Analyzing Implications of Pandemics Like Covid-19 On ASD Children & Dealing Strategies: A Case Study

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THESIS ACCEPTANCE CERTIFICATE

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DEDICATION

Dedicated to my exceptional parents, husband, siblings, and friends,

whose tremendous support and cooperation led me to this

wonderful world of accomplishment

DECLARATION

I hereby declare that except where specific reference is made to the work of others, the contents of this dissertation are original and have not been submitted in whole or in part for consideration for any other degree or qualification in this, or any other University. This dissertation is the result of my own work and includes the outcome of the work done.

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All praise for **Almighty ALLAH** Who is the ultimate source of all knowledge. **Almighty Allah** has made me reach this present pedestal of knowledge with quality of doing something novel, stimulating and path bearing. All respects are for **Holy Prophet Hazrat Muhammad (PBUH)** who is the symbol of guidance and fountain of knowledge.

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ABSTRACT

Autism Spectrum Disorder (ASD) is a neurological disorder marked by difficulties with social interaction, repetitive behavioral patterns, and constrained hobbies and interests. This lifelong disorder begins in early childhood and eventually causes problems throughout a person's life span. The severity of the symptoms may vary from individual to individual. Some children show symptoms of ASD within the first year of life. Others might not experience symptoms until 24 months of age or later. Although the exact cause of ASD is unknown, research has identified several contributing reasons, including genetics and certain environmental factors. There is no known cure for the disease, but intensive and early treatment can significantly improve the lives of individuals diagnosed with ASD.

Further, epidemiological studies have shown a rapid increase in the prevalence of ASD in recent years, with a prevalence of four to five times more in boys than girls. Even though there are no reliable statistics on autism in Pakistan, according to the Pakistan Autism Society, it is estimated that approximately 400,000 children in Pakistan are assumed to have ASD. This suggests a significant portion of the population suffers from the disease.

Moreover, when COVID-19 was declared a global pandemic, WHO suggested that governments worldwide should implement necessary protective measures to control the spread of virus and safeguard their populations. Pakistan was no exception to this approach. The potential restrictions not only reduced the virus's transmission but also caused significant disruptions in people's daily lives. These disruptions created new challenges and led to heightened psychological distress, especially for families of individuals with pre-existing mental health disorders, particularly Autism Spectrum Disorder. Therefore, this study aims to analyze and compare the unfavorable impact of Covid-19 pandemic on mental wellbeing of ASD and TD (typically developing) participants in Pakistan, potential factors predicting heightened parental distress, and to narratively characterize their needs. Additionally, it seeks to compare ASD children's behavior problems before and during global COVID-19 pandemic.

For this purpose, a total of 66 primary data samples from participants of ASD and TD groups were collected from Rawalpindi and Islamabad with the help of a comprehensively designed survey. The survey questionnaire included 6 sections related to participants and children demographic characteristics, parental exposure to COVID-19, impact of COVID-19 lockdown, behavioral problems and ASD support during lockdown, parental distress via DASS21 and 2 open response questions.

Analysis of the data begin with preprocessing, after preprocessing final dataset consisted of 51 samples (ASD= 21, TD=30). The survey's reliability analysis was also performed using Cronbach's alpha. Descriptive and comparative analysis were performed on various items of questionnaire. The results of this study reveals that demographic variables shows no significant difference between the two groups except for Child's gender. Even though the COVID-19 lockdown resulted in a challenging period for majority of families, ASD families reported increased difficulties and requiring more commitment than before in nearly all aspects of life as compared to the TD group. It was also found that ASD children showed more behavioral problems in terms of aggression (42.9%), repetitive (23.8%) and transition activities (42.9%) during lockdown than before it. Moreover, compared to parents of TD children (7.84%), parents of ASD children exhibits higher level of distress (17.56%).

The comparison of tested machine learning models ranked the severity of ASD symptoms, certain type of therapy the child receiving, group (ASD vs. TD), parental exposure to Covid-19, and difficulties in managing the child's daily routine and physiological distress as the most significant predictors of parental distress during Covid-19 pandemic. Lastly, majority of participants reported the need for financial support (17.6%), increased awareness (35.3%), and proper planning (37.3%) from the government during such crisis. Therefore, the findings of this study provide evidence which highlights the necessity for interventions aimed at assisting parents in reducing distress and developing effective coping strategies, especially for families with ASD. These interventions should be a collaborative effort of both healthcare professionals and government authorities.

CHAPTER 1

1. Introduction

The emergence of the COVID-19 pandemic had posed a significant threat to human life and health, with notable consequences for mental well-being. It generated anxiety, depression, and stress and caused long-term psychological suffering in adults and children in all aspects of life. People noticed significant changes in their daily lives, and the situation was even worse for those with pre-existing mental health disorders, primarily those with ASD [1].

Autism Spectrum Disorder

Autism Spectrum Disorder is a neurodevelopmental disorder characterized by impairments in social communication and interaction, as well as restricted and repetitive patterns of behavior. It is a common heterogeneous condition affecting the developing brain, with symptoms typically emerging in early childhood and persisting throughout a person's lifespan [2]. Moreover, Individuals with ASD often face additional challenges such as a typical language development, cognitive delays, specific interests or activities, and behavioral problems including aggression, anxiety, tantrums, and non-compliance [3]. The Diagnostic and Statistical Manual of Mental Disorders 5th edition (DSM-5) is a widely used reference for diagnosing ASD. Further, epidemiological studies have shown a rapid increase in the prevalence of ASD in recent years, with a prevalence of four to five times more in boys than girls [4].

Symptoms

The onset of ASD symptoms can vary among individuals. Some children exhibit signs within their first year of life, while others may not manifest symptoms until 24 months of age or later. Typically, individuals with more severe impairments are identified and diagnosed at younger ages compared to milder cases. The severity of symptoms also varies from person to person- from low to high functioning. For example, some children demonstrate normal to high intelligence, while others have lowered IQ and have trouble learning new knowledge. Also some ASD children require a lot of assistance in their daily life, while others may function independently [5]. Some of the core symptoms associated with ASD are shown in Figure 1[6].

Figure 1: Core and Associated Symptoms of ASD

Diagnosis and Treatment

Diagnosing ASD might be challenging due to the absence of a definitive medical test, such as a blood test. Doctors rely on careful observation of a child's behavioral patterns and developmental milestones to formulate a diagnosis. Individuals with ASD often require ongoing support and assistance from their families throughout their lives. However, there are currently no specific and effective medications available for the treatment of ASD [7]. The primary approach to managing ASD involves rehabilitative training to address core impairments in social and communicative skills, as well as potential co-occurring conditions such as intellectual disability and attention-deficit/hyperactivity disorder [ADHD] [8].

Moreover, early, comprehensive, and intensive behavioral intervention is widely acknowledged as an effective strategy for improving the long-term outcomes of children with ASD. This approach focuses on enhancing social and communication abilities to help children with disabilities to improve their skills throughout their life [9]. Some of clinical therapies essential for effective ASD treatment are as follow (Figure 2) [10].

Figure 2: Types of early intervention therapies for ASD

Applied Behavior Analysis (ABA) therapy encompasses various types and approaches that are popular in different geographical locations. Its primary objective is to teach children appropriate behaviors and skills, ultimately facilitating their integration into mainstream educational and community settings [10].

Developmental therapy or play therapy consist of multiple approaches that vary across states. These therapeutic interventions focus on enhancing social communication skills and promoting successful play and communication among children with autism and their peers [10].

Occupational therapy coupled with sensory integration therapy, targets the fine motor challenges commonly observed in children with autism. These challenges can hinder tasks such as handling utensils or engaging in drawing activities. ASD individuals also struggle with sensory issues that make it difficult for them to experience loud noises and bright lights. Occupational therapists help autistic children to develop their abilities and reduce sensory overload [10].

Speech therapy plays a crucial role in addressing speech delays and atypical language usage often experienced by children with autism. Early intervention in this domain facilitates language development, enabling children to catch up with their peers, utilize spoken language effectively, and employ nonverbal communication tools such as picture boards or sign language to express themselves [10].

Specialized School programs tailored for children with autism offer valuable learning opportunities in a group setting. These programs aim to amplify educational experiences and support the unique needs of children with disabilities [10].

Risk factors:

Despite extensive research, the complete range of etiologies that contribute to Autism Spectrum Disorder (ASD) is still largely unexplained, significant advancements have been made in the last decade regarding the

identification of certain neurobiological and genetic foundations, as well as risk factors, associated with this complex condition. ASD exhibits a high heritability, but it is also influenced by environmental factors (Figure 3) [11] [12].

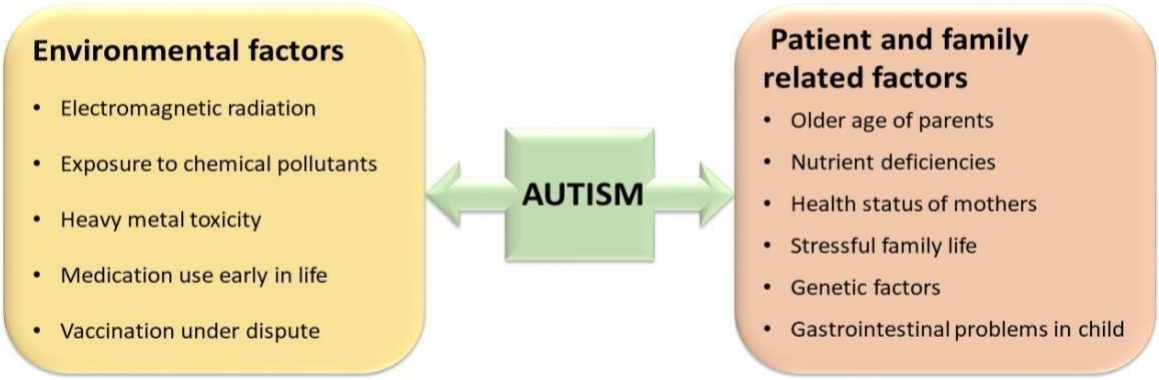


Figure 3: Causes and Risk Factors Associated with ASD

Prevalence

Worldwide prevalence:

Undoubtedly, Autism Spectrum Disorders (ASD) represents one of the extensively studied conditions within the realm of mental health. Among the contentious subjects concerning this population is the prevalence of this spectrum of disorders. There has been a significant surge in the number of reported cases, prompting the exploration of various hypotheses to interpret this phenomenon. Notable possibilities frequently examined include expanded diagnostic criteria, heightened awareness of the disorder, early-age diagnosis, and recognition of ASD as a lifelong condition [13].

According to the World Health Organization (WHO), the global prevalence rate of ASD is estimated to be 1 in every 100 individuals [14]. It is significant that different ethnic populations have distinct rates of ASD occurrence. For instance, in the United States, the Center for Disease Control and Prevention (CDC) established the ASD and Developmental Disabilities Monitoring Network (ADDM) in 2000 to systematically screen children for ASD. A recent report published by the Autism and Developmental Disabilities Monitoring Network showcased that the prevalence of ASD among children has reached 2.77%, equating to one in 36 children (Figure 4) [15]. Comparable to Western countries, ASD affects approximately 1% of children in mainland China [8]. It is estimated that the prevalence in Saudi Arabia is 1 in every 99 individuals [16]. In South Asia, ASD is estimated to affect more than 5 million children [17].

