study. The opinions of the participants toward NSI were favourable and in line with a prior study [1] which was similar to an international study that revealed positive attitudes among nursing students towards NSI [18]. The positive attitudes of students attest to the fact that nursing schools are the best setting for improving students' decision-making abilities and increasing their awareness of and behaviour regarding NSI attitudes before transmission in clinical practice [19]. However, the study also revealed areas of concern regarding attitudes, such as a smaller proportion of students believing NSIs are preventable (44.8%). This contrasts with a study in India, where 65% of nursing students believed in the preventability of NSIs [20]. This discrepancy highlights a potential area for improvement in fostering a belief in the effectiveness of preventive measures. There were also limitations on this investigation. The use of online surveys for data collection may result in recall bias and inaccurate conclusions. The study's limited generalizability may stem from its execution in a single private nursing college. However, there isn't much research about injuries and safety issues in nursing education in Pakistan, therefore this study fills the gap in knowledge in that area. Future research is strongly encouraged, especially with students pursuing careers in healthcare.

CONCLUSIONS

It was concluded that the students showed good knowledge and a positive attitude towards NSI. According to this study after performing nursing interventions recap of the syringe is recommended to decrease the risk of NSI remains challenging, but overall knowledge was good and positive attitude of the students towards NSI.

Authors Contribution

Conceptualization: NS
Methodology: TA
Formal analysis: R
Writing review and editing: AB

All authors have read and agreed to the published version of the manuscript.

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The authors declare no conflict of interest.

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Exploring Gender Differences in Perceived Stress, Internalized Stigma of Mental Illness, and Coping Styles among Caregivers of People Diagnosed with Psychiatric Illness

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ABSTRACT

Globally it is seen that not only the patients who are suffering from mental disorders but also the caregivers or family members are also facing multiple psychological distress due to their disturbances. **Objectives:** To measure perceived stress, internalized stigma, and coping styles among caregivers of psychiatric patients. **Methods:** 160 participants were selected through purposive sampling from eight hospitals in Lahore. The study questionnaire booklet included the Urdu versions of the Internalized Stigma Scale, Coping Styles Scale, and Perceived Stress Scale respectively. Pearson product-moment correlations and T-tests were computed to explore gender differences in levels of the study variables. **Results:** The results revealed that women spent more time with loved ones as compared to men. There was a strong relationship with most of the variables among men, whereas the copying style scale showed no relationship with all variables. There was a strong relationship reported among women on most of the variables but coping style indicates a negligible relationship with the internalized stigma of mental illness. The T-test indicates that there was a significant difference (p-value=0.04*) reported on the internalized stigma of mental illness stereotype endorsement among men and women, whereas the rest of the variables did not report any significant differences. **Conclusions:** It was concluded that future research should be conducted on caregivers to create awareness and mitigate internalized stigma of mental illness as well as reduce stress common among people.

INTRODUCTION

Psychological disorders are increasingly prevalent, affecting approximately one in four families globally [1]. This rise in mental illness places a significant burden not only on individuals but also on their caregivers, who often face profound emotional and psychological challenges. In Pakistan, caregivers typically provide support without financial compensation due to cultural and religious norms, contrasting with many European countries where caregiving is often compensated. This disparity highlights a critical research gap in understanding the unique challenges faced by caregivers in different cultural contexts. Despite extensive research on mental illness, there is a notable lack of studies focusing on the experiences of caregivers, particularly in Pakistan. Existing research has predominantly centered on patients, leaving a gap in our understanding of how caregivers manage internalized stigma, perceived stress, and coping strategies. According to one study, the caregivers of patients diagnosed with psychiatric illness reported severe psychological problems [2]. Patients suffering from different mental disorders experience perceived stress and internalized stigma by using different coping styles such as emotions-focused and problem-focused copying styles to move on in their life. The primary research problem is the inadequate understanding of how internalized stigma impacts caregivers' perceived stress and coping strategies, especially in culturally specific contexts such as Pakistan. While there is substantial

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literature on mental illness and patient experiences, there is a significant gap in research focusing on caregivers, particularly regarding how cultural and socio-economic factors influence their stress and coping mechanisms. This study is crucial for several reasons, such as it provides insights into the psychological burden borne by caregivers and highlights the impact of internalized stigma on their well-being. Understanding these dynamics will help in developing targeted support interventions and improving resources for caregivers in Pakistan and similar settings. The objective of this study is to investigate the relationship between internalized stigma, coping styles, and perceived stress among caregivers of individuals with psychiatric disorders in Pakistan. Specifically, it aims to: Assess how internalized stigma affects caregivers' psychological well-being; Explore the coping strategies used by caregivers in response to stigma and stress; Determine the impact of these coping strategies on caregivers' stress levels; and Develop recommendations for tailored support interventions for caregivers. The current study was influenced by "An Integrative Cognitive Model of Internalized Stigma among Caregivers and A Stress-Coping Model of Mental Illness Stigma" [3]. It was reported in every society that there was a strong social stigma, prejudice, and stereotype pattern related to mental illness. Such kind of stigma not only distresss psychiatric patients but also public prejudice and strongly influences their caregivers as well. Findings reported that most participants reported higher stress stigma and social prejudice. The research was conducted on "Comparing Affiliate Stigma between Family Caregivers of People with Different Severe Mental Illness in Taiwan" [4]. This study was conducted to examine the level of burden of mental illness, anxiety, depression, self-esteem, and affiliated stigma of caregivers diagnosed with depression, schizophrenia, and bipolar disorder, by using the ANOVA descriptive method. It was found that caregivers with schizophrenia disorder were highly stigmatized, anxious, depressed, and had lower levels of self-esteem as compared to depressive and bipolar caregivers. The caregivers with bipolar disorder were also highly stigmatized, anxious, depressed, and had less self-esteem as compared to depressive caregivers. Female caregivers as parents reported more burdened and stigmatized as compared to spouses [4]. In Pakistan, Rawalpindi city (Armed Forces Institute of Mental Health), research was done on caregivers of people diagnosed with mood disorders and schizophrenia disorder. It was examined that multiple factors were associated with increased caregivers' burden and stress in providing effective care to family members with severe mental illness [5]. It was reported that as much time is spent with patients a higher level of stigma and psychological stress was reported among caregivers, whereas as less time is spent with patients a lower level of stigma and stress was reported. The results also revealed that less stress, and burden were reported with higher levels of education, unmarried caregivers, higher socio-economic status, and living in urban areas so their psychological well-being was good as compared to others [5].

This study aims to measure perceived stress, internalized stigma, and coping styles among caregivers of psychiatric patients.

METHODS

It was a cross-sectional study and IBM SPSS version 21.0 was used for analysis. A total of 160 adult caregivers or family members of the patients diagnosed with psychiatric illness were selected from different government hospitals in Lahore. Urdu versions of all standardized questionnaires, such as Internalized Stigma of Mental Illness (ISMI), Coping Strategies Scale, Perceived Stress Scale, and demographic variables were utilized via purposive sampling to collect data from psychiatric wards. Inclusion criteria were caregivers diagnosed with psychiatric disorders and living with the patients for the last six months. Patients must diagnosed by a professional psychiatrist and admitted to the hospital in the last two months. Exclusion criteria were participants diagnosed with any medical or psychiatric disorder. Caregivers who were taking care of more than two family members diagnosed with psychiatric or chronic disorders. Internalized Stigma of Mental Illness was introduced by Ritsher, Otilingam, & Grajales in 2003, and there are twenty-nine items used for the adult population. This was translated into Urdu. The Coping Styles Scale (CSS) is a self-report assessment that consists of twenty-two items on a five-point Likert scale with the age range of eighteen to fifty years old. It is divided into two major groups (i) Problem-focused coping and (ii) Emotion-focused coping [6]. The Perceived Stress Scale (PSS) was used to "measure the degree to which situations in one's life are appraised as stressful" [7]. To check the relationship between study variables Pearson Product Moment Correlation Coefficient was applied and the T-test was utilized to explore the comparison of gender differences among men and women on all variables. Informed consent was taken before collecting data, and ethical guidelines were followed. At the end of data collection, the caregivers were offered counselling services to manage their stress level, for this approval was taken from hospital professionals. Approval of educational institutions, the Board of Advance Research Studies, and the IRB Board were sought out for this research. The Institutional Ethical Committee overviewed the research proposal including the research aim, methodology, proposed statistical analysis and expected outcomes and after careful investigation, the IRB ethical committee approved the present research study. Moreover, the IRB Reference number was IRB-224/06-2020. The total time duration of the research process and

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data collection was between June 2020 to July 2021.

RESULTS

The mean age of men was 34.14 (SD=13.69) and for women, it was 36.50 (SD=12.40) years. Men (56%) outnumbered women (44%) in the sample. The length of time living with the patient for women was higher than for men as the male participants of this research were reported based on the length of time living with the patient less than one month was 9 percentile was 10.34 (Table 1).