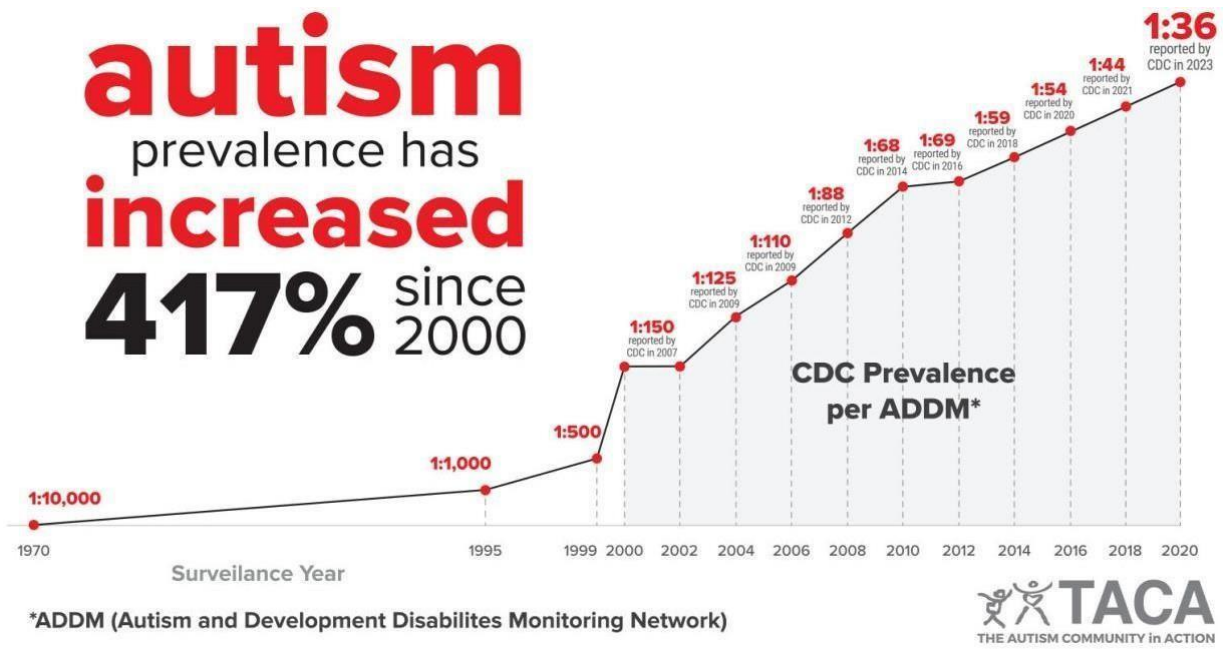


Figure 4: Prevalence rate of ASD since 1970

Prevalence in Pakistan:

Regarding the incidence of autism in Pakistan, there are no trustworthy statistics. About one in thirty six children in the US population has autism, and the frequency is rising. According to South Asian statistics, Pakistan may experience the same prevalence of the condition as the rest of the world[18]. However, according to the Pakistan Autism Society, approximately 400,000 children in Pakistan are thought to have ASD [19]. Due to the likelihood of societal shame, lack of knowledge, awareness, resources, and diagnostic experience, most of these children, unfortunately, go undiagnosed in Pakistan. The affected children, who must endure the weight of the disorder and be mistreated, are more unfortunate than the parents, who frequently suffer in silence [20] .

Impacts of COVID -19 pandemic:

WHO declared COVID-19 a pandemic in March 2020, after it affected the entire world, beginning in Central China. This global emergency resulted in the highest number of lockdowns ever at the same time in history [21]. Approximately 3.9 billion people were in some sort of lockdown by the first week of April 2020 [22]. At first, the lockdown was a common defensive strategy imposed by governments to keep infection numbers under control in their respective countries [3]. Pakistan was no exception. Preventive measures such as the closure of offices, all levels and forms of educational institutions and mosques , the suspension of Umrah activities , enforcement of stay-at-home orders, the transition to working from home, social distancing norms, the use of face masks and other rigorous restrictions significantly reduced the spread of the virus [23] [8]. Although the

actions taken were commendable and necessary, they created new difficulties and challenges for the global population [24].

The challenging circumstances during the pandemic, coupled with limited access to medical care, have led to a range of emotional reactions, such as anxiety, mental health issues, and inappropriate behavior [25]. Furthermore, the utilization of online medical services often failed to meet the needs of patients and presented difficulties in providing qualified assistance [26] [27].

Moreover, education has also been significantly affected by the pandemic, with a deterioration in students' academic performance observed in various countries. Implementing alternative forms of education has proven challenging, particularly for individuals requiring additional support. Evaluating the effectiveness of such educational approaches has proven to be a complex task. Young individuals have emphasized both the advantages and disadvantages of distance learning. The advantages include the ease of adopting digital tools, as well as parental and academic support. However, drawbacks of online learning encompass issues related to concentration, self-study planning, self-discipline, decreased engagement, negative emotions (such as stress, fatigue, and fear of exams), and a lack of face-to-face interaction with peers. In comparison to traditional schooling, students generally rated remote education as having lower quality [27].

Children with ASD as a vulnerable population

Considering the significant presence of individuals with Autism Spectrum Disorder in society and the increasing prevalence of this neurodevelopmental condition, it is rational to infer that a considerable portion of the ASD population required support and assistance, especially in the face of the demanding circumstances associated with the pandemic [28]. The hallmark features inherent to ASD, characterized by constrained and repetitive behavioral patterns often manifested as a strong insistence on maintaining sameness, rigid adherence to routines, or engagement in ritualistic behaviors, can give rise to various difficulties in adapting to the disruptions imposed by the pandemic [29] [27].

In general, children with ASD benefit from a range of educational, medical, and therapeutic services because of their unique developmental and learning demands. Therapies for ASD such as ABA (Applied Behavior Analysis), speech, occupational therapy etc. demand continuation and can only be provided by trained professionals for effective outcomes. These services were either eliminated or drastically scaled back during the epidemic, which might have made it difficult to manage numerous aspects of life [27]. Further, the interruption of in-person education, extracurricular and social activities, routine healthcare, irregular sleep patterns, lack of professional support, and financial insecurity might also have threatened physical and mental well-being of families associated with Autism [30].

Parents of children with ASD may also encounter specific challenges during the pandemic. They must exercise heightened vigilance in caring for their child due to the frequent unpredictability of their child behavior and

emotions, in addition to the typical challenges of parenting. Children diagnosed with ASD may demonstrate disruptive behavior during mealtimes. For instance, they may exhibit challenging eating behaviors such as selective eating, which is dependent on factors like food presentation, texture, type, or smell. Consequently, parents of children with ASD may find themselves managing their children's behavior and hostility while simultaneously juggling their other familial and occupational responsibilities. Not surprisingly, these circumstances have a compounded impact on the physical and mental health of parents. The detrimental consequence of such situation is that parents may approach or experience a state of breakdown or exhaustion in the near future [23].

It was already well known that parents of ASD children have overall greater levels of anxiety and stress compared to those of typically developing children, which could have notably increased during the pandemic [3]. Therefore, the most relevant objective of this study is to examine the behavioral changes and psychological suffering of parents and their children with ASD, as well as the significant difficulties they faced during the lockdown.

Justification:

Autism, traditionally regarded as a rare disorder, is experiencing a notable rise in prevalence, even within developed nations. In fact, it is currently recognized as one of the fastest-growing disabilities affecting children [13]. A number of global organizations such as The American Society of Autism (ASA), the National Autistic Society (NAS) in the UK, the Autism International Foundation (AIF), and the International Organization of Parents of Autistic Child have been created to offer assistance and medical care to parents and children with autism around the world.

In Pakistan, both government and private sectors have established a limited number of schools, primarily in larger cities, that claim to meet the educational requirements of autistic children. However, due to an insufficient evaluation methodology, autistic children are often grouped together with children experiencing mental retardation in specialized schools. Moreover, even schools and healthcare services that claims to provide special education facilities lack the latest knowledge, equipment, and skills necessary to effectively address the unique needs and challenges faced by children with autism.

In general, the lack of specially constructed facilities for tackling ASD and learning difficulties is a problem in Pakistan. This indicates that only a small percentage of children who have ASD receive support. There is a dearth of one-on-one tutoring, home tutoring, and daycare facilities for these kids, and the teacher-to-student ratio makes it difficult to see progress. A dream is an early intervention and transition to regular schools or an inclusion program. The poor cannot afford therapy due to the excessive cost of examinations and therapies. The medical community lacks training, CME programs, and general population knowledge. At the national level, there are no advocacy programs, funding possibilities, or awareness campaigns.

SCALeD (Society for Children with Autism and Learning Differences) created the PCA (Pakistan Centre for Autism) project with all these factors in mind to address this pressing social need in Pakistan. Under the direction of a few well-known Pakistani figures and donors, the project began in 2012 [31].

As we are familiar with the fact that the COVID-19 lockdowns have affected the everyday lives of people and above mentioned facts highlight the importance of skilled training, awareness and financial insurance for ASD individuals especially in times of such crisis. Hence, this study will focus on numerous issues faced by ASD children and their parents during the lockdown in Pakistan specifically in Islamabad and Rawalpindi as well as recommend coping strategies to overcome routine difficulties of insufficient resources (human, infrastructure, technology, etc) during the lockdown. Previously various researchers have performed similar studies in many different regions to investigate the impact COVID-19 pandemic on ASD children and their parents, as the experiences of parents from different regions/ countries could be different because of availability or unavailability of resources and awareness of the disorder. In developing countries, particularly Pakistan, the impact of COVID-19 on ASD is still unfolding and little is known about it [32]. To the best of our knowledge, no such attempt related to COVID -19 impacts on ASD has been conducted previously in Pakistan. Hence further research could be done to find out the impacts of the COVID -19 pandemic on ASD individuals and their parents of different regions or countries.

Problem Statement:

Based on above discussion the major issue referred in this study in that ***Empirical investigation regarding effectiveness of complete/smart lockdown during pandemic in case of children with neurological and developmental disorders and their associated parents are lacking, especially in case of Pakistan.*** Therefore, there is a need to perform an analysis based on certain facts and figures.

Proposed Solution:

This research aims to conduct an ***Evidence based survey analysis to determine the usefulness of dealing strategies during pandemics, their limitations and way forward for children with neurological and developmental disorders like ASD.***

Objectives of the study:

The major objectives of research includes

- A survey analysis to determine the effectiveness of complete/smart lockdown during pandemics for children having neurological and developmental disorders and their associated parents.
- Measuring and comparing the degree of depression, anxiety and stress (DAS) of associated parents of affected children during pandemics.

- Highlighting significant factors for improvement in dealing strategies to overcome routine difficulties hence supporting data driven decision making.

CHAPTER 2

Literature Review

Significant research has been done in the past that examined the difficulties experienced ASD children and their families during COVID-19 lockdown. Evidence from various studies suggests the worsening of symptoms in ASD children also such families, parents/caregivers endure more stress compared to parents of children without ASD. There are several known factors that increase parental distress and the probability of developing mental health problems during pandemic. Factors which includes handling children behavioral problems, managing their daily routines, severity of ASD symptoms, lacking of social and financial support etc. are relevant that may boost distress in parents. It has also been found that higher level of distress significantly and negatively affects the parents-child relationship.

An online survey by Talal Alhuzimi (2021) was conducted via email on a sample of 150 parents of ASD children in Saudi Arabia to explore their stress and emotional well-being during the COVID-19 outbreak. The questionnaire, which was developed in English and then translated to Arabic, gathered information about the parents' demographics, the family's ASD status, ASD support during the COVID-19 pandemic, the severity of the ASD behaviors compared to the child's pre-COVID-19 eating behaviors, parental stress, and emotional well-being. Further, this study was the first to employ the PSI-SF and GHQ-12 scales to measure parents' mental health and emotional well-being, respectively. However, due to time constraints, a pilot study was not conducted to assess the study. It was discovered that the COVID-19 pandemic negatively impacted the parental stress and emotional health of parents with ASD in Saudi Arabia, recommending the Saudi Ministry of Health set up and expand support services for parents of children with ASD [23]. Another online survey of 211 Saudi Arabian parents with ASD children was conducted by Youssef Althiabi to examine their attitudes, anxieties, and perceptions of mental health care. For data collection, the questionnaire was generated using the Survey Monkey website in English and, afterward, translated by professionals into Arabic. For scoring parental anxiety and mental health status, the Hospital Anxiety and Depression Scale (HADS) and General Health Questionnaire (GHQ-12) were used, respectively. It was found that their anxiety level was noticeably greater during COVID-19 and mothers were more affected. The internal consistency of the research questions was also evaluated in a pilot study using Cronbach's Alpha [3].

In 2020, another survey-based online study, conducted by Collizi et al., aimed to investigate the consequences of the COVID-19 pandemic on individuals with Autism. The study also aimed to determine the needs of these

individuals during the lockdown and identify any pre-pandemic characteristics that could predict adverse outcomes. Data were gathered from 527 survey participants through Google Forms, which included a comprehensive questionnaire consisting of 40 questions. These questions examined various aspects, including social-demographic and clinical features, the pandemic's impact on overall well-being, and the specific requirements to address such emergency situations. The findings illuminated the significant challenges posed by the COVID-19 emergency for individuals with ASD and their families. These challenges involves greater difficulties in managing daily activities, particularly in terms of free time and structured activities, and an increase in the frequency and severity of behavioral issues. The study also highlighted various needs, including a heightened demand for healthcare support, notably in-home assistance and interventions designed to address the effects of quarantine measures. It's crucial to note that the study relied on self-reported data from parents/guardians, which could introduce bias and might not comprehensively consider the experiences of ASD individuals themselves. Additionally, the survey's geographical scope was limited to Northern Italy, potentially constraining the generalizability of its findings to other regions. Furthermore, the absence of a comparison group comprising non-ASD individuals makes it challenging to describe the specific impact of the pandemic on individuals with ASD when compared to the general population [33].

In 2021, Levante et al. performed a study which aimed at exploring the psychological impact of the COVID-19 lockdown on families having children with and without ASD. For this objective, the dataset was gathered through online surveys from Italy, with a total of 120 participants, 53 of whom were ASD parents and 67 were TD (Typically developing) parents. Spearman's correlation was used to find out the relationship between variables, while mediation models were applied using Process v3.0 to examine the interplay between parental distresses (predictor variable), children's emotional responses (mediators), and children's playing activities (outcome variable) during the period of mandatory lockdown. Additionally, chi square test, paired sample t -tests, and independent sample t-tests were also performed to compare variables between the two groups. All statistical analyses were performed using SPSS version 25. The study found that parental distress influenced children's emotional responses and playing activities, with ASD children expressing more positive emotions but engaging in less playing activities in comparison to TD children. The study also reported increased behavioral problems and parental distress in the ASD sample during the COVID-19 lockdown, highlighting the need for interventions to reduce parental distress and develop coping strategies for the better management of the caregiver-child relationship. One of the key limitation of the study was that it was cross-sectional and relied solely on online data collection of children aged between 5-10 years. Moreover, the study did not include control groups with other clinical conditions, which could have provided further support for the specificity of the findings [34].

Wang et al. (2021) conducted an analysis to discover the psychological distress, specifically anxiety and depression, induced by the COVID lockdown among parents of children with Autism Spectrum Disorder. The study gathered data through a self-reported online platform from participants across three provinces of China. The dataset comprised responses from 1764 participants in the ASD group and 4962 participants in the typically

developing (TD) group. The survey covered six primary sections, including Demographics, the impact of the COVID-19 outbreak, the Connor-Davidson Resilience Scale (CD-RISC), the Simplified Coping Style Questionnaire (SCSQ), the Self-rating Anxiety Scale (SAS), and the Self-rating Depression Scale (SDS), designed to gather data from eligible participants [8].

Various variables extracted from the above-mentioned sections were utilized as covariates to account for their influence on the anxiety and depression scores obtained via SAS and SDS, respectively. The study also conducted independent t-tests and chi-square tests to compare various variables between both groups and to explore correlations among them. The results revealed that parents within the ASD group showed lower levels of resilience, engaged in more negative coping strategies, and experienced higher levels of anxiety and depression symptoms compared to parents in the TD group, all attributed to the impact of the COVID-19 pandemic. The findings emphasize the significance of parental training programs, financial support, and the necessity to address the unique challenges faced by parents of autistic children during lockdown. However, this study had a cross-sectional design, which limits the ability to assess changes in psychological distress over time. Furthermore, the study lacked data on the severity of ASD symptoms in children, making it challenging to differentiate the effects of ASD itself from those of COVID-19 on psychological distress [8].

Fong et al. (2021) performed a study in Malaysia that provides valuable insights into the psychological well - being of parent-child dyads and child behavior in families with children formally diagnosed with an autism spectrum condition during the COVID-19 lockdown. The study utilized a quantitative research design and an online survey to collect data 72 parent-child dyads with children diagnosed with autism spectrum condition (ASC) and 62 parent-child dyads with typically developing (TD) children. The questionnaire consisted of demographic and diagnostic information, ASC symptoms, children's inattention, hyperactivity/impulsivity, perceived stress, depression, and anxiety, as well as parents' perceived stress, depression, anxiety, and well-being. The results show that there were no significant impact of lockdown on ASC symptoms, and children of both groups experienced negative effects on attention, hyperactivity/impulsivity, and anxiety. Further, parents of children with ASC reported increased level of depression, anxiety, and stress compared to parents of TD children. The findings suggest the need for policy and practice recommendations to support families with Autistic children during the pandemic. The research depends on a self-report measures, which may be subject to bias. Furthermore, the study focused on the impact of the lockdown in Malaysia limiting its generalizability to other contexts. The study did not include a follow-up period to consider long-term impacts of lockdown [21].

In 2022, Kreysa et al. conducted a study that covered a comprehensive literature review focusing on the impacts of the COVID-19 pandemic on the quality of life for school-age individuals, both autistic and neurotypical. This study incorporated original data obtained from a multinational online survey, with a particular emphasis on examining changes in activities, overall well-being, and social interactions within families with autistic children during the COVID-19 pandemic. The survey findings unveiled that both autistic and neurotypical children

encountered decrease in their well-being and an increase in anxiety levels. However, the impact on adaptability was significantly more pronounced among children with autism. The study further discussed the imperative need of addressing the challenges confronted by families subjected to pandemic restrictions. It also highlights potential opportunities for social involvement and success, particularly in older children and young adults with ASD during the COVID-19 outbreak [35].

Dekker et al. in 2021 conducted an online survey analysis aimed at investigating the consequences of the COVID-19 pandemic on families and individuals with Autism Spectrum Disorder. This study was a mixed-methods approach to comprehensively assess the overall functioning and symptoms of individuals with ASD, in addition to examining parental and family functioning, both in the short term and long term. Data of participants were gathered at two distinct time points: during a COVID-19 peak (T0) and subsequently (T1). Furthermore, pre-COVID dataset were obtained from clinical records. The research also sought to discover the risk and protective factors associated with resilience and gain insights into the needs of perceptual and informational during such a crisis.

It's important to acknowledge that the study may introduced bias and subjectivity as it relied on self-report measures collected from parents. Additionally, the study's geographical scope was limited to Rotterdam, constraining its generalizability to other regions. Moreover, the study faced limitations stemming from a relatively small sample size and the absence of a control group, which made it challenging to establish a connection between the COVID-19 pandemic and the observed outcomes within ASD families [1].

In 2022, Aneta Lew-Koralewicz conducted a study in Poland with the objective of exploring potential effects of the COVID-19 pandemic on the psychosocial and educational functioning of students diagnosed with Autism Spectrum Disorder. This qualitative study included a dataset of 10 secondary school students with ASD and used informative phenomenological methods for data analysis. The study's findings showed a spectrum of effects induced by the COVID-19 pandemic on the respondents. On a positive side, they reported being able to spend quality time with their families and detach from challenging social relationships. Conversely, they also experienced difficulties in emotional functioning, online education issues, experienced increased levels of stress and anxiety, and dealt with feelings of loneliness. These outcomes underscore the importance of providing support to individuals with ASD on emotional, social, and educational levels during such pandemics. However, it's important to recognize that the survey sample obtained from only Poland may limit the generalizability of its findings [27].

In 2022, Furar et al. conducted a similar study in the United States that aimed to find out the impact of COVID-19 lockdown measures on parental ratings of personal concerns, as well as concerns related to their children, on issues such as family conflict and the loss of social and educational support for children ASD. This investigation was performed through an online survey. The dataset consisted of responses from 246 parents of school-aged children with ASD, collected retrospectively at three separate time points before COVID outbreak, at the

beginning of pandemic and upon survey completion. The study's outcomes discovered a rising level of concern among parents and their children over time. Interestingly, parents reported higher levels of concern for themselves compared to their children. These findings highlight the persistent need for increased availability of services and support systems for families affected by ASD during public emergencies like the COVID-19 pandemic. However, certain limitations inherent to this study, including potential biases associated with the study design and the restriction of generalizability due to the parent-reported survey data only from the United States [36].

Isensee et al. conducted a recent study (2022) with similar objective in both Germany and Austria to examine the impact of the COVID-19 pandemic on families with children with Autism Spectrum Disorder. For the purpose of data collection online surveys were used. The comprehensive survey utilized in this research encompassed 74 questions, addressing various aspects including socio-demographic characteristics, clinical attributes of the children, and adjustments in family routines during the lockdown, parental mental health, and their perceptions of positive changes during the lockdown period. The findings indicated that nearly 50% of the families experienced elevated levels of parental stress and aggravated ASD symptoms during the pandemic. Further, disruptions in therapy sessions, increased intra-familial conflicts, and augmented usage of psychopharmacological medications for children were also reported. Despite these challenges, the outcomes also identified perceived benefits associated with the COVID-19 pandemic, highlighting the need for further investigation into its long-term effects. Moreover, it emphasized the significance of identifying and promoting parental protective factors to to boost overall well-being in ASD families. Nevertheless, it is essential to spot certain limitations of this study. The findings of the study cannot be generalizable to individuals of other regions given that the survey was exclusively conducted in Germany and Austria [37].

Based on the above-mentioned studies, the main challenges faced by ASD children and their families during the crisis include:

Closure of educational institutes and health care services:

Lack of access to technology and loss of support provided by the educational system is one of the greatest challenges for ASD children and their parents. Using virtual schooling instead of normal schooling can fail to develop skills and add stress to financial and emotional hardship for families of children with special health needs [24]. The loss of home nursing, therapies, personal protection equipment, various medical supplies, and secure access to healthcare providers are among other challenges [38]. Additionally, delay in diagnosis and check-ups/treatment of ASD children significantly worsens behavioral and cognitive outcomes and may raise the risk of serious COVID-19 problem [30].

Increase in parental stress and challenging behaviors of ASD children:

The burden on parents has increased during the crisis because of being a teacher, therapists, taking care of families, and lack of caregiver support from grandparents and other close relatives [39] . This increases parental physiological stress and anxiety which in turn negatively impacted their children with ASD, worsening their symptoms, posing more behavioral difficulties, and harming their mental health [23]. Furthermore, the elimination of social interaction, predictable daily routine, and physical activity developed Aggression, temper tantrums, and stress among special children [40]. An increased proportion of parents faced trouble overseeing their kids' everyday activities, particularly when it came to free time and structured activities [33].

Loss of insurance and financial instability of parents:

Dropping therapies due to lost access to insurance benefits and an increase in financial burden because of the economic uncertainty during the pandemic in turn leads to severe long-term behavioral outcomes [30]. As children with developmental disorders already struggle with picky eating, worsening food insecurity caused by the loss of financial resources to purchase food and the unavailability of the child's favorite foods has posed additional hurdles for the parents [38].

Lack of support from government and community stakeholders:

Limited social support from government officials and lack of assistance from healthcare administrators was another challenge faced by the parents and special children [40].

The fear of the contagiousness of the disease:

An additional difficulty was the possibility of these children contracting the virus and adhering to the regulations, such as social isolation, mandatory masks, and obstruction of emergency medical care [3]. Families with children in skilled nursing facilities had been concerned about the possibility of COVID-19 spreading through facilities and the loss of visitors. As a result, they were forced to make the difficult choice of attempting an abrupt integration of their children with complex needs into their homes without the proper support to ensure their well-being [38]. Further, the challenges faced by children with mental disorders also include the possibility of a parent or caregiver getting seriously infected with the virus and needing hospitalization or passing away, leaving them without any guardian [40].

Research Gap:

All these problems mentioned are faced by ASD children and their families in Saudi Arabia, Malaysia, China, Poland, US, Italy, Germany etc. during COVID-19 pandemic but none of the researches provided a worldwide comparison of all pandemic effects as the experiences of parents from different regions/ countries could be

different. It might not be appropriate to generalize their findings and dealing strategies and apply them to parents from other nations.

To the best of our knowledge the consequences of COVID-19 pandemic and parental distress encountered by ASD children and their parents in Pakistan has not been assessed yet. Therefore, this research is the first to attempt to close this gap in knowledge through empirically investigating the effectiveness of complete/smart lockdown during pandemic on parents from their own perspectives.

CHAPTER 3

Methodology:

Research methodology simply discusses and explains the practical implementation of the "how" aspect within a research study. A key part of thesis, study, or research paper, the methodology chapter more precisely explains the systematic strategies adopted by a researcher to construct a study that yields results of both validity and reliability, substantively addressing the research's fundamental goals, objectives, and questions. It refers to the collection of practical decisions regarding what type of data to collect (e.g., qualitative or quantitative data), from who to collect it from (i.e., the sampling strategy), how to collect it (i.e., the data collection method) and how you'll analyze it (i.e., the data analysis techniques) [41].

The chapter thoroughly discuss the designing of questionnaire, collection of quantitative and qualitative data, data pre-processing, data visualization and data analysis. It also discusses the software tools used for analysis.