Table 1: Descriptive Statistics of the Sample (n=160)

Variables		Frequency (%)
Gender	Men	87 (55.6%)
	Women	73 (44.4%)
Length of Time Living with the Patient	Men	
	Less Than One Month	9 (10.34%)
	More Than One Month	78 (89.66%)
	Women	
	Less Than One Month	17 (23.29%)
	More Than One Month	56 (76.71%)
Education Level	Men	
	Secondary or Below	65 (74.6%)
	Graduation or Higher	44 (25.2%)
	Women	
	Secondary or Below	58 (39.2%)
	Graduation or Higher	15 (6.9%)

The internalized stigma of mental illness consisted of 29 items highly reliable (0.90). The perceived stress scale consisted of 10 items and it is also good reliability (0.75). The coping style scale consisted of 22 items and it has good reliability (0.77). The problem-focused coping style consisted of 8 items and it is also good reliability (0.75) (Table 2).

Table 2: Cronbach's Alpha Reliability of Internalized Stigma of Mental Illness, Perceived Stress Scale and Coping Style Scale (n=160)

Variables	No of Items	*a*
Internalized Stigma of Mental Illness	29	0.90
Internalized Stigma of Mental Illness Alienation	6	0.74
Internalized Stigma of Mental Illness Stereotype Endorsement	7	0.74
Internalized Stigma of Mental Illness Discrimination Experience	5	0.68
Internalized Stigma of Mental Illness Social Withdraw	6	0.68
Perceived Stress Scale	10	0.75
Coping Style Scale	22	0.77
Problems Focus Coping Styles	8	0.75
Emotion Focus Coping Style	14	0.62

Note, a=Cronbach Alpha

There is a strong positive correlation among most of the variables, whereas the emotion-focused coping style revealed a significant correlation with the internalized stigma of mental illness and its four subscales including alienation, stereotype endorsement, discrimination experience, social withdrawal, and perceived stress scale variables. There was not any significant relationship between the internalized stigma of mental illness stigma resistance and with emotion-focused copying style scale (Table 3).

Table 3: Correlation Matrix of Study Variables in Men (n=87)

Scales	1	2	3	4	5	6	7	8	9	10
1. ISMI	-	-	-	-	-	-	-	-	-	-
2. ISMIA	0.90*	-	-	-	-	-	-	-	-	-
3. ISMISE	0.89**	0.73**	-	-	-	-	-	-	-	-
4. ISMIDE	0.92**	0.79**	0.83**	-	-	-	-	-	-	-
5. ISMISW	0.81**	0.72**	54	0.69**	-	-	-	-	-	-
6. ISMISR	0.64**	0.45**	0.57**	0.49**	0.43**	-	-	-	-	-
7. PSS	0.55*	0.48**	0.49**	0.47**	0.46**	0.41**	-	-	-	-
8. CSS	0.33**	0.29**	0.29**	0.27*	0.29**	0.24*	0.33**	-	-	-
9. CSSpfcs	0.08	0.03	0.12	0.04	0.02	0.21*	0.09	0.76**	-	-
10.CSSefcs	0.42**	0.40**	0.37**	0.36**	0.44*	0.181	0.40*	0.88**	0.36**	-
11. M (SD)	74.71 (14.8)	15.43 (4.13)	19.00 (4.48)	13.05 (3.23)	14.18 (3.39)	13.03 (2.15)	24.64 (7.80)	73.67 (11.03)	29.95 (5.67)	43.72 (7.67)

Note. ISMIA=internalized Stigma of Mental illness, Alienation, ISMISE=Internalized Stigma of Mental illness Stereotype Endorsement, ISMIDE=Internalized Stigma of Mental illness Discrimination Experience, ISMISW=Internalized Stigma of Mental illness Social withdrawal, ISMISR, Internalized Stigma of Mental illness Stigma Resistance, CSS, Coping Style Scale, CSSpfcs=Problem Focus Coping Style Scale, and CSSefcs=Problem Focus Coping Style Scale

There is a strong positive correlation of ISMI (**p<0.01) with most of the variables. There was not any significant relationship reported among internalized stigma of mental illness discrimination experience, social withdrawal, and perceived stress scale variables. Problem-focused coping style variables do have not any significant association with the internalized stigma of mental illness social withdrawal and stereotype endorsement. It was also found that emotions-focused coping styles did not have any significant relationship with the internalized stigma of mental illness, alienation, stereotype endorsement, discrimination experience, and stigma resistance, emotions-focused coping styles have a negative relationship with the internalized stigma of mental illness and social withdrawal (Table 4).

Table 4: Correlation Matrix of Study Variables in Female (n=73)

Scales	1	2	3	4	5	6	7	8	9	10
1. ISMI	-	-	-	-	-	-	-	-	-	-
2. ISMIA	0.85**	-	-	-	-	-	-	-	-	-
3. ISMISE	0.87**	0.70**	-	-	-	-	-	-	-	-
4. ISMIDE	0.79**	0.59**	0.62**	-	-	-	-	-	-	-
5. ISMISW	0.75**	0.55**	0.55**	0.49**	-	-	-	-	-	-
6. ISMISR	0.57**	0.38**	0.33**	0.37**	0.31**	-	-	-	-	-
7. PSS	0.32**	0.27*	0.29**	0.16	0.19	0.29*	-	-	-	-

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8. CSS	0.20	0.24*	0.16	0.19	0.03	0.24*	0.34**	-	-	-
9. CSSpfcs	0.26*	0.28*	0.17	0.27*	0.07	0.28*	0.24*	0.89**	-	-
10.CSSefcs	0.12	0.19	0.13	0.11	0.09	0.18	0.37**	0.99**	0.67**	-
11. M (SD)	78.43 (11.8)	16.09 (3.10)	20.36 (4.13)	13.76 (2.62)	14.94 (2.92)	13.26 (2.31)	26.61 (5.25)	72.91 (12.44)	28.97 (5.78)	43.94 (7.82)

There was a significant difference among both genders on the internalized stigma of mental illness stereotype endorsement (p=0.04*, Cohen's d=0.31), whereas, there were not any significant differences reported among all other variables. It was revealed that men (M=24.64, SD=7.80) and women (M=26.61, SD=5.25) showed a marginally significant difference in PSS, Cohen's d=0.29. There was no significant difference between men and women in the coping style scale but a significant difference was found in the problem-focused coping style, where women (M=48.97, SD=5.78) scored significantly higher than men (M=29.95, SD=5.67), Cohen's d=3.32 (Table 5).

Table 5: Comparison of Gender Differences (Men and Women) on All Variables

Variables	Men	Women	t(304)	p	95% CI		Cohen's d
	M ± SD	M ± SD			LL	UL	
1. ISMI	74.71 ± 14.83	78.43 ± 11.30	-1.73	0.08	-7.96	0.51	0.28
2. ISMIA	15.43 ± 4.13	16.09 ± 3.10	-1.12	0.68	-1.81	0.50	0.18
3. ISMISE	19.00 ± 4.48	20.37 ± 4.13	-1.99	0.04*	-2.72	-0.01	0.31
4. ISMIDE	13.05 ± 3.23	13.76 ± 2.63	-1.50	0.13	-1.64	0.22	0.24
5. ISMISW	14.18 ± 3.39	14.94 ± 2.92	-1.50	0.14	-1.77	0.23	0.09
6. ISMISR	13.03 ± 2.15	13.27 ± 2.31	-0.63	0.52	-0.92	0.47	0.10
7. PSS	24.64 ± 7.80	26.61 ± 5.25	-1.84	0.07	-4.09	0.14	0.29
8. CSS	73.67 ± 11.03	72.91 ± 12.44	.409	0.68	-2.90	4.42	0.06
9. CSSpfcs	29.95 ± 5.67	48.97 ± 5.78	1.08	0.29	-0.81	2.78	3.32
10.CSSefcs	43.72 ± 7.67	43.94 ± 7.82	-0.18	0.85	-2.64	2.20	0.02

DISCUSSION

Past research reported, that a higher level of stigma develops a higher level of stress so to minimize this, maximum coping styles need to be implemented to take good care of patients diagnosed with psychiatric illness [8]. In previous research, it was reported that problem-focused coping styles were mostly practised coping styles, and emotion-focused coping styles were less likely practised among both genders (men and women). It was also reported that there was no significant relationship between perceived stress and the stigma of mental illness [9]. In another research, it was reported that most people practice emotion-focus coping styles frequently to overcome daily life issues [10]. In various research, it was reported that coping styles PFCS and EFCS and perceived stress did not have any significant differences among male and female [11-13]. Another Indian study explored that sometimes cultural background and differences have significantly influenced the perception of schizophrenia illness. It was also revealed that family members were highly affected by the perception of illness of schizophrenia and several coping styles were adopted to manage their stress [14]. However, another study reported that as the stigma increases the psychological distress and burden also increase which requires maximum practice of coping styles among caregivers of patients with psychiatric illness [15]. In Bangalore and India, research was conducted on caregivers of psychosis patients to the results indicate that caregivers did not notice any change in the behaviour of their dear ones because of illiteracy and lack of awareness of psychiatric illness so they could not handle their psychosis symptoms. caregivers reported that the perceived stigma of illness of their loved ones also affects the mental health as well as the daily life of the caregivers [16]. Another research was conducted in the UK on caregivers of patients diagnosed with schizophrenia and schizoaffective disorders. Results indicated that socioeconomic burden, mental stress, and psychological disturbances were moderately reported among caregivers across multiple cultures. The majority of the participants, living with schizophrenia and schizoaffective or both disorders reported higher levels of emotional disturbances and imbalances [17]. Caregivers of patients suffering from mental disorders have numerous psychological disturbances and mental distress, including stress, anxiety, depression, lack of social interaction, various interpersonal conflicts, multiple emotional problems, psychological distress, social pressure, and even mental illness [18]. Results were also supported by previous research conducted in China in 2005-2008 on adult participants [19]. A previous study explored that female caregivers were more stigmatized due to stress and social/mental stigma as compared to male caregivers [20]. During data collection and analysis, it was observed that individuals lack awareness of psychiatric illness and psychological disorders because it is most commonly considered mental disorders that are highly labelled and stigmatized by society, so they need to work and create awareness among people. According to the World Health Organization (WHO), mental health awareness would be for patients, caregivers, external relatives, and other common individuals so that the stigma of mental illness can be minimized. The main goal of the current study was to develop awareness among local people related to the psychological distress of caregivers of patients suffering from psychiatric disorders.