In this study both quantitative and qualitative data are analyzed. Quantitative data are countable and measurable and are expressed as numbers while qualitative data are descriptive in nature related to words, types and languages [42]. Overall workflow of research methodology is demonstrated in Figure 5

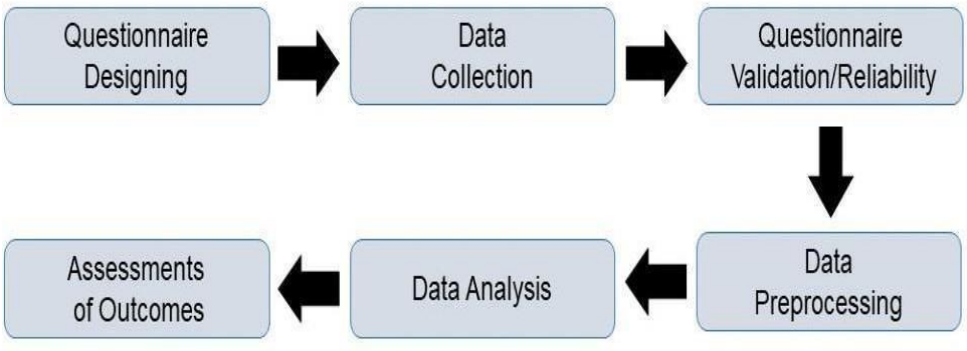


Figure 5: Complete methodology

Questionnaire Designing

This study employs a questionnaire-based survey methodology to examine the effects of COVID-19 lockdown measures, with a primary focus on comparing the effectiveness of complete/smart lockdown strategies on parents and their children. Therefore, the target participants of the survey included parents/guardians (referred to as 'parents') residing in Islamabad and Rawalpindi who had at least one child with Autism Spectrum Disorder or with typical development. The questionnaire was specifically designed in English and Urdu, by taking consultation from relevant professors, psychologists, and adapting the finding of previous researches. The survey was created and disseminated online through Google Forms using a hyperlink. It encompasses five sections related to demographic data of the participants and children (14 items), exposure to COVID-19(5 items), impacts of COVID-19 lockdown (12 items), severity of ASD behaviors in comparison to the pre-COVID-19 status (6 items)and ASD support during COVID-19 (4 items), parental stress information using DAAS-21, and two open response questions. Multiple-choice questions allowed participants to select only one response per item. While the survey structure was largely consistent for both groups, a dedicated section was designed specifically for parents of children with ASD.

Demographic data

In the initial section, the survey assessed demographic information about the responding participant, and children with and without autism. A total of 14 questions were asked from the participants, covering aspects such as participant's gender and age, place of residence, family status, relationship with the child, educational qualifications, family income, total number of children, child's age and gender, as well as the child's educational status (e.g., regular school, special education, or at home). Parents of children on the Autism spectrum were additionally required to provide supplementary demographic data regarding their child's disorder. This include information on the specific type of neurodevelopmental disorder, the severity of symptoms, and the type of therapy the child receiving.

Parental Exposure to COVID-19"

Second section of survey included five questions investigating parental exposure to the COVID-19 pandemic. Parents were asked whether they, their partner, their relatives, or their friends had tested positive for COVID-19 or shown similar symptoms. Lastly, a question asking whether any of their relatives or friends or colleagues had died because of COVID-19. Each question was worth 1 point if the participants/partner/relative/friend had tested positive for COVID-19 or had related symptoms, whereas they scored 0 points if they tested negative. Regarding the question asking whether someone had died because of COVID-19 infection, it scored 1 point if yes, and 0 if no. A cumulative score was obtained as the sum of the items, with higher scores indicating a higher level of parental exposure [34].

Impact of COVID-19 lockdown

This section of study aims to investigate the impact of COVID-19 through a comprehensive set of questions, providing valuable insights into the various aspects influenced by the pandemic. Participants were queried about the challenges they encountered during the crisis, encompassing 12 items distributed across six categories, namely: (1) Daily routines, (2) Educational condition, (3) Social development, (4) Economic/ working condition, (5) Behavior issues, and (6) Child's physiological distress. These categories were expected to be highly impacted by COVID-19 lockdown. Each item's response option was measured on a scale ranging from 0 ("Not at all") to 3 ("Very much").

Questions related to Behavioral problems and ASD support during COVID-19

This segment of the survey comprises two parts, specifically designed for parents of children with ASD. The first part consists of three formulated questions aimed at exploring behavioral problems in children with ASD before and during the lockdown period. Each question seeks to gather information from parents regarding the following aspects:

1. Aggressive behaviors: "Was your child aggressive towards him/herself before/during the lockdown?"

2. Repetitive behaviors: "Did your child show repetitive behaviors before/during the lockdown?"

3. Transition management: "Had your child face difficulties in managing the transition from one activity to another before/during the lockdown?"

Parents were asked to rate each question on a scale from 0 ("Not at all") to 3 ("Very much") to assess the severity of these behaviors during the lockdown period compared to before it [34].

The second part focuses on gathering information related to the availability of ASD support and services during the COVID-19 pandemic, specifically from school, local healthcare services, and private therapists. Parents were asked to rate their satisfaction with the support provided by the following entities:

(i) Hospitals/rehabilitation centers and therapists/doctors (2 items).

(ii) Schools/academic centers and private tutors/teachers (2 items).

Responses were measured on a scale ranging from 0 ("Strongly agree") to 3 ("Strongly disagree"). By employing this structured survey, valuable insights can be obtained concerning the behavioral challenges experienced by ASD children during the lockdown and the adequacy of support and services available to them amidst the pandemic.

Parental stress and mental health during COVID-19

Evidence suggested that increases parental physiological stress and anxiety in turn negatively impacted their children with ASD, making it essential to measure parental distress and identify the factors promoting it during the crisis. In this section of the questionnaire, parental distress during the COVID-19 lockdown was evaluated using the 21-item, self-reported Depression, Anxiety, and Stress Scale questionnaire (henceforth referred to as DASS-21). The DASS-21 is designed to evaluate distress as a composite construct, including depressive, anxious, and stress- related symptoms. For instance, depressive symptoms were evaluated through items such as "I felt discouraged and depressed" (item 13). Anxiety was measured using items like "I felt scared for no reason" (item 20), while stress levels were evaluated by items such as "I felt stressed" (item 11). Each subscale (the Depression, Stress and Anxiety subscales of the DASS-21) comprises seven items, and participants rated each item on a Likert scale ranging from 0 ("Did not apply to me at all") to 3 ("Applied to me very much or most of the time"). A higher score on the scale indicates a higher level of depression or anxiety symptoms. These specific items are carefully designed to evaluate the perceived unpredictability, uncontrollability, and overall sense of overload experienced by the participants in their lives [34].

Open response questions

The final section of the survey comprises two open-response questions. These questions aim to gather additional information from parents regarding the challenges they encountered during the COVID-19 lockdown, beyond those already mentioned. Furthermore, the section inquiries about potential strategies that could prove helpful in addressing such global emergencies in the future. Participants are encouraged to provide detailed and insightful responses to these questions.

Data Collection:

In this research, a primary dataset of dimensions 51 rows by 64 columns was utilized. The dataset comprised information from 21 parents/guardians of children diagnosed with Autism Spectrum Disorder and 30 parents/guardians of typically developing children. Data collection occurred between February and July 2023, through direct face-to-face interviews and online formats. Access to parents of children with ASD was obtained from Benazir Bhutto Hospital in Rawalpindi and Step to Learn School in Islamabad. Parents of typically developing children were also recruited as controls from regular schools, and other sources. A QR code to access the online survey was provided. Parents of children with ASD and parents of TD children received invites from teachers in special schools or regular schools, respectively. Only one attempt could be made to finish the survey using the same IP address. The study design was cross-sectional, and parents were requested to retrospectively consider the same lockdown period when they were compelled to stay at home due to the COVID-19 pandemic. The research objectives were briefly explained to the parents, and they were assured that their responses would be used solely for research purposes. Participation in the study was pursued only with the parents' agreement via consent forms. The survey was disseminated online through major social media platforms such as WhatsApp and Facebook, and snowball sampling technique was employed. To be included in the study, participants needed

to meet the following criteria: (1) being a parent or guardian of a child with an ASD diagnosis aged between 4 to 18 years or being a parent or guardian of a typically developing child aged between 4 to 18 years; (2) possessing the ability to read and understand the English or Urdu language; and (3) being a Pakistani citizen.

Statistical validity and reliability of questionnaire

After designing and validating the questionnaire through professionals, the reliability of its items was assessed using Cronbach's alpha. Evaluating a survey's validity is crucial to ensure the acquisition of meaningful data, and Cronbach's alpha serves as a valuable measure during the survey validation process [43] .

Cronbach's alpha

Cronbach's alpha is a statistical measure employed to assess the reliability or internal consistency of a scale or survey questions. It quantifies the extent to which the items on the scale are interrelated or correlate with one another. Ranging from 0 to 1, Cronbach's alpha yields higher values when the scale demonstrates greater internal consistency or reliability. For research purposes, a Cronbach's alpha value of 0.7 or higher is generally considered acceptable [43].

Mathematically, Cronbach's alpha can be represented as a function of the number of test items and the average inter-correlation among the items, along with the average variance. For conceptual clarity, the formula for Cronbach's alpha is presented below:

$$\alpha = \frac{N\epsilon}{\bar{v} + (N-1)\bar{c}}$$

Here, N represents the number of items, c is the average inter-item covariance among the items, and v denotes the average variance [43].

Data Preprocessing

The raw data collected from face-to-face interviews and online Google Forms were entered into a Microsoft Excel file to facilitate data manipulation and cleaning for subsequent analysis. Data preprocessing is a crucial step in converting raw data into a clean dataset before subjecting it to statistical analysis. The preprocessing procedure involves identifying and rectifying missing values, noisy data, duplicate entries, and other inconsistencies in the dataset to ensure its quality and reliability for subsequent statistical analysis [44].

Missing data:

One of the major concerns during preprocessing is handling missing data, which can significantly impact the validity of the study's findings. As the data is obtained from primary sources, the first step involves checking the data completeness. Upon inspection, a few missing values were identified in the variable "Participant's age" within the dataset. To address the issue of missing values, various methods exist, including case deletion, Mean substitution, Maximum likelihood, and Expectation maximization. For this study, mean substitution is employed to estimate the missing values in the variable "Participant's age". Mean substitution involves replacing the

missing values with the mean of the observed values for that variable. By conducting data preprocessing and addressing missing data through Mean substitution, using the Statistical Package for Social Sciences (SPSS), the dataset becomes more reliable, thereby enabling accurate and dependable statistical analysis in the subsequent stages of the research.

Recoding of categorical variables:

Given that a significant proportion of the variables within the dataset exhibit categorical characteristics, another essential phase in data preparation involves the recoding or transformation of categorical string variables into labeled numeric equivalents. This transformation is facilitated through the utilization of the "Recode into Same Variables" function within the SPSS software. The outcome of this process is the generation of corresponding numeric representations for the categorical variables. An illustrative representation of these categorical variables, alongside their respective numeric counterparts, is presented in Table 1.

Response Rate:

Furthermore, total 67 parents participated in the survey. However, 2 of the participants were excluded because their children did not fall within the specified age range for the study. Out of the 65 participants, 14 were further excluded from the analysis as their children were reported by the parents to have intellectual disabilities or other developmental difficulties, and thus were not considered "typically developing" for the purposes of this study. After applying these exclusion criteria, the final sample size consist of 51 participants.

Table 1: Recoding of Categorical variables in to Numeric labels

Sr.#	Variables	Categories	Numeric labels
1	Participant's Gender	Male	0
		Female	1
2	Place of living	City	0
		Village	1
3	Family situation	Nuclear Family	0
		Joint Family	1
4	Relationship with child	Father	0
		Mother	1
		Guardian	2
5	Educational qualification	Uneducated or under matric	0
		Matriculation or Inter	1
		Bachelors or above	2
6	Family monthly income (PKR)	Less than 20,000	0
		20,000-40,000	1

		Greater than 40,000	2
7	Total children	1	0
		2	1
		3	2
		Greater than or equal to 4	3
8	Child's Gender	Male	0
		Female	1
9	Child's educational status	At Home	0
		Regular School	1
		Special School	2
10	Data label	Normal	0
		ASD	1
11	Severity of symptoms	Mild	0
		Moderate	1
		Severe	2
12	Type of therapy	Other	0
		Private therapy	1
		Home guidance therapy	2
		Rehabilitation Center	3

Data Analysis

After preprocessing, data analyses were performed on clean dataset using IBM SPSS software version 20 and Google Collab. The process of analyzing data entails applying analytical or statistical methods to find relevant information. It gives life to dead data and gives meaning to useless facts. For accurate research results, data analysis depends on data visualization, descriptive statistics, and inferential statistics [45].

Data Visualization

The very first step in data analysis is data visualization. Data visualization entails the graphical or pictorial representation of information and data. By employing visual elements such as charts, graphs, and maps, data visualization tools offer an accessible means to perceive and understand trends, outliers, and patterns i n data [46]. In this study, continuous variables from the primary data were visualized using histograms, while categorical variables were represented using bar charts with the help of SPSS.

Descriptive Statistics

Descriptive statistics are methods used to summarize and describe the key characteristics of a dataset. It includes measures of central tendency, such as mean, median, and mode, which give information about the typical value in the dataset. Additionally, measures of variability, such as range, variance, and standard deviation, describe the spread or dispersion of the data. These measures are useful in understanding the trends and tendencies of the distribution of uni-variate variables [47].

In this research, prior to the main analysis descriptive statistics were utilized to deliver baseline information regarding survey participants' ASD and TD children. Continuous variables were described using the mean (M) and standard deviation (SD), while categorical variables were presented as frequencies with corresponding percentages.

Inferential Statistics

Inferential Statistics involves various statistical techniques, including correlation analysis, assessment of associations between attributes, and hypothesis testing. Its purpose is to extrapolate information from a smaller sample to make predictions and draw conclusions about a larger population. This field employs probability theory and statistical models to estimate population parameters and make inferences about population hypotheses based on sample data [48].

The primary objective of inferential statistics is to provide precise and dependable information about the entire population using sample data. By ensuring the accuracy and reliability of the conclusions drawn, inferential statistics facilitates informed decision-making and generalization of findings beyond the observed sample [48].

Comparative Analysis:

Inferential statistics are frequently employed to measure the differences between treatment groups. These statistical techniques utilize measurements derived from the sample of subjects in the experiment to compare the treatment groups and draw inferences about the broader population of subjects [49]. As mentioned in this survey research, continuous variables were described using measures of central tendency, such as mean (M), and measures of variability, such as standard deviation (SD). The differences between two groups were compared using independent t-tests. Categorical variables were represented as frequencies with corresponding percentages, and the differences between the two groups were compared by conducting chi-square tests.

In scientific research, comparative analysis through inferential statistics allows researchers to draw meaningful conclusions about the effectiveness of treatments, the significance of differences between groups, and the generalizability of findings to the larger population. The outcomes of these test provide valuable insights about potential differences in quantitative variables between the ASD and TD groups.

Chi-square tests

Pearson's chi-square (χ^2) tests, often referred to simply as chi-square tests, constitute a prevalent class of nonparametric tests. Nonparametric tests are employed for datasets that deviate from the assumptions underpinning parametric tests, particularly the presumption of a normal distribution. Chi-square tests are specifically designed to assess hypotheses concerning the distribution of categorical variables. These variables, whether nominal or ordinal, define groupings such as gender or nationalities. Given their inherent constraint to a limited set of discrete values, categorical variables cannot follow to a normal distribution [50].

Within the context of this research, a comparison was undertaken between two groups—the Autism Spectrum Disorder and Typically Developing samples—across eight categorical variables: Participant's Gender, Place of living, Family situation, Relationship with child, Educational qualification, Family Monthly income, Child's Gender and Total children. This comparison was conducted using the Chi-square (χ^2) test. Pearson's chi-square tests employ the subsequent formula to compute the test statistic, chi-square (χ^2):

$$X^2 = \sum \frac{(O - E)^2}{E}$$

Where:

- X^2 represents the chi-square test statistic
- Σ signifies the summation operator (indicating "sum of")
- O denotes the observed frequency
- E symbolizes the expected frequency

The application of the chi-square test for comparing the distribution of two populations involves the formulation of hypotheses, the selection of a significance level, computation of the test statistic, and derivation of the corresponding p-value to establish support for or against the null hypothesis. The magnitude of the difference between observations and expectations (expressed as O - E in the equation) directly influences the magnitude of the chi-square value. To determine whether this difference is statistically significant, the computed chi-square value is contrasted with a critical value [50].

To assess whether there is statistical evidence that the related population measures are substantially different, chi-square test compare the distributions of categorical variables between groups. This statistical test assesses whether there is a significant association or relationship between two categorical variables [51]. In this case, null and alternate hypothesis for each categorical variable is as follow:

Null hypothesis (H_0) = There is no significant association between the two variables of TD and ASD sample

Alternative hypothesis (H_1) = There is a significant association between the two variables of TD and ASD sample

$$\alpha = 0.05$$

Independent t-tests

The Independent Samples t-test, a parametric test, compare the means of two distinct and independent groups, seeking to determine whether statistical evidence exists to support the claim that the corresponding population means are significantly different. The formula for the two-sample t-test is depicted as follows:

$$t = \frac{\bar{x}_1 - \bar{x}_2}{\sqrt{(s^2(\frac{1}{n_1} + \frac{1}{n_2}))}}$$

Where:

- "t" signifies the computed t value,

- "x_1 and x_2 " represent the means of the two compared groups,

- "s_2" pertains to the pooled standard error of the two groups,

- "n_1 and n_2 " correspond to the number of observations within each respective group.

A larger t value signifies that the difference between group means surpasses the pooled standard error, indicating a more substantial difference between the groups' characteristics. The procedure for employing the independent sample t-test to compare the means of two groups involves hypothesis formulation, significance level determination, and the subsequent interpretation of the corresponding p-value to either uphold or disprove the null hypothesis [52] [53].

To assess whether there is statistical evidence that the population measures are substantially different, the independent sample t-test emerges as a fitting choice due to its capacity to contrast the means of two independent populations. The null hypothesis (H_0) and alternative hypothesis (H_1) of the Independent Samples t-test can be presented as:

H_0: $\mu_{TD} = \mu_{ASD}$ ("equality of the two population means")

H_1: $\mu_{TD} \neq \mu_{ASD}$ ("inequality of the two population means")

With a significance level (α) set at 0.05, the Independent Samples t-test necessitates an assumption of homogeneity of variance—signifying that both groups possess equal variance. SPSS software incorporates Levene's Test, a variance homogeneity assessment, whenever an independent samples t-test is executed.

The hypotheses underlying Levene's test are:

H_0: $\sigma_{TD^2} - \sigma_{ASD}^2 = 0$ ("equality of population variances for groups 1 and 2")

H_1: $\sigma_{TD^2} - \sigma_{ASD^2} \neq 0$ ("inequality of population variances for groups 1 and 2")

Rejecting the null hypothesis of Levene's Test implies a violation of the homogeneity of variances assumption, suggesting unequal variances between the two groups. Within the context of this research, t test was used to compare the means of the following continuous variables: Participant's Age, Age of child, Parental Exposure to Covid-19 and Parental distress in the ASD and TD groups [53].

Paired Sample t-Tests:

The Paired Samples t-Test is a method employed to compare the means of two measurements derived from the same individual, object, or related entities. This approach aims to determine whether there exists statistical evidence indicating that the mean difference between paired observations significantly deviates from zero. The Paired Samples t-Test falls within the purview of parametric tests. The test statistic for the Paired Samples t-Test, denoted as "t," follows the formula given below

$$\mathbf{t = x_{diff} / (s_{diff}/\sqrt{n})}$$

where

- x_{diff} denotes the sample mean of the differences
- $\mathbf{s_{diff}}$ symbolizes the sample standard deviation of the differences
- **n** stands for the sample size (i.e., the number of pairs)

The hypotheses for paired t test are mathematically correspondent:

H_0: $\mu_1 = \mu_2$ ("equality of the paired population means")

H_1: $\mu_1 \neq \mu_2$ ("inequality of the paired population means")

$$\alpha = 0.05$$

Subsequently, the calculated t value is juxtaposed with the critical t value, having degrees of freedom (df) equal to n - 1, derived from the t distribution table corresponding to a selected confidence level. If the calculated t value surpasses the critical t value, the null hypothesis is rejected, leading to the conclusion that the means exhibit significant dissimilarity**.** Paired sample t-tests were computed in this research to compare children's behavioral problems before and during the lockdown [54].

Modeling

A model is an informative demonstration of an object, person, or system. Model development refers to the deployment of selected subsets of features to create models capable of predicting valuable information and signifying associations between independent and dependent variables [55].

In this study, five different models, including linear regression, logistic regression, decision tree, random forest, and XG-Boost, have been developed to determine whether potential explanatory variables could predict heightened distress (measured by DASS-21) among parents of children with Autism Spectrum Disorder and typically developing children. Each model was developed with three different subsets of features as covariates using IBM SPSS software and Google Collab. Subsequently, these predictor variables were integrated into all the developed models, following these steps:

- **In Model 1,** all demographic variables were included as dependent features.

- **In Model 2,** the groups or data labels (differentiating between families with TD children and those with children with ASD) were added as covariate.

- **In Model 3**, "Parental Exposure to COVID-19" and "Impact of COVID-19 lockdown" were introduced as predictor variables.

These sequential models were formulated to systematically differentiate the potential impacts of different factors on parental distress within ASD and TD groups.

Regression Analysis

Regression analysis involves a collection of statistical methods that are employed to estimate the associations between a dependent variable with one or more independent variables. This methodology serves a dual purpose: firstly, to measure the strength of the relationships between these variables, and secondly, to formulate predictive models for their future interactions. Within the scope of regression analysis, various forms are present, including linear regression, multiple linear regression, logistic regression and nonlinear models. Notably, the most common models are those of simple linear, multiple linear regression and logistic regression. In cases where the relationship between dependent and independent variables is nonlinear, nonlinear regression analysis is commonly applied, particularly for complicated datasets [56] [57].

Regression Analysis - Simple Linear Regression

Simple linear regression constitutes a model designed to evaluate the association existing between a continuous dependent variable and an independent variable. The simple linear model is mathematically represented by the following equation [56]:

$$Y = a + bX + \epsilon$$

Where:

- Y signifies the dependent variable
- X stands for the independent (explanatory) variable
- a denotes the intercept
- b represents the slope
- ϵ embodies the residual (error) term

Regression Analysis – Multiple Linear Regression

The significant difference between the multiple linear regression analysis and the simple linear model is the inclusion of several independent variables. Mathematically it is represented as follows [56]:

$$Y = a + bX_1 + cX_2 + dX_3 + \epsilon$$

Where:

- Y represents the dependent variable
- X_1, X_2, X_3 stand for the independent (explanatory) variables
- a signifies the intercept
- b, c, d denote the respective slopes

Regression Analysis – Logistic Regression

Like linear regression, logistic regression is also used to estimate the relationship between a dependent variable and one or more independent variables, but it is used to make a prediction about a categorical variable versus a continuous one. A categorical variable can be true or false, yes or no, 1 or 0, et cetera. This type of statistical model (also known as *logit model*) is often used for classification and predictive analytics. Logistic regression estimates the probability of an event occurring, such as voted or didn't vote, based on a given dataset of independent variables. Since the outcome is a probability, the dependent variable is bounded between 0 and 1. In logistic regression, a logit transformation is applied on the odds—that is, the probability of success divided by the probability of failure. This is also commonly known as the log odds, or the natural logarithm of odds.

A logistic regression models the probability of a response dependent on individual characteristics. As probability is a ratio, what modeled the logarithm of chance given by the following equation:

$$\log\left(\frac{y}{1-y}\right) = b_0 + b_1x_1 + b_2x_2 + b_3x_3 + \cdots + b_nx_n$$

This equation can be used for classification problem and used to predict the output in the form of probabilities ranging from 0 to 1 [57].

Decision Tree

A decision tree is one of the most powerful supervised learning methods used for classification and regression tasks. It represents a flowchart like structure that starts at the root node with a specific data question, and leads to branches that hold potential answers. These branches then lead to internal (test) nodes, which pose more questions that result in more outcomes. This non-parametric process continues until the data reaches a terminal (or "leaf") node. Each leaf node contains a class label (outcome). The decision tree is created by recursively splitting the training data into subsets based on attribute values until a stopping criterion is met [58].

Random Forest:

Random Forest is known as one of the most versatile and frequently used supervised learning algorithms in the domain of data science. This algorithm is frequently used in both classification and regression modelling by constructing decision trees on diverse subsets of the data. For classification, it employs a majority vote mechanism, while for regression, it utilizes averaging to determine the outcome. Random Forest operates by creating an ensemble of multiple decision trees, thus establishing a single predictive model. By merging the outputs of these trees, the Random Forest method provides associated and highly accurate prediction. Its popularity is mainly attributable to its user-friendly nature and adaptability, enabling it to effectively address a wide range of classification and regression tasks [59].