CONCLUSIONS

It was concluded that this study provides valuable insights into gender differences in perceived stress, internalized stigma, and coping styles among caregivers of individuals with psychiatric illnesses. Key findings indicate that female caregivers report higher levels of perceived stress and internalized stigma compared to their male counterparts.

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Women also spend significantly more time providing care, which may contribute to their heightened stress levels. While both men and women show strong relationships between the study variables, coping styles among caregivers have different implications: men exhibit more pronounced correlations with stress and stigma, whereas women's coping styles show a minimal relationship with internalized stigma.

Authors Contribution

Conceptualization: SB, ES
Methodology: SB, ES
Formal analysis: AN, HY
Writing review and editing: SB, ES, AN, HY, RS

All authors have read and agreed to the published version of the manuscript.

Conflicts of Interest

The authors declare no conflict of interest.

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Prevalence of Forward Head Posture and Its Association with Smartphone Use among University Students

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ABSTRACT

A person exhibits forward head posture when their spine is out of neutral alignment with their head. Nowadays, smartphones are a necessary tool whose use is becoming increasingly significant. The side effect of smartphone use is forward head posture, which is most common among university students. **Objectives:** To determine the prevalence of forward head posture and its association with smartphone use among university students. **Methods:** This correlational study was conducted on university students with a sample size of 340. Both male and female students aged between 18-28 years, who use their smartphones for at least four hours and have no previous record of birth defects of cervical and lumber vertebrae were included. Whereas, any history of cervical surgery, or spinal abnormalities was excluded from the study. The goniometer and ruler method were used to measure the craniovertebral angle, and a smartphone addiction scale was used to screen the participants. **Results:** A positive correlation was found between craniovertebral angle and duration of smartphone usage with a correlation coefficient of r=0.084 and p=0.02. In contrast, a negative correlation was observed between the ruler method and the duration of smartphone usage with a correlation coefficient of r=0.54 and p=0.403. **Conclusions:** It was concluded that the prevalence of forward head posture was found to be 47.9% by the ruler method and 62.1% by the craniovertebral angle measurement. There is a correlation between craniovertebral angle and smartphone use and the duration of smartphone usage.

INTRODUCTION

A state of musculoskeletal equilibrium that places the least amount of strain and tension on the body is known as proper posture. Maintaining the angel wings or the retracted shoulder blades, together with the ears in line with the shoulders, are characteristics of proper posture. The most beneficial position for the spine is one that reduces spinal stress and is ideal for the spine [1]. The forward movement of the cervical vertebrae and hyperextension of the upper cervical region characterize a forward head position (FHP) and a bad head and neck posture [2]. Teenagers' widespread use of laptops, smartphones, and computers has caused a misalignment of their heads and neck. Most of their time was spent on smartphones, particularly during the COVID-19 pandemic, for things like playing games, social media friend talk, online classes, and searching for study materials [3]. Ergo, it was not recommended to keep the head lowered to stare at the screen for extended periods. This results in bad posture, including rounded shoulders, a head that protrudes with the chin pushed in, and Forward Head Posture (FHP) [4]. Forward head posture (FHP) has several other names such as text neck, scholar's neck, wearies neck, and reading neck etc., Smartphone addiction is characterized by compulsive smartphone use, a lack of control brought on by overindulgence, and behavioral addiction [2]. Users of smartphones typically have their

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heads tilted forward in their bodies. In that posture, the head naturally prefers to be in front to preserve the body's equilibrium because the spinal bones bend forward in that direction [5]. Long-term forward-facing head position can lead to musculoskeletal conditions like upper crossed syndrome, muscle shortening surrounding the articulation of the Atlantic-occipital, and increased pulling of the muscles surrounding the joints, resulting in persistent neck discomfort [6]. Forward head posture is 66% common between the 20 -30 age range with female more likely to exhibit it (24.1%) than male [1]. According to the studies, 70% of the physical therapy students and 85.5% of the dental staff members reported forward head posture [7, 8]. A survey among university students in Pakistan has revealed that 63.96% had a forward head posture [9]. It's characterized by the forward displacement of cervical vertebrae in association with hyperextension of the upper cervical region. This condition is caused by the combined weakening of deep cervical flexor muscles, mid-thoracic rhomboid muscles for shoulder retraction, and mid and lower trapezius muscles. Numerous factors such as sleeping with a head too high, use of computers and laptops for extended periods and weakening of back muscles, usually contribute to this condition [2]. This abnormal condition causes modification in cervical and thoracic vertebrae leading to muscle imbalance and thoracic limitation causing hindrance in rib cage expansion. As a result, lung volume is decreased. Therefore, these could be blamed for chronic respiratory and musculoskeletal issues compromising the patient's daily tasks [10]. Cervicogenic headaches, temporomandibular problems, neck pain, and post-concussive headache have all been linked to FHP [11]. Research has shown that when the cervical spine's lordotic curvature was straightened, the F-wave in the upper limb's median nerve was significantly reduced, indicating decreased motor-neuronal excitability. Only a few research studies have examined the connection between FHP and poor somatosensory and sensorimotor integration [12]. Fercho et al., determined the kinematic analysis of the frontal head body of smartphone users. They concluded that smartphones contribute more to frontal head injuries and maximum buckling occurred at C0-C1 vertebra [13]. Bomen et al., conducted an observational study to determine the high level of association between cell phone use and shoulder extension, forward bending, and thoracic kyphosis among students. The study concluded that the relationship between smartphone use and head and shoulder extension was not significant [14]. Janet et al., determined the impact of the smartphone on the front neck in physical therapy students and people who use smartphones for a long time. It was found that students with anterior neck stiffness had larger craniovertebral angles and range of motion compared to normal neck stiffness, and students with anterior neck stiffness also used smartphones for 5-6 hours a day [15]. Patel et al., conducted a cross-sectional study to identify factors associated with neck pain among student smartphone users. This study concluded that both personal factors of smoking and ergonomic aspects of neck flexion posture are associated with the occurrence of neck musculoskeletal problems in smartphone users [16]. To restore muscle balance between agonist and antagonist muscles, increase muscle strength and reduce muscle weakness. Exercise is effective in correcting postural disorders and maintaining the relationship between the head and shoulders. It is important to improve shoulder stability by simultaneously strengthening the scapular stabilizers while stretching the pectoralis minor muscle [17]. It is hypothesized that the prevalence of neck disorders among smartphone users may be associated with forward head posture and smartphone addiction or overuse.

This study aimed to determine the prevalence of forward head posture and its association with smartphone use among university students. The findings of this study may trigger an initiative for awareness and strategies to prevent the occurrence of neck pain among smartphone users. It will help students how to maintain good posture, reduce disabilities and adopt a healthy lifestyle.

METHODS

This correlational study was conducted on university students of Islamabad, Pakistan for a duration of 6 months from December 2023 to June 2024. The sample size was 340 which was calculated through the EPITOOL website by using the prevalence of FHP (0.67) [18]. Non-probability purposive sampling technique was used. Both male and female university students aged between 18-28 years, who use their smartphones for at least four hours and have no previous record of birth defects of cervical and lumber vertebrae were included in this study. Any history of cervical surgery, shoulder trauma, spinal abnormalities, pre-existing neck disorders such as polyarticular disease, spinal arthritis, inherited brain disease or neck torticollis were excluded from the study. The informed consent was signed by all the participants who fulfilled the inclusion criteria. The goniometer and ruler method was used to measure the forward head posture, and they had good reliability (ICC=0.830) [19], smartphone addiction scale (SAS-SV) questionnaire with the internal consistency and concurrent validity of SAS-SV were verified with a Cronbach's alpha of 0.911. Smartphone addiction scale (SAS-SV) is a 10-item measure of smartphone addiction. A 6-point Likert scale, with 1 representing strongly disagree and 6 representing strongly agree, is used to score each item. Because the SAS-SV was created especially for smartphones and excludes internet addiction, it is helpful. It was employed to evaluate the relationship between forward neck posture and cell phone use [20]. To check

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FHP by ruler method, encourage the students to stand up against the wall. Following an assessment, students showing forward neck position were measured using a ruler between the wall and structure located on the posterior surface of the occipital bone, at the level of the superior nuchal line. The forward neck posture is indicated if the measurement is more than three inches. Craniovertebral angle (CVA) was measured by goniometer, the participants were in a sitting position, the goniometer's axis was placed at the C7 spinous process, with the stable arm horizontally aligned at the C7 level and the movable arm at the ear's tragus, from where the angle is measured. The normal angle was 49.9 degrees and subjects with lower CVAs typically have higher FHP [21]. The IBM SPSS version 22.0 was used for data analysis. Descriptive data were analyzed through mean, standard deviation, frequency and percentages while association among two variables were analyzed by Pearson's correlation. The study has been approved by the Ethical Committee of the Institute of Health & Management Sciences, Islamabad, ref no: IHMS/DPT/SZABMU-2023/274, whereas informed consent was taken from all participants through a printed form in the English/local language. Every participant's privacy and sovereignty were respected and safeguarded.