XGBoost

XGBoost, which stands for Extreme Gradient Boosting, represents a scalable and distributed gradient-boosted decision tree (GBDT) machine learning technique. It provides parallel tree boosting and stands as the forefront machine learning tool for addressing regression, classification, and ranking tasks. Decision trees are created in sequential forms in this algorithm. A crucial characteristic of XGBoost involves assigning weights to all independent variables, which are subsequently input into the decision tree to make predictions. The weights of variables that the tree predicts incorrectly are improved, and these variables are then used as input for the development of subsequent decision tree. These individual classifiers or predictors eventually combine to create a robust and more precise model. XGBoost is highly versatile as it is capable of handling regression, classification, ranking, and user-defined prediction tasks [60].

Assessments of Analysis

In this study, five different modelling techniques have been employed sequentially to systematically separate the potential impact of different factors (independent variables) on parental distress. For linear regression distress

score, which is a continuous variable is used as dependent variable. The generated linear regression models using SPSS software are evaluated with the following measures:

R – It represents the square root of R-Squared and indicates the correlation between the observed and predicted values of the dependent variable [61].

R-Square - R-Square shows the proportion of variance in the outcome variable that can be predicted from the independent variables [61].

Adjusted R-Square - As additional predictors are introduced to the model, the explained variance in the outcome variable may arise due to chance. Adjusted R-Square provide a more accurate estimate by considering the true population R-Squared [61].

F and Sig. - The F-value is obtained by dividing the Mean Square Regression by the Mean Square Residual. The corresponding p-value helps determine whether the predictor variables precisely predict the dependent variable [61].

B - In the regression equation, these values represent the unstandardized coefficients for predicting the dependent variable from the independent variable. These coefficients are represented in their natural units [61].

Beta - These coefficients values are standardized and tells us about association between dependent and independent variables. They result from standardizing all variables before running the regression, allowing comparisons of coefficient magnitudes [61].

t and Sig. - These columns provide the t-value and p-value for testing the null hypothesis that the coefficient/parameter is equal to 0. Statistically significant features have p-values less than the selected alpha level [61].

Logistic Regression models were also developed using SPSS software, and the dependent variable for these models was binary level of parental distress. The generated linear regression models are evaluated with the following measures:

Chi-square – The Sig. of chi square represents the probability of obtaining the chi-square statistic under the assumption that the null hypothesis is true. In simpler terms, it determines the likelihood of observing collective effect of the independent variables, on the dependent variable. This value is commonly referred to as the p-value and is compared to a predetermined significance level, typically set at 0.05 or 0.01, to assess the overall statistical significance of the model [62].

Beta (β) – These values correspond to the coefficients for the logistic regression equation for predicting the dependent variable from the independent variable. They are expressed in log-odds units, the prediction equation is [62]. It is given by the equation

$$\log\left(\frac{p}{1-p}\right) = b_0 + b_1x_1 + b_2x_2 + b_3x_3 + b_4x_4$$

Where p is the probability of an event of "Severe to Extremely Severe" case and 1-p indicated the event of "Normal to Mild" case.

Wald and Sig. –the Wald chi-square value and the associated 2-tailed p-value, are employed to test the null hypothesis that the significance of independent variable is equal to 0. A two-tailed test is used, where the p-value is compared to a predefined significance level (alpha). Variables with p-values less than alpha are considered statistically significant. For example, if alpha is set at 0.05, coefficients with a p-value of 0.05 or lower are considered statistically significant. This implies that the null hypothesis can be rejected, indicating that the variables is statistically significant [62].

Exp (B) – These values represent the odds ratios for the outcome variable. They are obtained by exponentiation the corresponding coefficients. These ratios gives insights into the likelihood of an event occurring, such as the impact of independent variables on dependent variable [62].

The remaining three classifiers i.e. Decision tree, Random forest, and XG-Boost were developed using Google Collab using scikit learn library. For the application of these machine learning models, the data was randomly divided into train test set to achieve the best possible accuracy. In this study, their performance was evaluated with the following estimators:

Accuracy:

Accuracy is defined as the percentage of the correct predictions (TP, TN) of the models over total sample. It is defined as the [63]

$$Accuracy = \frac{Number\ of\ correct\ predictions}{Total\ number\ of\ prediction} = \frac{TP + TN}{TP + TN + FP + FN}$$

Where

- True positive (TP) are "Severe to Extremely Severe" cases correctly predicted by model.
- False positive (FP) are "Normal to Mild" cases incorrectly predicted as "Severe to Extremely Severe".
- True negative (TP) are "Normal to Mild" cases correctly predicted by model.
- False negative (TP) are "Severe to Extremely Severe" incorrectly predicted as "Normal to Mild".

Feature importance

Feature importance generally refers to a class of techniques employed to assign scores that indicate the usefulness or value of each feature in creating machine learning models. These importance scores are explicitly calculated for each attribute within the dataset that allows attributes to be ranked and compared relative to one another.

They are useful for gaining a deeper understanding of the input data and the model. The relative scores can provide insights by identifying which features are most relevant to the target variable and, conversely, which features hold less relevance [64].

Therefore, in this study, all the mentioned techniques for assessment of feature importance and significance will highlight the potential factors that play a major role in exacerbating distress experienced by parents of individuals with ASD and TD children due to the restrictions imposed by the pandemic.

CHAPTER 4

Results/Analysis:

The purpose of this study is to determine the effectiveness of complete/smart lockdown during pandemics for children having neurological and developmental disorders particularly ASD and their associated parents and to measure and compare the degree of depression, anxiety and stress (DAS) of associated parents of affected children during the pandemics. This chapter explain the results obtained by implementing the methodology explained in preceding chapter. Results of data visualization, descriptive and inferential analysis are presented in this section.

Data Set:

As previously mentioned, data collection was halted after obtaining a total of 66 surveys, and after preprocessing, the final dataset for analysis consisted of 51 participants. It is important to note that due to this limited sample size, some of the analyses presented herein may have low statistical power and should be interpreted with caution. The primary data has been collected from various sources of Islamabad and Rawalpindi. Detail of data sources and sample are mentioned in Table 2

Table 2 : Sources of primary data

Sr#	Source of Data	Mode of Data	Sample Size (N=51)
1	Benazir Bhutto Hospital	F-T-F Interviews	ASD=11 TD=8
2	Step to learn School	Online	ASD= 10
3	Regular Schools	Online	TD=22

Reliability Analysis:

Reliability analysis was performed to assess the relationship between individual items in the questionnaire. The internal consistency of the survey's items is determined using the Alpha (α) Reliability Coefficient, determined through Cronbach's alpha. This coefficient indicates a higher level of internal consistency among items, signifying that the measure the same underlying construct consistently. The Cronbach's Alpha value was a measure to see connectivity between the different items, i.e., how closely related a set of items were as a group. Higher values of Cronbach's Alpha mean the items were significantly correlated to be structured together.

In this research, a random sample of 20% from the complete dataset was selected for pilot study. After this selection, a reliability analysis test was performed on the pilot data using IBM SPSS Statistics Software. Furthermore, the correlation coefficient is specified as $rs \geq 0.2$, implying a minimum threshold for what is considered a meaningful level of correlation among survey's items. The Cronbach's alpha shown in table 3 suggests that the all the items of questionnaire are significantly correlated to be structured together.

Table 3: Reliability Statistics of Survey Items

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
0.911	0.918	48

Demographic Characteristics:

A total of 51 candidates participated in the study, comprising 21 parents/guardians of children diagnosed with Autism Spectrum Disorder and 30 parents/guardians of typically developing children. For data visualization as mentioned in previous chapter bar graphs and histograms were plotted to understand trends and tendencies in dataset (Table 4, 5 and 6). Furthermore, thirteen demographic variables, including both continuous and categorical variables, were selected for descriptive analysis. The continuous variables included "Participant's Age" in years and "Child's Age" in years. The categorical variables included "Participant's Gender," "Place of living," "Family situation," "Relationship with child," "Educational Qualification," "Family Monthly Income (PKR)," "Total number of children," "Child's Gender"," "Educational status of child", "Severity of symptom," and "Type of therapy child receiving". Among the parents/guardians of children with ASD, 16 (76.2%) were females, while 5 (23.8%) were males. The mean age of this group was 42.10 years, with a standard deviation (SD) of 10.054 years. In the group of parents/guardians with typically developing children, 22 (73.3%) were females, while 8 (26.7%) were males. This group had a mean age of 38.80 years, with an SD of 8.323 years.

A comparative analysis was executed on ten demographic variables. Out of these 10 variables 8 categorical variables were selected, on which chi square test was performed. The chi-square test's p-value was compared with the predefined significance level ($\alpha = 0.05$) to determine the statistical significance of the variables. The statistical evaluation of categorical variables, including "Participant's Gender," "Place of living," "Family situation," "Relationship with child," "Educational Qualification," "Family Monthly Income (PKR)," and "Total number of children," reveals that no substantial differences in distributions exist between the ASD and TD groups as their p-value is greater than the predefined level of significance ($\alpha=0.05$). Hence we are unable to

reject the null hypothesis stating that their exhibit no significant association between the two variables of TD and ASD sample. However, the variable "Child's Gender" exhibits a statistically significant variation in distribution (p=0.007) between individuals with ASD and those in the typically developing group.

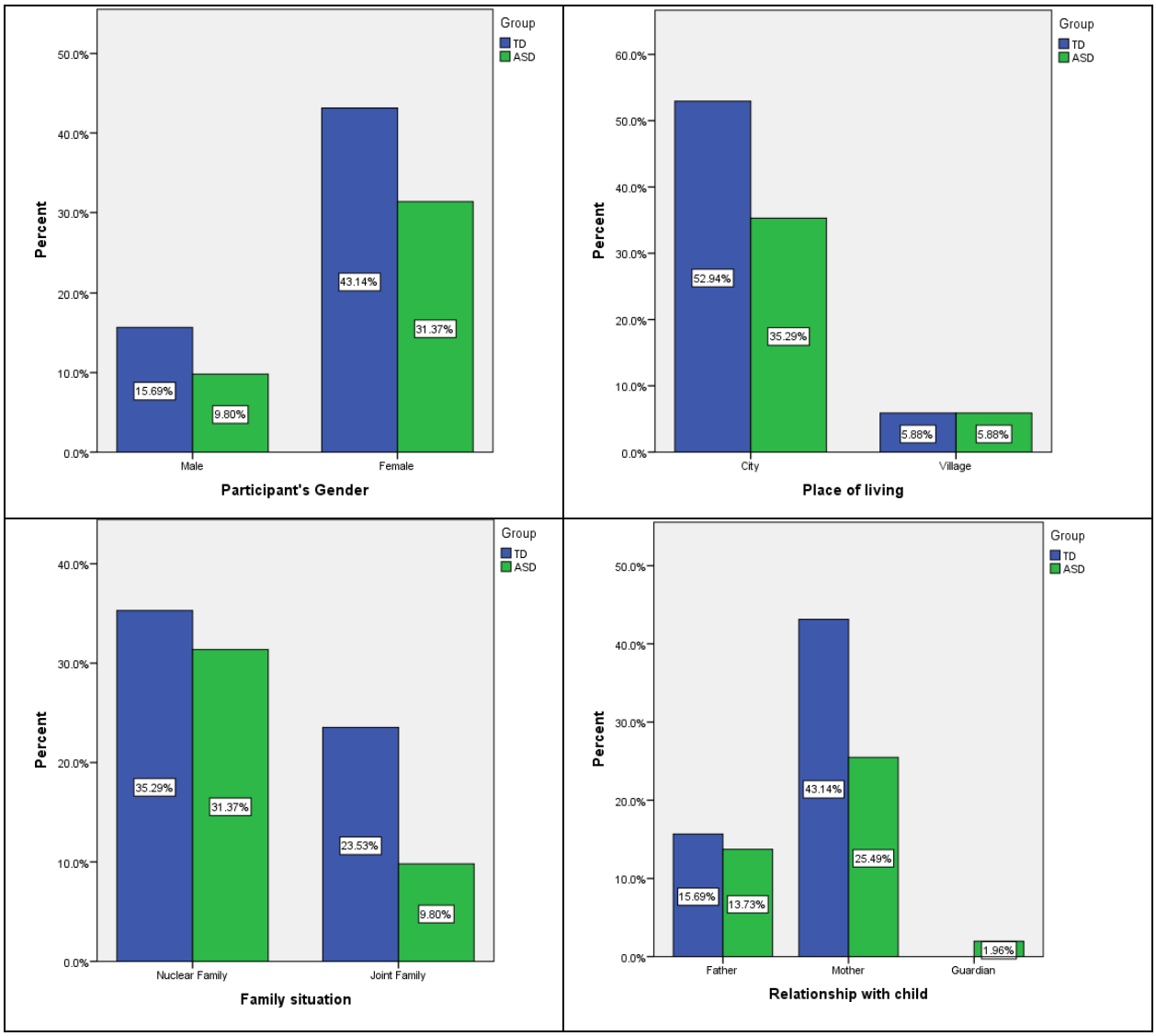
Regarding continuous variables, the t-test's calculated p-values provide evidence to reject the null hypothesis, consequently enabling acceptance of the alternative hypothesis. The statistical evaluation indicates that the variables "Participant's Age" and "Child's Age" showed insignificant difference between the means of ASD and TD cases. The characteristics of the sample along with the results of the comparisons between the two groups are presented in Table 4.

Table 4: Descriptive and comparative analysis of demographics of ASD and TD samples

Sr.#	Variable	Categories	ASD cases (n=21)	T.D cases (n=30)	Comparisons	p-Value
1	Participant Gender n (%)	Male	5 (23.8%)	8 (26.7%)	X^2 (1)=0.053	p=0.818
		Female	16 (76.2%)	22 (73.3%)		
2	Participant's Age		42.10 (10.054)	38.80 (8.323)	t(49)=-1.277	p=0.208
3	Place of living n (%)	City	18 (85.7%)	27 (90%)	X^2 (1)=0.219	p=0.640
		Village	3 (14.3%)	3 (10%)		
4	Family situation n (%)	Joint Family	5 (23.8%)	12 (40%)	X^2 (1)=1.457	p=0.227
		Nuclear Family	16 (76.2%)	18 (60%)		
5	Relationship with child n (%)	Father	7 (33.3%)	8 (26.7%)	X^2 (2)=1.850	p=0.396
		Mother	13 (61.9%)	22 (73.3%)		
		Guardian	1 (4.8%)	0 (0%)		
6	Educational qualification n (%)	Uneducated or under matric	1 (4.8%)	3 (10%)	X^2 (2)=3.300	p=0.192
		Matriculation or Inter	5 (23.8%)	2 (6.7%)		
		Bachelors or above	15 (71.4%)	25 (83.3%)		
7	Monthlyincome n (%)	Less than 20,000	2 (9.5%)	0 (0%)	X^2 (2)=3.235	p=0.198
		20,000 to 40,000	5 (23.8%)	6 (20%)		
		Greater than 40,000	14 (66.7%)	24 (80%)		
8	Total children n (%)	1	4 (19%)	5 (16.7%)	X^2 (3)=1.714	p=0.634
		2	2 (9.5%)	7 (23.3%)		

		3	11 (52.4%)	14 (46.7%)		
		=>4	4 (19%)	4 (13.3%)		
9	Child's Age M (SD)		8.69 (3.509)	10.83 (5.032)	t(49)= 1.684	=0.099
10	**Child's gender** **n (%)**	**Male**	**17 (81%)**	**13 (56.7%)**	**X^2 (1)=7.217**	**p=0.007**
		Female	**4 (19%)**	**17 (43.3%)**		
11	Child's educational status n (%)	At Home	6 (28.6%)	2 (6.7%)		
		Regular School	6 (28.6%)	28 (93.3%)		
		Special School	9 (42.9%)			
12	Symptoms n (%)	Mild	5 (23.8%)			
		Moderate	11 (52.4%)			
		Severe	5 (23.8%)			
13	Type of therapy child receiving n (%)	Rehabilitation center	6 (28.6%)			
		Home guidance therapy	1 (4.8%)			
		Private therapy	2 (9.5%)			
		Other	12 (57.1%)			
14	Parental exposure to Covid-19 M (SD)		2.42 (1.71)	2.16 (1.51)	t(49)=-0.576	p=0.568

Table 5: Illustrating Bar graphs of demographics among ASD and TD group



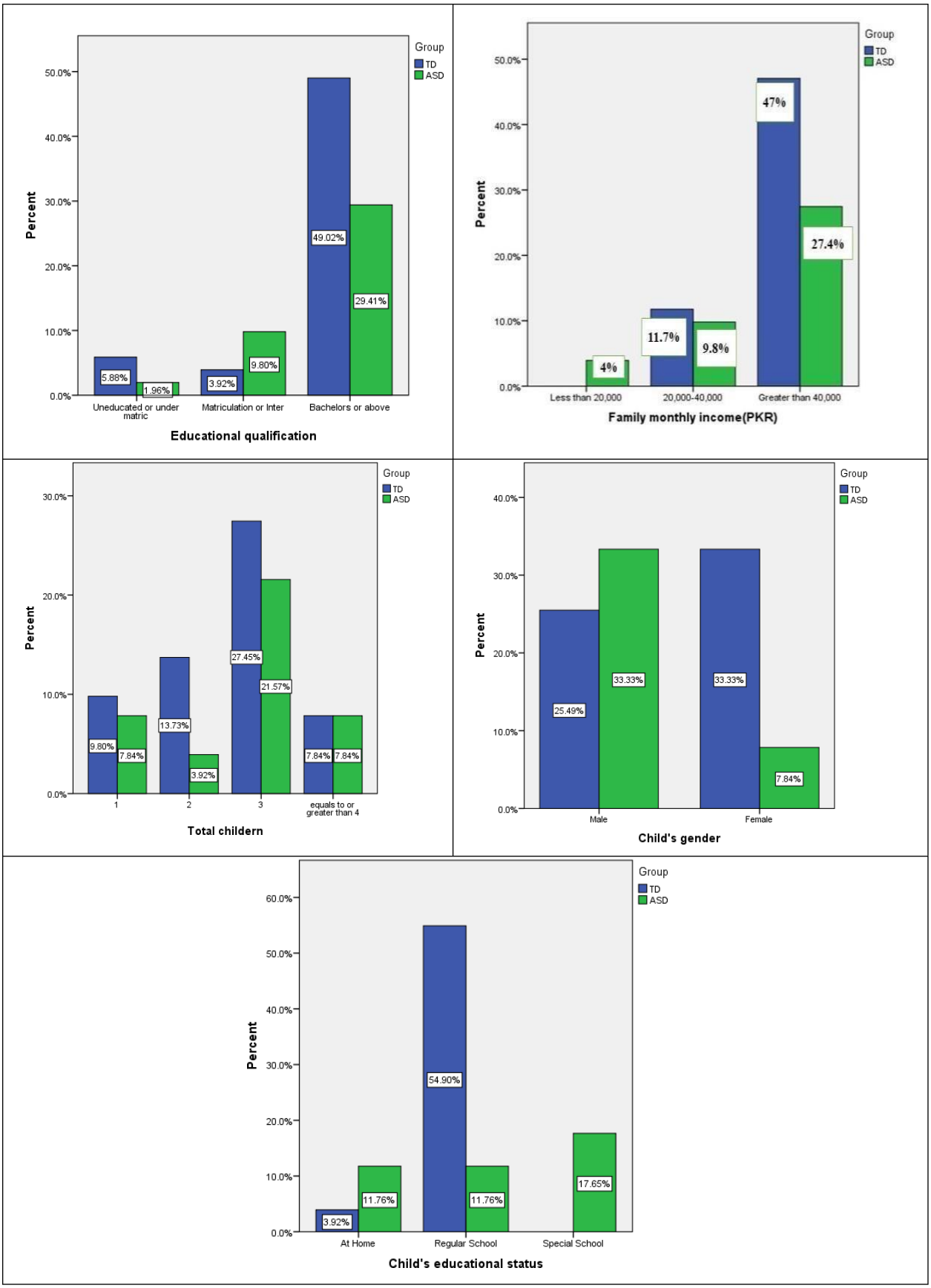

Group
TD
ASD
Percent
50.0%
40.0%
30.0%
20.0%
10.0%
0.0%
5.88%
1.96%
3.92%
9.80%
49.02%
29.41%
Uneducated or under matric
Matriculation or Inter
Bachelors or above
Educational qualification
4%
11.7%
9.8%
47%
27.4%
Less than 20,000
20,000-40,000
Greater than 40,000
Family monthly income(PKR)
9.80%
7.84%
13.73%
3.92%
27.45%
21.57%
7.84%
7.84%
1
2
3
equals to or greater than 4
Total childern
25.49%
33.33%
33.33%
7.84%
Male
Female
Child's gender
3.92%
11.76%
54.90%
11.76%
17.65%
At Home
Regular School
Special School
Child's educational status

Table 6: illustrating Bar graphs of ASD group features

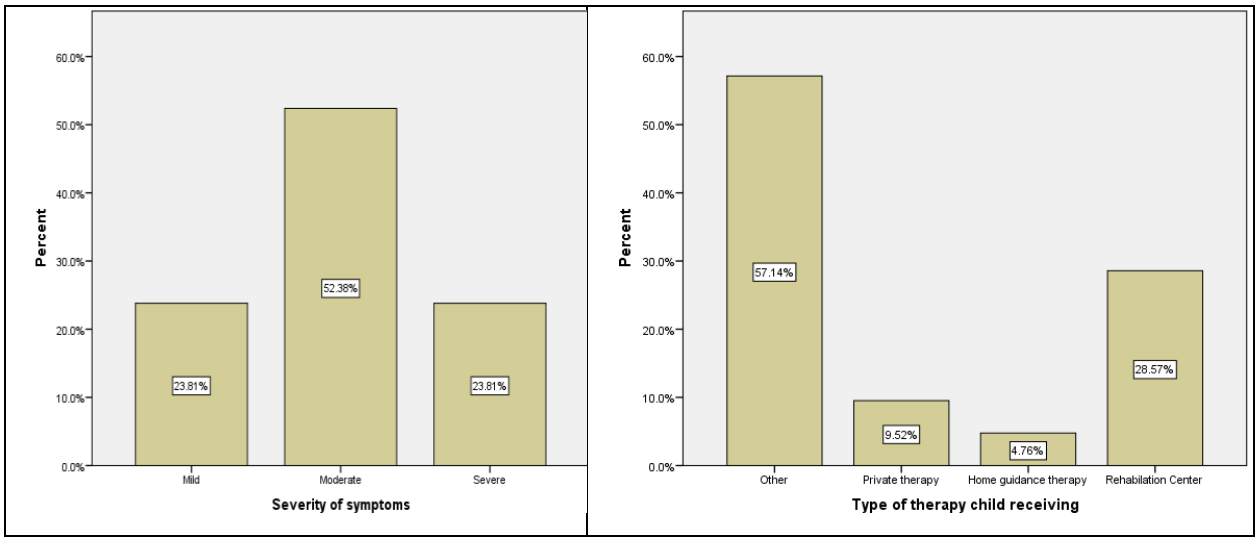
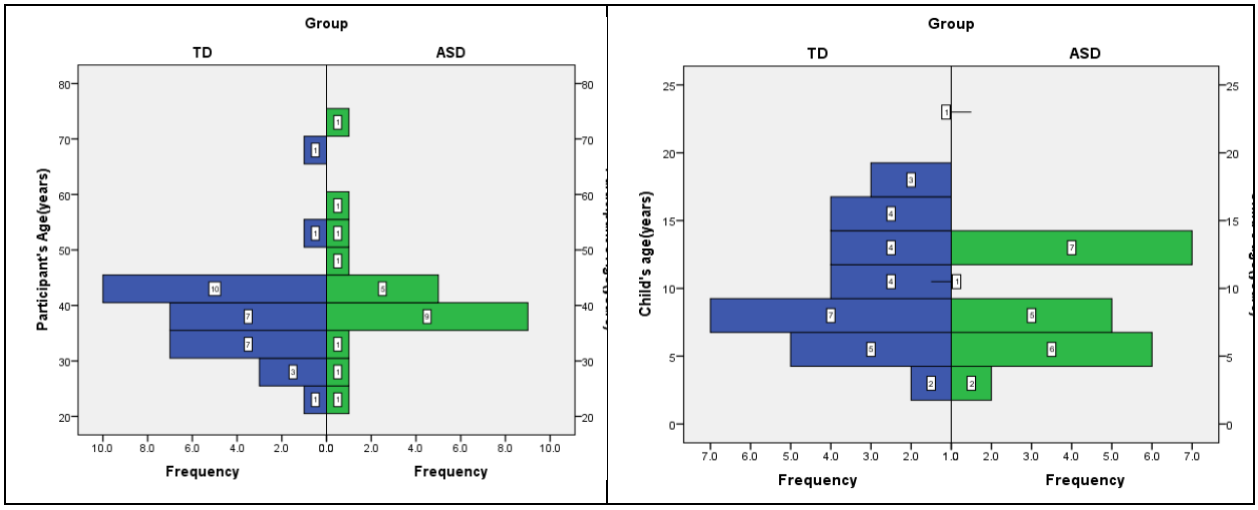


Table 7: illustrating Histograms of participant's and child's age among ASD and TD groups



Parental Exposure to COVID-19:

The second section of the survey, "Parental Exposure to COVID-19," underwent both descriptive and comparative analyses (Table 4). A cumulative score was derived from the items, signifying parental exposure levels in both Autism Spectrum Disorder group (M = 1.84; SD = 1.650; range 0–5) and the typically developing group (M = 0.86; SD = 0.690; range 0–5). This cumulative score, indicating exposure intensity, was calculated by summing the individual item scores. The comparison of the cumulative scores was conducted using an independent t-test (t = 0.576, p = 0.568). Notably, the calculated p-value for the Parental Exposure score was greater than the 5% significance level, representing a statistically insignificant difference in means between the ASD and TD cases.