RESULTS

This study involved 340 students, 130 of whom were male and 210 of whom were female (Figure 1).

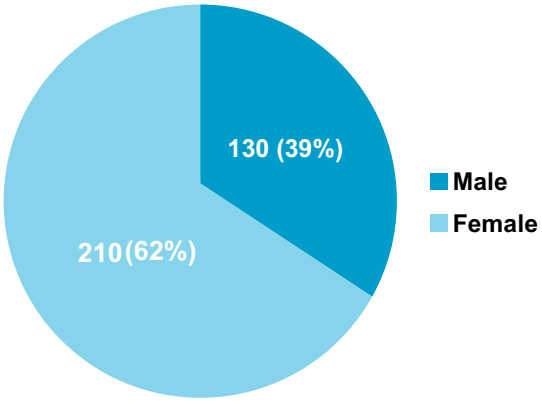

Figure 1: Gender distribution among study participants

The participants' average age was 21 ± 1.9 years, height was 5.4 ± 0.4 feet, weight was 58 ± 11 kg, and their average body mass index was 22 ± 4.8 kg/m2. The average time spent using a smartphone was 6.2 ± 3.4 years, with a screen size of 6.1 ± 0.6 cm and use of a smartphone 6.7 ± 3.6 hours per day. The average study hours at the university were 5.8 ± 2.2, whereas at home, they were 2.5 ± 1.7 (Table 1).

Table 1: Demographic Data of the study Participants

Variables	Mean ± SD
Age (Year)	21 ± 1.9
Height (Ft)	5.4 ± 0.4
Weight (kg)	58 ± 11
BMI (kg/m^2)	22 ± 4.8
Smartphone's Screen Size (cm)	6.1 ± 0.6
Duration of Smartphone Use Years	6.2 ± 3.4
Use of Smartphone Hours A Day	6.7 ± 3.6
University Study Hours	5.8 ± 2.2
Home Study Hours	2.5 ± 1.7

The majority of students utilize their right hand 178 (52.4%), students used their smartphones with their left hand 16 (5%), 144 (43%) used their smartphones with both hands and 282 (83%) students took notes on their smartphone (Table 2).

Table 2: Smartphone Usage of Students

Variables	Frequency (%)
Use of Hand During Smartphone	
Right	178 (52.4%)
Left	16 (4.7%)
Both	144 (43%)
Study Notes Took A Smartphone or Notebook	
Yes	282 (82.9%)
No	55 (17.1%)

The average craniovertebral angle was 47 ± 4.4 degrees, and the mean value of the ruler method was 3.3 ± 1.4 cm. The prevalence of forward head posture was found to be 47.9% by the ruler method and 62.1% by the craniovertebral angle measurement (Table 3).

Table 3: Methods for Measuring Forward Head Posture

Methods	Mean ± SD	n (%)
Ruler Measurement (cm)	3.3 ± 1.4	163 (47.9%)
CVA	47 ± 4.4	211 (62.1%)

The Smartphone Addiction Scale (SAS) indicates that 79 students, or 23.2%, out of 340 students, agree that using their smartphones prevented them from completing their assigned work. 100 people (29.4%) disagreed that they found it difficult to focus on class assignments when using a smartphone. While using a smartphone, 92 (27.1%) reported experiencing pain in the wrists or back of the neck; 88 (25.9%) disagreed that they would be unable to live without a smartphone. 73 (21.5%) strongly disagreed that they should keep their smartphone in mind even when they are not using it, and 80 (23.5%) disagreed that they should feel anxious and irritated when they are not holding their smartphone. 95 respondents (27.9%) disagreed that they would never stop using their smartphone, even if it was already hurting their daily lives. 78 respondents (22.9%) agreed that they constantly check their phones to make sure they don't miss other people's conversations on Facebook and Twitter. 96 respondents (28.1%) agreed that they had used their phone longer than they had intended. Finally, 66 respondents (19.4%) disagreed that others around them thought they were using their phones excessively (Table 4).

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Table 4: Smartphone Addiction Scale

Questions	Strongly Disagree n (%)	Disagree n (%)	Weakly Disagree n (%)	Weakly Agree n (%)	Agree n (%)	Strongly Agree n (%)
Missing planned work due to smartphone use	62 (18.2%)	60 (17.6%)	36 (10.6%)	44 (12.9%)	79 (23.2%)	59 (17.4%)
Having a hard time concentrating in class, while doing assignments, while working due to smartphone	38 (11.2%)	100 (29.4%)	51 (15.0%)	47 (13.8%)	68 (20%)	36 (10.6%)
Feeling pain in the wrists or at the back of the neck while using a smartphone	50 (14.7%)	61 (17.9%)	35 (10.3%)	51 (15.0%)	92 (27.1%)	51 (15.0%)
Will not be able to stand not having a smartphone	69 (20.3%)	88 (25.9%)	39 (11.5%)	40 (11.8%)	56 (16.5%)	48 (14.1%)
Feeling impatient and fretful when I am not holding my smartphone	56 (16.5%)	80 (23.5%)	50 (14.7%)	57 (16.8%)	70 (20.6%)	27 (7.9%)
Having my smartphone in my mind even when I am not using it	73 (21.5%)	71 (20.9%)	51 (15%)	57 (16.8%)	55 (16.2%)	33 (9.7%)
I will never give up using my smartphone even when my daily life is already greatly affected by it	61 (17.9%)	95 (27.9%)	42 (12.4%)	46 (13.5%)	68 (20%)	28 (8.2%)
Constantly check my smartphone so as not to miss conversations between other people on Twitter and Facebook	53 (15.6%)	69 (20.3%)	30 (8.8%)	60 (17.6%)	78 (22.9%)	50 (14.7%)
Using my smartphone longer than I had intended	32 (9.4%)	56 (16.5%)	51 (15%)	54 (15.9%)	96 (28.2%)	51 (15%)
The people around me tell me that I use my smartphone too much	54 (15.9%)	66 (19.4%)	41 (12.1%)	50 (14.7%)	65 (19.1%)	64 (18.8%)

The findings show that there is a relationship between smartphone use and CVA, r=0.067 and p=0.695, but no correlation between the ruler approach and smartphone use (r=0.058), p=0.557. The study's findings showed a significant positive correlation (r=0.084, p=0.002) between smartphone time and CVA. Conversely, there was a negative link between the length of time spent on a smartphone and the ruler approach, with a correlation coefficient of r=0.54 and p=0.403 (Table 5).

Table 5: Relationship among FHP with Smartphone Use

Methods	Duration of Smartphone	Use of Smartphone
Ruler		
Pearson Correlation	0.403	0.557
Sig. (2-Tailed)	0.54	0.058
CVA		
Pearson Correlation	0.002	0.695
Sig. (2-Tailed)	0.084	0.067

DISCUSSION

Forward head posture (FHP) is the forward movement of the cervical vertebrae and hyperextension of the upper cervical region characterize a forward head position and a bad head and neck posture. Smartphone addiction is characterized by compulsive smartphone use, a lack of control brought on by overindulgence, and behavioral addiction [2]. Users of smartphones typically have their heads tilted forward in their bodies. In that posture, the head naturally prefers to be in front to preserve the body's equilibrium because the spinal bones bend forward in that direction [5]. The purpose of this study was to determine the prevalence of forward head posture and its association with smartphone use among university students. Bomen *et al.*, precisely investigated to find out how college students' prolonged shoulder, head-forward position, and spinal kyphosis relate to their dependence on smartphones. The results of the investigation showed that there is no meaningful relationship between extended shoulders, thoracic kyphosis, or tilted heads and dependency on smartphones [14]. In the current study, the result suggests there was no correlation between the ruler method and the use of smartphones but in contrast, there was a correlation between CVA (craniovertebral angles) and the use of smartphones r=0.067, p=0.695. the outcome of this investigation concluded that the CVA angle was reduced in neck positioned upwards. The prevalence of forward head posture according to the ruler method was 47.9%, and according to craniovertebral angle measurement was 62.1%. Janet *et al.*, identified that across physical therapy students, advanced neck spot was prominent and that smartphones showed a detrimental effect and going on top head spot in widespread consumers of handsets. In a sample size of 100 students, who use smartphones for approximately four hours daily, a goniometer, craniovertebral angle and plumb line were used as outcome measures. The results of the study demonstrated that, with an average variance of 14.97 between the two student groups, there is a statistically significant difference between students with forward head positions and those in the group acting as a control. Smartphone addiction is more common among students' forward-leaning vertebral location [15]. In the current study, with a sample size of 340, the ruler method, goniometer and SAS questionnaire were used as outcome measures. The result concluded that CVA increased in students who used smartphones more than four hours per day. Among physical therapy learners, Patil *et al.*, evaluated a high incidence of reliance on smartphones and its association with erect gaze and spine damage. The objective of the study was to find how frequently learners contemplating reintegration are

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dependent on their cell phones as well as its relationship to neck dysfunction and forward head posture by using a craniovertebral angle. The neck disability index, the mobile phone obsession scale-SV, structured interview survey responses and the image-based biomechanical assessment of the head positioning orientation for forward head posture were used for data collection. When smartphone addiction was broken down by gender, it was shown that males were more prone to smartphone addiction than females. A significant correlation has been seen between smartphone habit and the corresponding neck disability index and forward head alignment (FHP). According to the study's findings, physiotherapy students were more likely to be addicted to smartphones, which can result in forward head posture and neck impairment [16]. In the current study, the ruler method, goniometer and SAS questionnaire were used. The current study's findings indicated a robust positive correlation between CVA (craniovertebral angles) and the duration of smartphones. In contrast, a negative correlation was observed between the Ruler method and the duration of the smartphone. Another longitudinal investigation to determine the precedence of forward head posture and pertaining hazards among university students. As stated by the results, the majority of individuals with forward head posture were between the ages of 18 and 21 and male participants had a somewhat higher extensiveness of front-facing orientation of the head than female participants. The results also showed that there is a direct link between front-facing skull position and computer and smartphone use [18]. A study was onducted to determine how common forward head posture is among college-bound students and how it relates to gender, BMI, and neck pain. The participants' average age was 19.8 ± 1.42 years. Female students were dominated by 60%. It was revealed that 63.3% had lowered CV angle and 36.7% had normal CV angle. CV angle and BMI were significantly correlated (p=0.003). There was no significant correlation between gender and neck discomfort and the CV angle (p>0.05) [1]. The majority of the students in the current study, who were 21 years old, were female. The length of smartphone usage had a positive link with CVA and a negative correlation with the ruler approach. The majority of the students had forward head position as evidenced by a decreased craniovertebral angle.

CONCLUSIONS

It was concluded that the prevalence of forward head posture was found to be 47.9% by the ruler method and 62.1% by the craniovertebral angle measurement. The current study indicates a significant association between CVA and smartphone use and there is no association between the ruler approach and smartphone use. According to the results, the duration of the smartphone and CVA also showed a strong favourable link. It is recommended that future research focus on the participants over an extended period of time, as the capacity to recognize the cervical angle may vary over time. Additionally, future studies should investigate the responsiveness of the WPD software in longitudinal research for more accurate and dependable results.

Authors Contribution

Conceptualization: AS[1]
Methodology: AS[1], AS[2], ML, RF, RK, SA
Formal analysis: NR, AR
Writing, review and editing: AS[1], AS[2], ML, RF, RK, NR

All authors have read and agreed to the published version of the manuscript.

Conflicts of Interest

The authors declare no conflict of interest.

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Original Article

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Prevalence and Correlation of Lumbo-pelvic Pain with Depression, Anxiety, Stress and Mobility levels in Pregnant Women

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ABSTRACT

Pregnancy-related lumbo-pelvic pain (LPP) is a prevalent condition with physical and psychological risk factors. **Objective:** To investigate the relationship between lumbo-pelvic pain during pregnancy, psychological and physical risk factors. **Methods:** An observational cross sectional study recruited 210 pregnant women from a reputable tertiary care hospital. Duration of study was 6 months. The study was conducted in line with ethical standards set by the ethical committee of CMH Lahore Medical College and Institute of Dentistry. In accordance with the Declaration of Helsinki. Written informed consent was taken from each participant. This study interviewed the pregnant ladies in 2nd and 3rd trimesters and collected data about demographic information and included the Pregnancy Mobility Index Scale (PMI), the Disability, Anxiety, Stress Scale (DASS-21) questionnaire and Numeric Pain Rating Scale (NPRS). Authors explained each term mentioned in all questionnaires to participants in Urdu or Punjabi language so that every participant was able to understand complex terms. Spearman correlation coefficient test had been used for calculating correlation. **Results:** LPP was reported in 146 pregnant women. There was a significant correlation between pain and psychological risk factors such as: between LPP and stress there was r=0.39, p<0.05, between LPP and anxiety there was r=0.36, p<0.05, between LPP and depression there was r=0.41, p<0.05. There was a weak correlation between LPP and physiological risk factors with p-value of 0.002 and r=0.212. The mean age of participants was 27.46 years. **Conclusions:** Lumbo-pelvic pain was found in 69.5% pregnant women. Lumbo-pelvic pain was significantly correlated with mobility levels and psychological factors such as depression, stress and anxiety in 2nd and 3rd trimesters.

INTRODUCTION

When both the low back and the pelvis are affected by pain, it is referred to as lumbo-pelvic pain (LPP). LPP has been extensively examined in the general population and has a wide range of effects on a person's quality of life, employment, and productivity [1]. LPP is defined as "pain or discomfort placed between the 12th rib and the gluteal fold [2, 3]. Despite different definitions, there appears to be agreement that when low back pain (LBP) and pelvic girdle pain (PGP) are not distinguished, the term "LPP" is used [4]. Some women view pregnancy as a painful and difficult time [5]. The lumbo-pelvic area effected during pregnancy is known as pregnancy-related LPP (PRLPP) [6]. This type of pain affects women all over the world and significantly raises health care costs [7]. LPP is present in 40.6% women in 3rd trimester of the pregnancy [8]. Additionally, it has been reported in 76.2% women in last month of their pregnancy. Women who have LBP face a larger decline in their health-related quality of life during pregnancy [9]. Pregnancy-related LBP has the potential to develop into a lifelong issue. Mostly women who do not engage in exercises during pregnancy tend to develop LPP. LBP from previous pregnancies, back discomfort during menstruation, being younger, and a lack of physical exercise are risk factors for LBP during pregnancy [10]. LPP during pregnancy has been extensively studied in American Caucasian populations but largely ignored in Hispanic and

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Asian populations. It is a prevalent pregnancy related discomfort but it is a complex issue with physical, psychological, and financial effects. Research in the US has revealed that lumbopelvic discomfort during pregnancy was influenced by high pregnancy mobility index (PMI) scores, and economic unreliability [11]. Unfortunately, women are more likely than male to experience psychological distress as a result of many social, familial, occupational, and health problems that have an indirect impact on LPP [12]. According to another study, severity of pregnancy-related LPP was positively correlated with activity restrictions but not with physical activity behaviors [13]. Mostly, mobility levels denote physical risk factors during pregnancy. To measure and label a variety of mobility levels, the Pregnancy Mobility Index was introduced in 2006 specifically for pregnant women in place of pelvic girdle questionnaire that was not meant for pregnant ladies specifically and was general in nature. This questionnaire has been validated in its use and has been translated into many languages to record normal daily activities, household chores related activities and outdoor activity levels in pregnant women. For psychological factors, depression, anxiety and stress scale (DASS-21) is a short version scale of 21 items that has been validated in adults. It is a routine clinical based outcome measure [14]. Previously, it has been administered in 343 pregnant women from the time of their pregnancies to the 5-year postpartum period in an Australian study. It effectively registered comparable differences in levels of depression, anxiety and stress in pregnant women in this longitudinal study [15]. Numeric pain rating scale (NPRS) consists of 0-10 numbers, 0 means no pain and 10 means highest possible level of pain. This is a validated scale that correlates to poorly controlled pain with higher scores [16]. It has been used in pregnant women related studies for gauging pain levels [17]. Most of the studies have reported high prevalence of LPP during the third trimester mostly but have not included the 2nd trimester as well. Additionally, it has been reported that not doing exercises and financial issues leading to depression are main risk factors for LPP but it is still untaped that separately three psychological aspects i.e. depression, stress and anxiety; and overall mobility have any correlation with LPP or not. Therefore, this study intended to examine how frequently pregnant women feel lumbo-pelvic discomfort with a focus on possible correlations with psychological and physical risk factors.

This research aimed to advance knowledge of the complex interactions between physical changes, psychological health, and the occurrence of lumbo-pelvic discomfort during pregnancy.

METHODS

It was an observational cross-sectional study and the data were collected from a reputable Tertiary Care Hospital in Lahore. The duration of the study was 6 months from May 2023 to October 2023. The Ethical Review Committee CMH Lahore Medical College reviewed this study and issued an IRB letter with reference number: 706/ERC/CMH/LMC for conducting this research. The study was conducted in line with ethical standards set by the ethical committee of CMH LMC & IOD and under the Declaration of Helsinki. Written informed consent was taken from each participant. The total sample size was 210 and pregnant females in 2nd and 3rd trimester between the ages of 18 to 40 years were included. The following sample size calculator was used:

$n = z2\ p(1-p)/d2$

$z = 1.96$

$p = 0.153$

$d = 0.05$

The recruitment of participants was through the non-probability convenient sampling technique. Patients with hypertension, systemic illness, cognitive impairment, incontinence issues were excluded from the study. The researchers conducted detailed reviews of the participant's medical history and demographic data such as age, trimester, total number of children, and current number of pregnancy. Data were collected through questionnaires during interviews conducted by physiotherapists. Authors explained each term mentioned in all questionnaires to participants in Urdu or Punjabi language so that every participant was able to understand complex terms. Data were analyzed using SPSS version 25.0. Numeric Pain Rating scale (NPRS) for pain, Pregnancy Mobility Index (PMI) for mobility and physical activity levels, and Depression, Anxiety, Stress scale-21 (DASS-21) for gauging psychological factors were used. NPRS is a modified version of Visual Analogue Scale with an evenly spaced scale containing 0 to 10 numbers. 0 means no mean and 10 means worst imaginable pain [18]. At first participants were asked to identify and mark the location of pain from 12th rib to gluteal fold. Then they were asked about the intensity of pain using NPRS. For mobility levels that present physical factors PMI was used. It is 24-item scale and related to different mobility tasks at home and outdoors. Greater the score, greater is the level of mobility limitations. It records responses on a likert scale such as: 0= no difficulty, 1= slight difficulty, 2= mild difficulty, 3= severe difficulty and 4 = unable to perform the activity. Then in the end, the sum of all recorded scores is calculated that ranges from 0 to 96. Here is the interpretation of PMI:

a) 0-20: Minimal or no mobility issues
b) 21-40: Mild to moderate mobility difficulties
c) 41-60: Significant mobility difficulties
d) 61-96: Severe mobility impairment

DASS-21 was used to record psychological 3 sub factors such as depression, anxiety and stress through 21 items. It also followed likert scale 0 to 4, with 0 being not applicable at all and 4 meaning fully applicable most of the time.

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Recorded scores as per the categories such as depression, stress and anxiety were summed and then multiplied by two to get values according to each category. Its interpretation [17-18] is as follows:

Depression:
Normal: 0-9; Mild: 10-13; Moderate: 14-20; Severe: 21-27; Extremely Severe: 28+

Anxiety:
Normal: 0-7; Mild: 8-9; Moderate: 10-14; Severe: 15-19; Extremely Severe: 20+

Stress:
Normal: 0-14; Mild: 15-18; Moderate: 19-25; Severe: 26-33; Extremely Severe: 34+

The Kolmogorov-Smirnov test was run to check normality of data. As long as the p-value was below 0.05, all data were nonparametric. To find relationships between pain levels, PMI, stress, anxiety, and depression, the Spearman correlation test was utilized. Quantitative variables were expressed using percentages, means and standard deviations. P-values less than 0.05 showed significant correlations. PMI has high reliability and validity with Cronbach Alpha = 0.80 or higher during pregnancy and after pregnancy. Overall Cronbach Alpha=0.74 for DASS-21 [19]. Reliability was also reported higher in the case of NPRS for low back pain with ICC=0.99 [20].

RESULTS

Table 1 shows the clinical and descriptive stats of the study population. The mean age of participants was 27.46 ± 5.5, and the mean NPRS score was 3.74 ± 2.88. Mean scores of NPRS represent moderate levels of pain in pregnant women.

Table 1: Clinical and Descriptive Stats of Study Population

Variables	Mean ± S.D	Minimum	Maximum
Age of Participant (Years)	27.46 ± 5.05	18	40
NPRS*	3.74 ± 2.88	0	10
Stress	10.59 ± 8.21	0	38
Anxiety	11.57 ± 7.81	0	36
Depression	7.96 ± 7.76	0	36
PMI*	10.99 ± 5.24	0	61.54

*NPRS: Numeric pain rating scale for pain levels; PMI: pregnancy mobility index for physical factors

Table 2 shows the prevalence of lumbo-pelvic pain among the study population. More than the average number of pregnant women experienced LPP in the 2nd and 3rd trimester.

Table 2: Prevalence of Lumbo-Pelvic Pain (LPP) in Pregnant Ladies with 2nd and 3rd Trimesters

Variables	Response	Frequency (%)
LPP (210 Participants)	Yes	146 (69.52%)
	No	64 (30.48%)
LPP in 2nd Trimester	Yes	48 (70.60%)
	No	20 (29.40%)
LPP in 3rd Trimester	Yes	98 (69.00%)
	No	44 (31.00%)

Table 3 shows the correlation of lumbo-pelvic pain with psychological factors and mobility levels in pregnant ladies. According to the table, there were moderate correlation of pain (NPRS) with psychological factors, and no correlation was found between pain and mobility levels in 2nd trimester. On the other hand, in third trimester, LPP had weak correlations with pain and mobility levels.

Table 3: Correlation of Pain (NPRS) with Psychological Variables (DASS-21) and Mobility Levels (PMI) in 2nd and 3rd Trimester

Trimester	Variables	p-value*	r-value*
2nd	Stress	0.00	0.583
	Anxiety	0.00	0.424
	Depression	0.00	0.517
	PMI	0.44	0.096
3rd	Stress	0.00	0.310
	Anxiety	0.00	0.333
	Depression	0.00	0.365
	PMI	0.003	0.248
Total 210 Participants	Stress	0.00	0.40
	Anxiety	0.00	0.40
	Depression	0.00	0.41
	PMI	0.002	0.21

*Spearman Correlation Test was applied with r-values interpreted as: 0 to 0.3-weak correlation; 0.3-0.5-moderate correlation; 0.5-0.7-strong correlation & 0.7 onwards-very strong correlation. P value is interpreted as: p>0.05 no significant difference exists and p<0.05 significant difference exists.

Figure 1 shows that mostly pregnant women had moderately impaired levels of physical activity during both trimesters but a large number of women with 3rd trimester as compared to 2nd trimester faced mobility restrictions.

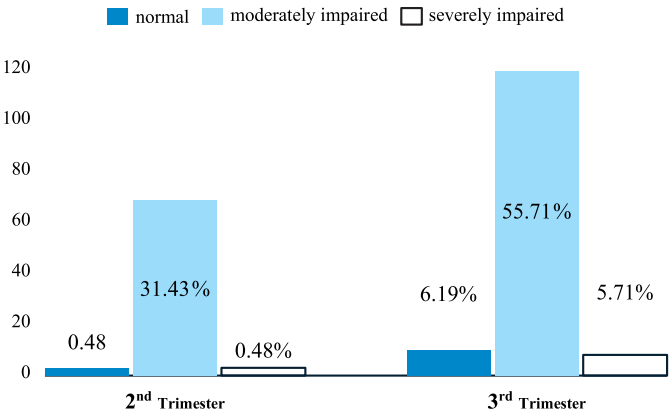

Figure 1: Gender distribution among study participants

DISCUSSION

The high prevalence of LPP in pregnant women shows that this condition is a significant public health concern. The prevalence of lumbopelvic pain varies greatly among healthcare systems. Overall, it was noticed that 55.71%

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pregnant women in the third trimester and 31.43% in the 2nd trimester faced moderately impaired mobility. On the other hand, 5% of women in the 3rd trimester reported moderate limitations in mobility levels. Our current study's results are consistent with earlier accounts of ADL challenges brought on by pain sensations related to LPP in pregnancy. According to Gashaw *et al.*, study that was conducted in Ethiopia 57% of pregnant women with lumbo-pelvic discomfort indicated that it restrained their ADLs moderately, and 49% avoided daily activities including running, stair climbing, doing hectic work, and lifting weights activities that are part of the PMI [21]. When assessed by their capacity to carry out their regular ADLs, it was discovered that more than half of the pregnant women with low back pain had a moderate level of impairment. In contrast to present study that only reported 5% women with extreme activity limitations, that Ethiopia based study showed that 43% women with pregnancy experienced extreme levels of activity limitations. In a systematic review done by Shanshan *et al.*, prevalence of LPP remained between 58% to 63% in pregnant women according to continent, BMI and age [22]. Higher BMI and old ages had an impact on increased prevalence. Additionally, gestational age did not matter for LPP. Similarly, the current study reported that occurrences of LPP remained similar in 2nd and 3rd trimesters. But as far as age is concerned, most of the data had a mean age of mid-twenties but still the prevalence was quite high. A cross-sectional study done by Eroglu *et al.*, included 160 pregnant women in Türkiye. They reported LPP in 73.4% of women. Moreover, significant correlations were reported between pain levels and disability with $p<0.001$. Same was found between pain, depression and anxiety. This study's results are validating the current study's results [23]. Uzelpasaci *et al* interviewed 107 pregnant women and tried to find relations of pain levels with musculoskeletal and physical risk factors [27]. They found mild intensities of low back ache but the current study reported moderate intensity of LPP in the reported population. Similar to current study, they reported more disability levels in 3rd trimester. They reported that presence of diastasis recti and abdominal muscle thickness were not related to low back pain intensity levels. In contrast to current study, it was established that physical inactivity was not related with LPP in 3rd and 1st trimesters, however, there was positive association between LPP and sedentary behavior in 2nd trimester.

CONCLUSIONS

A significant number of pregnant women experience moderate physical impairments during both the second and third trimesters, with a notable increase in mobility impairments during the third trimester. Additionally, lumbo-pelvic pain was prevalent in over half of the participants and showed a moderate correlation with psychological factors, while its correlation with physical factors was weak.

Authors Contribution

Conceptualization: SMAMN
Methodology: SMAMN, SZHS, MI, FC, FR
Formal analysis: SMAMN, AR
Writing-review and editing: YS, AR

All authors have read and agreed to the published version of the manuscript.

Conflicts of Interest

The authors declare no conflict of interest.

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Original Article

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Impact of Multidimensional Poverty on Immunization: Evidence from Pakistan

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ABSTRACT

The association between health and poverty is well well-known concept, but poverty extends beyond income and encompasses multiple dimensions. Good health is not always attributed to wealth, but many other factors contribute to maintaining good health and life expectancy. **Objective:** To investigate the association between multidimensional poverty and immunization. **Methods:** Using the data of the Pakistan Demographic Health Survey (2017-18), the study focuses on three dimensions of poverty (income, education, and living standard) and adopts immunization as a health variable. The study examines, with the help of descriptive statistics and multivariable logistic regression that how the health variable is associated with multidimensional poverty measures. The effective curves are used to identify which dimensions of poverty are more effective in predicting the association of poverty with poor health. Additionally, the study applies the dual cut-off method to identify the proportion of population in poverty. **Results:** The results of the study demonstrate that composite measures of multiple poverty dimensions are more effective predictors to identify individuals in poor health than a unidimensional poverty measure such as income. Individuals experiencing multiple dimensions of poverty face more health issues as compared to those who are poor in just a single dimension. **Conclusions:** The study confirms the importance and relevance of multidimensional poverty for health and suggests focusing on multiple aspects of poverty rather than considering a single dimension. Encouraging collaboration among health, education and social welfare departments can be helpful to address poverty and improve health holistically.

INTRODUCTION

The idea of multidimensional poverty is derived from Sen's Capabilities theory [1]. Sen's theory highlights inequalities arising from individual preferences and capabilities. These inequalities are formed if primary capacities and goods are uniformly distributed among the people, and then they reveal their preferences. Capabilities are seen as the freedom or opportunity a person has to choose among different combinations of functionings that they have reason to value. The notion of capability and the theory of multidimensional poverty are helpful to explore key features of human life and overall well-being. These frameworks explore how various dimensions of poverty can be hurdles to a person's ability to achieve the functioning they have reason to value. This also allows us to find the association between health and multidimensional poverty [2]. The existence of poverty is one of the acknowledged restricting factors to achieve the objective of sustainable growth. Poverty has been discussed in different forms, including the monetary poverty in its single dimension; however, the inclusion of Sen's capability approach converted the debate from a single dimension to multiple dimensions of poverty, including the different social and economic aspects of social disadvantages. Some socio-economic attributes were considered as the key attributes of this capability approach, like education, health and housing facilities. Though researchers preceded their thinking to some other distinct aspects of multidimensional poverty like child poverty, energy poverty and health poverty, however, the last one achieved unprecedented attention of researchers because its

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impact on the performance of the economies was not ignorable [3]. Health has been analyzed in the research in various aspects, including the association of health with poverty [4, 5]. After the idea of multidimensional poverty, it has been included in the multidimensional analysis as a dimension of poverty [6]. Some studies analyzed the deprivations of individuals in different aspects of health [7-9]. Most of the studies conducted on multidimensional poverty and health adopted health as a poverty aspect or analyzed the multidimensional health poverty, taking different aspects of health and identifying deprivation of individuals in these aspects. Some studies investigated how different types of poverty (unidimensional and multidimensional) affected health and used effective curves to identify which type of poverty was a better predictor of poor health [10]. The association between health, poverty and multidimensional poverty had been analyzed in different ways in Pakistan. The majority of the studies have examined how poverty affected health [11-14]. Different studies examined the impact of health facilities on poverty in rural Punjab and analyzed the relationship between health poverty and climate variability in provinces of Pakistan [15, 16]. Some studies analyzed how poverty affected the health of children and mothers [17, 18]. In multidimensional poverty analysis, most of the studies included health as a dimension of poverty [19-21]. However, one study used different dimensions of health poverty and estimated the multidimensional poverty health index (MPHI) [22]. These studies give a clear understanding regarding the poor health, the cause of relationship between health and poverty and, multi-dimensional features of health poverty. An important limitation of these studies is the lack of analysis that how multidimensional poverty affects the health. This gap has been attempted to be filled in the current study, and the current study has examined the effect of multidimensional poverty on health considering immunization as a dependent variable and unidimensional and multidimensional poverty as explanatory variable. The research examined the relationship between health and multidimensional poverty and gave some guidelines to the stakeholders that what aspects of multidimensional or unidimensional poverty could be addressed. The study focused upon three dimensions of poverty: wealth, education and living standard. Preceding studies had proved that these three dimensions of poverty were independently related to health even after controlling the income [23].

The study aims to concentrate upon the evidence achieved from PDHS which indicated that the wealth poor individuals were 53.88% and multidimensional poor individuals were 96%. Considering the importance of the multidimensional poverty, it is of great interest to analyze to what extent MP effects the health of the individuals and implies to policies of health care in Pakistan.

METHODS

The microdata attained by the Pakistan Demographic and Health Survey 2017-18 were utilized in the study. The DHS project is funded through USAID (an American agency of international development) that supports the processes of implementation of health and population surveys in all over the world. The National Institute of Population Studies (NIPS) under the aegis of the Ministry of Health in Pakistan implemented it. The sampling frame used for the survey is the same as it was created by the Pakistan Population and Hosing Census 2017 and that was complete list of Enumeration Block (EBs). The estimates of the survey cover all the provinces of Pakistan (Punjab, Khyber Pakhtunkhwa, Sindh, and Baluchistan), Gilgit Baltistan, Islamabad Capital Territory, FATA and AJK. Samples were chosen independently through a two-stage selection process in every stratum. This study selected the Household Questionnaire from the total six questionnaires used for the DHS survey, which reflects the health issues of the population of Pakistan. After removing missing values, 50,495 households were included in the analysis. The current study adopted the dual-cutoff approach to construct the measures of multinational poverty. This measure can be divided into two unique steps: (1) the identification step, which helps to distinguish the poor from non-poor (2) the aggregate step, which brings the poor into an overall indicator of poverty. Following these two steps, the study initially defines deprivation as a shortfall from a definite cutoff point. Secondly, poverty is defined as a shortfall of the total of deprivations from a definite cutoff point. Each dimension is given equal weight as it is narrated by Atkinson [24]. The current study considered three poverty dimensions: living standard, education, and wealth, with equal weight to all dimensions. The study considered immunization as a proxy of health variable and analyzed it with unidimensional and multidimensional poverty separately. Some studies analyzed the contribution of immunization to the improvement of health and survival of life [25]. Currently, the three most popular ways of identification exist: unidimensional, union and intersection. Under the unidimensional approach, all the indicators of welfare are combined in a single aggregate variable, and the cutoff point is defined based on this aggregate variable. An individual is taken as a poor when his or her achievements become below this cutoff level. This approach of identification is useful in situations when all dimensions of deprivation affect the aggregate indicator. The union approach is taken into account when an individual is deprived of any single dimension of poverty. This is commonly used, but it may be overly exclusive and may lead to overestimation when the number of dimensions' increases. The intersection method is applied when someone is deprived in all dimensions to be recognized as

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poor. This method often leads to an underestimation of poverty. For example, in our data using this method, only 0.1% of the respondents are identified in the poverty. Union method covers more individuals in poverty, but it possibly reduces the odds of recognizing individuals in poor health. In the alternative, the intersection approach can raise the probability of finding the people who are in bad health, but it may reduces the numbers of a actual individual in group of poor people. [26]. To curb the above-explained problem, based on three dimensions (1. wealth, 2. education and 3. standard of living), the study formulated some types of poverty. Writing format, various forms of poverty can be laid out, such as D = (1, 2, 3) $\geq$ 2, being individuals who are lacking in a minimum of two of the three aspects of poverty. And also D (1, 3) tells us about individuals who are deprived in 1 and 3 measures of poverty. Unidimensional poverty like D (1) =1, D (2) =2 and D (3) =3 are not left out in this classification. Putting aside three dimensions of poverty, there will be varieties of multidimensional poverty. Analogues of poverty in 3 dimensions to D = (1, 2, 3) $\geq$ k, where K=1, 2 and 3 or D(1, 2, 3)= 3. D =(1,2,3)$\geq$ 1 reveals that a group of people will be assumed to be poor in one of the 3 dimensions that are included. D(1, 2, 3)= 3 indicates that the individuals are poor by all three aspects of poverty.The study first concentrated on three one-dimensional types of poverty measures (D (1)=1, D (2)=2, and D (3)=3) followed by multi-dimensional measures of poverty (D= (1, 2)=1, D= (1, 3) =1, D= (2, 3)=1 and D= (1, 2, 3)=3) and compared each form of poverty and rate of immunization (in indicator poor health) with each form of poverty. It used a logistic model for regression analysis after controlling the other factors (gender, age and marital status). In health research, the ordered logit model is commonly used when the dependent variable possesses more than two ordered categories, like low, medium and high. The logistic model is an appropriate selection when the dependent variable has two categories. In this way total of seven equations are estimated. The first three equations are based on unidimensional poverty, taking a single indicator of each dimension.

$$\log(y_1) = \alpha_0 + \alpha_1 x_1 + \mu \quad (1)$$

$$\log(y_1) = \alpha_0 + \alpha_2 x_2 + \mu \quad (2)$$

$$\log(y_1) = \alpha_0 + \alpha_3 x_3 + \mu \quad (3)$$

$$\log(y_1) = \alpha_0 + \alpha_4 (x_1 + x_2) + \mu \quad (4)$$

$$\log(y_1) = \alpha_0 + \alpha_5 (x_1 + x_3) + \mu \quad (5)$$

$$\log(y_1) = \alpha_0 + \alpha_6 (x_2 + x_3) + \mu \quad (6)$$

$$\log(y_1) = \alpha_0 + \alpha_6 (x_1 + x_2 + x_3) + \mu \quad (7)$$

The effectiveness is measured in two terms, first by asking about poverty type as an effective definition of poor health, without identifying a different kind, giving a broader coverage to the poor and with a higher OR of poor health. Second, the paper compared the probability of the model that indicates the poor health with every kind of poverty. However, this method may constitute a trade-off between the coverage of the population in the deprivation group and the probability of occurrence of individuals in the group of poor health individuals. The results suggest that increasing the cutoff points, i.e., targeting more intersections of dimensions of poverty (as it reduces the coverage of individuals in poverty dimension).

RESULTS

Regression analysis demonstrates the estimated outcomes obtained from the output of estimated logistic regression models applied separately to each type of poverty dimension. In the following tables of output, the first column shows different types of poverty dimensions. The second columns talk about the coverage of population in poverty, while the third and fourth column indicates the odds ratios (OR) of poor health concerning each dimension and their confidence intervals (95% CI), respectively. The fifth column presents p (z), which indicates that the variable is likely to be a significant predictor of outcome. The study determined a 95% confidence interval to check the association between poor health and poverty. The results indicated that this association in terms of OR was significant at the 5% level for the maximum types of poverty. In the logistic regression model, the value of log-likelihood indicates how well the estimated model explains the observed data. Particularly, it uses the logarithm of the likelihood function that measures the probability of observation of a given set of outcomes (dependent variable) given the parameters of the model. It is maximized during the estimation as the larger the log-likelihood, the better the model fits the dataset. Results indicate the logistic model regression output explaining the impact of different types of poverty on immunization. In unidimensional poverty, D (1) =1 and D (2) =1 (the impact of wealth and education on health) is positive, as well as all types of multidimensional poverty are predicting their positive relation with immunization, except D (3) =1. Higher OR values indicate greater odds of poor immunization. Unidimensional poverty shows significant associations with wealth (OR=1.389) and education (OR=1.224). Multidimensional poverty, combining multiple deprivations, shows even higher odds, with the highest OR (1.531) when at least one deprivation is present in wealth or education (Table 1).

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Table 1: The Estimated Analysis Between Different Types of Poverty and Immunization

Type of Poverty	Poverty	OR	95% CI	Log likelihood	p>(z)
Uni -Dimensional Type of Poverty and Immunization					
D (1) =1	53.8%	1.389228	1.334453-1.446251	-33593.287	0.000
D (2) =1	60.4%	1.223697	1.177972-1.271197	- 33667.783	0.000
D (3) =1	10.3%	.7694182	0.7263929-0.8149919	-34283.67	0.061
Multidimensional Type of Poverty and Immunization					
D (1, 2) ≥1	92%	1.530311	1.428026-1.639922	-33648.987	0.000
D (1, 3,) ≥1	63.6%	1.137378	1.094279-1.182174	-33700.486	0.000
D (2,3) ≥1	60.4%	1.300974	1.25003-1.353995	-33638.498	0.000
D (1, 2, 3) >1	93%	1.431219	1.329102-1.541181	-33676.755	0.000
D (1, 2, 3) =3	1.8%	1.431219	1.329102-1.541181	-33676.755	0.000

Note: The OR shows the estimated odds ratio of poor health, obtained from the logistic regression models to predict poor health by poverty. D denotes the number of deprivations in the dimensions in the subsequent parenthesis, where 1 = household wealth, 2 = education, 3 = housing conditions.

Figure 1 shows the combination of effective types of poverty and the proportion of individuals in poverty. The effectiveness is assessed with the highest proportion of poverty and a high odds ratio. Moving from left to right the curve shows that multidimensional poverty (D (1, 2) >1 and D (1, 2, 3) >1 cover more individuals in poverty with higher odd ratio, while unidimensional poverty (D (1) =1) has lowest coverage of population as well as lowest OR. This confirms the validity of multidimensional poverty in the effectiveness of identifying the poor status of health. In unidimensional poverty, education is the most relevant correlate to immunization (Figure 1).

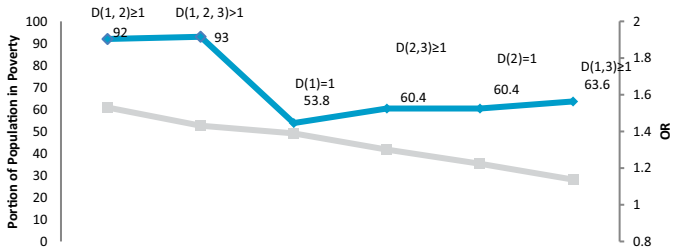

Figure 1: The Effective Poverty Curve for Poor Immunization

The curve shows the combination of the population in poverty (X-axis) and the odds ratio (Y-axis) of poor immunization for every effective type of poverty.

DISCUSSION

The study analyzed and compared the impact of unidimensional and multidimensional poverty on health by taking immunization as a proxy of health variable and regressing them separately with different dimensions of poverty. When using immunization as a health variable, the study found that in unidimensional poverty, wealth and education had a significant impact on health, with high OR and covering a prominent proportion of the population with the least immunization. In the analysis of multidimensional poverty, two-dimensional poverty (combining education and wealth (D= (1, 2≥1)) gives more significant results, predicting that less educated and poor people have more risk of being less immunized. The results are strengthened from the literature as some studies found a strong relationship between income, education and least immunization [27]. Some studies narrated that in Pakistan, low levels of education and low economic status remained the main hurdles in immunization of children, as well as women's empowerment, which was a significant factor in low immunization [28, 29]. Ahmed and Ahmed analyzed the impact of poverty and social status on immunization in Pakistan and determined that poverty was a big obstacle to immunization in Pakistan [28]. The OR ratio of D (1, 2) ≥ 1 is highest among the results, which indicates that wealth and education, as combined, are the most prominent factors contributing to immunization, following D (1, 2, 3) ≥ 1, which is the combination of all three types of poverty. Concluding the analysis, the two types of poverty, D (1, 2) ≥1 and D (1, 2, 3) ≥1, are the most significant predictors of poor immunization, as these possess high OR; additionally, these cover a significant portion of the population in poverty. In unidimensional poverty, D (2) =1 covers the highest proportion of the poor population, meaning that the less educated people have the least tendency to the immunization. The results of the estimation are significant, all odd ratios lie in the range of the confidence interval, and the probability of z is in the range of 95% confidence interval. This finding is consistent with the results of many preceding studies, which mentioned a close association between education and immunization [30]. The results achieve strengthen from literature as some studies found a strong relationship between income, education and least immunization [31]. Khan *et al.*, considered that education and low economic status remained the main hurdles in immunization of children, as well as women's empowerment, which was a significant factor in low immunization [32, 33]. The study recommended that emphasizing the multidimensional poverty, the health status of the people could be improved. So, the policymakers might address MP more seriously rather than focusing on unidimensional poverty. Addressing a single aspect of poverty, education, particularly female literacy, can be a catalyst to increase the motivation for immunization.Some other key points can be helpful for policy formation.

- In short run program of addressing multidimensional poverty, educational programs on immunization, hygiene and preventive health care can be launched with conditional cash payments, which can be linked to

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maternal and child health care visits. In long run, education on immunization and health care knowledge can be included in syllabus while to reduce financial burden health insurance can be introduced.

- Government might formulate policies to enhance awareness about diseases and the importance of immunization to escape the ill health.
- A media campaign can play a vital role in creating awareness among the people about immunization.
- Energy subsidies might be given to low-income people to ensure their access to electricity and clean fuel.
- The government might formulate a mechanism for collaboration among health, education and social welfare departments to eradicate poverty and improve health holistically.
- A well-coordinated strategy can improve the health disparities and overall well-being of the people. sectors.

CONCLUSIONS

It was concluded that the study confirms the importance and relevance of multidimensional poverty for health and suggests focusing on multiple aspects of poverty rather than considering a single dimension. Encouraging collaboration among health, education and social welfare departments can be helpful to address poverty and improve health holistically.

Authors Contribution

Conceptualization: AUH
Methodology: AUH
Formal analysis: AUH, SA, UA
Writing review and editing: AUH, MSA

All authors have read and agreed to the published version of the manuscript.

Conflicts of Interest

The authors declare no conflict of interest.

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