Impact of COVID-19 Lockdown:

The section of questionnaire contains items in 6 categories which enables the assessment of difficulties faced by parents during lockdown period. A significant percentage of parents reported that during pandemic they sometimes faced challenging situation in managing various aspects of their child's life. These challenges included meal management (45.1%), allocation of free time (35.3%), adherence to sleeping routines (31.4%), adapting to online learning conditions (41.2%), coping with school-related tasks (49%), handling social interactions (25.5%), addressing aggression (45.1%), managing tantrums or temper issues (49%), addressing fears (51%), managing anxiety (33.3%), navigating their own work situation (39.2%), and dealing with financial matters (37.3%). In aggregate, for each activity, a nearly overlapping proportion of parents reported experiencing heightened difficulty during the lockdown period (Table 8).

Furthermore, the comparison of COVID-19 Impacts on both ASD and TD groups was done by performing independent sample t-test between the proposed 6 categories of this section which includes (1) Daily routines, (2) Educational condition, (3) Social development, (4) Economic/ working condition, (5) Behavior issues, and (6) Child's physiological distress. A cumulative score for each category was obtained by summing the individual item scores, with greater score indicating greater difficulty regarding that aspect during lockdown. Results of comparisons are shown in Table 9

Table 8: Descriptive statistics of Impact of COVID-19 lockdown

Sr#	Dimensions	Variables	Not at all	Sometimes	Often	Very much
1	**Daily routines n ,%**	Meal	n=12 23.5%	**n =23 45.1%**	n =9 17.6%	n =7 13.7%
		Free-time	n =10 19.6%	**n =18 35.3%**	n =16 31.4%	n =7 13.7%
		Sleep routine	n =15 29.4%	**n =16 31.4%**	n =14 27.5%	n =6 11.8%
2	**Educational condition n ,%**	Online tools	n =16 31.4%	**n =21 41.2%**	n =9 17.6%	n =5 9.8%
		School work	n=8 15.7%	**n=25 49%**	n=8 15.7%	n=10 19.6%
3	**Social development n ,%**	Social interaction	n =10 19.6%	n =13 25.5%	**n =17 33.3%**	n =11 21.6%
4	**Economic/ working**	Work	n=12	**n=20**	n=5	n=14

	Condition n ,%		23.5%	**39.2%**	9.8%	27.5%
		Finances	n=14 27.5%	**n=19 37.3%**	n=6 11.8%	n=12 23.5%
5	**Behavior issues n ,%**	Aggression	n =7 13.7%	**n =23 45.1%**	n =7 13.7%	n =14 27.5%
		Temper issues	n=8 15.7%	**n=25 49%**	n=9 17.6%	n=9 17.6%
6	**Child's physiological Distress n ,%**	Fears	n=14 27.5%	**n=26 51%**	n=9 17.6%	n=2 3.9%
		Anxiety	n=18 35.3%	**n=17 33.3%**	n=13 25.5%	n=3 5.9%

Table 9: Comparative analysis of Impacts of COVID-19 lockdown

Sr#	Categories	Group	Mean	T	p-value
1	**Daily routines**	**TD**	**3.13**	**-2.50**	**0.01**
		ASD	**4.80**		
2	Educational condition	TD	2.30	-0.71	0.48
		ASD	2.66		
3	**Social development**	**TD**	**1.23**	**-2.99**	**0.004**
		ASD	**2.04**		
4	Economic/ working condition	TD	2.26	-1.89	0.06
		ASD	3.38		
5	**Behavior issues**	**TD**	**2.16**	**-3.88**	**0.001**
		ASD	**4.00**		
6	Child's physiological distress	TD	1.70	-1.72	0.09
		ASD	2.42		

The above outcomes indicates that there exists significance difference in means of three categories i.e. Daily routines, Social development, and Behavior issues ($p<0.05$) among ASD and TD group. This shows that parents of ASD children faced daunting challenges in managing their child's Daily routine, social development and behavior issues as compared to parents of TD children. However, no significant difference was found in means

of Educational condition, Economic/ working condition, and Child's physiological distress between the two groups ($p > 0.05$).

Behavioral Problems Before and During Lockdown:

The employed section facilitates the assessment of behavioral problems in children before and during COVID-19 period. For the comparison of children's behavioral problems prior to and during the lockdown, paired-sample t-tests were conducted. The results presented in the Table 10 and 11 demonstrate significant distinctions concerning parental perceptions of children's aggressive behaviors, repetitive behaviors, and the transition between activities.

Table 10: Paired Sample Statistics

	Items	**Mean**	**N**	**Std. Deviation**
Pair 1	Was your child aggressive towards him/herself before the lockdown?	1.29	21	0.784
	Was your child aggressive towards him/herself during the lockdown?	2.10	21	0.995
Pair 2	Did your child show repetitive behaviors before the lockdown?	1.14	21	0.655
	Did your child show repetitive behaviors during the lockdown?	1.76	21	0.995
Pair 3	Had your child faced difficulties in managing the transition from one activity to another before the lockdown?	1.14	21	0.793
	Had your child faced difficulties in managing the transition from one activity to another during the lockdown?	2.05	21	1.071

Table 11: Paired Samples test

	Paired items	Mean	Std. Deviation	T	P -value
Pair 1	Was your child aggressive towards him/herself before the lockdown? - Was your child aggressive towards him/herself during the lockdown?	-0.810	0.680	-5.458	**0.000**
Pair 2	Did your child show repetitive behaviors before the lockdown? - Did your child show repetitive behaviors during the lockdown?	-0.619	0.590	-4.812	**0.000**

Pair 3	Had your child faced difficulties in managing the transition from one activity to another before the lockdown? - Had your child faced difficulties in managing the transition from one activity to another during the lockdown?	-0.905	0.768	-5.396	**0.000**

Aggressive Behaviors: Children showed more aggressive behaviors towards themselves during the lockdown (M = 2.10; SD = 0.99) compared to before it (M = 1.29; SD = 0.78). The t-value of -5.458 indicates a significant difference, with a p-value of 0.000. This suggests that the increase in aggressive behaviors during the lockdown is unlikely to be a random occurrence.

Repetitive Behaviors: Children showed more repetitive behaviors during the lockdown (M = 1.76; SD = 0.99) compared to before it (M = 1.14; SD = 0.65). The t-value of -4.812 indicates a significant difference, with a p-value of 0.000. This suggests that the increase in repetitive behaviors during the lockdown is unlikely to be a random occurrence.

Transition between Activities: Similarly, significant differences were found regarding the transition from one activity to another. Children with ASD showed more repetitive behaviors during the lockdown (M = 2.05; SD = 1.07) compared to before it (M = 1.14; SD = 0.79). The t-value of -5.396 indicates a significant difference, with a p-value of 0.000. This suggests that the increase in transition between activities during the lockdown is unlikely to be a random occurrence.

Consequently, as the p-value of all the items in both samples is lower than the chosen significance level (α = 0.05), we are able to reject the null hypothesis, indicating that children exhibited a higher prevalence of behavioral problems during the lockdown compared to before it.

ASD Support during COVID-19 Lockdown:

Following the emergency outbreak, a substantial portion of parents indicated their partial dissatisfaction with the available support from local and private healthcare services, as well as support from educational centers. The majority of these parents expressed disagreement (Hospitals/rehabilitation centers: Disagree = 47.6%, Therapist/doctors: Disagree = 57.1%, Schools/academic centers: Disagree = 38.1%, Private tutors/teachers: Disagree = 42.9%) during COVID-19 pandemic. Conversely, a slightly lesser proportion of parents showed agreement for each type of support (Hospitals/rehabilitation centers: Agree = 33.3%, Therapist/doctors: Agree = 23.8%, Schools/academic centers: Agree = 28.6%, Private tutors/teachers: Agree = 28.6%) during the emergency outbreak (Table 12).

Table 12: Descriptive Statistics of ASD support during COVID -19 lockdown

Sr#	Variables	n=21	Strongly Agree	Agree	Disagree	Strongly disagree
1	Hospitals/rehabilitation Centers	N	0	7	**10**	4
		%	0%	33.3%	**47.6%**	19%
2	Therapist /doctors	N	0	5	**12**	4
		%	0%	23.8%	**57.1%**	19%
3	Schools/academic centers	N	1	6	**8**	6
		%	4.8%	28.6%	**38.1%**	28.6%
4	Private tutors/teachers	N	1	6	**9**	5
		%	4.8%	28.6%	**42.9%**	23.8%

Maternal Distress:

This section of employed questionnaire facilitates the assessment of distress experienced by parents throughout the COVID-19 period, which, in the context of this study, aligns with the lockdown timeframe. The total distress score in parents was calculated as the mean of all items of DASS 21. This score represents higher levels of distress as reflected by elevated scores. Moreover, the independent samples t-test indicates a significant difference in maternal distress between the two distinct groups (ASD and TD). Specifically, the Table 13 presents the outcome of the comparison of the total distress score across the two groups, namely Autism Spectrum Disorder and typically developing children. Given that the p-value falls below the 5% threshold of significance ($t(49) = 2.618$, $p = 0.012$) suggesting that parents of children with ASD ($M = 16.4$; $SD = 9.97$) experienced higher levels of distress in comparison to parents of TD children ($M = 9.83$; $SD = 7.99$).

Table 13: Independent sample t test for comparison between Maternal Distress in ASD and TD parents

Variable	Mean		t	df	p-value
Total distress Score	TD	9.83	2.618	49	**0.012**
	ASD	**16.43**			

Further, the distress score was converted in to categorical variable "level/ severity of distress". Levels of parental distress calculated from the score are as follow (Table 14)

Table 14: Levels of parental distress calculated from the score

Levels of Distress	**Distress score**
Normal	0-9
Mild	10-13
Moderate	14-20
Severe	21-27
Extremely Severe	28+

For modeling, the level of distress is further converted in to binary variable with only two categories, i.e. Normal to Moderated encoded as 0 and Severe to Extremely severe encoded as 1. The comparison of binary distress level using chi square test shows significant difference in distribution between ASD and TD groups is shown in Table 15.

Table 15: Chi-square test for comparison between binary levels of maternal Distress in ASD and TD parents

Variable	**Categories**	**ASD N(%)**	**TD N(%)**	**Chi-square**	**df**	**p-value**
Binary level of distress	Normal to Moderate	12(57.1%)	26(86.7%)	5.669	1	0.017
	Severe to Extremely Severe	**9(42.9%)**	**4(13.3%)**			

Model Development:

One of the primary objective of this survey based research is to find out the features that are significant in increasing parental distress with the help of developing various models i.e. Linear Regression, Logistic Regression, Decision Tree, Random Forest an XGBoost. For this purpose three types of models have been developed using different sections of questionnaire. The first model was created with all demographic variables, the second model was generated using group/data label (whether the participant had a child with ASD) as predictors, and the third model was developed with Parental Exposure and Impact of COVID-19 lockdown as covariates. The continuous variable "Total Distress Score" were used as outcome feature for development of linear regression models. Whereas, for all the other models, including logistic regression, decision tree , random forest an XGBoost, categorical variable "Binary level of distress" was used as dependent feature.

Development of linear Regression models:

In the linear regression models, predictor variables including demographic features, Group or Data labels, Parental Exposure Score and all the categories of Impact of COVID-19 lockdown associates with total distress score using SPSS. The standardized estimates for each model determine the association of potential explanatory variables and the incremental predicted variance for any given set of variables. Detailed outcomes of all three regression models are discussed below.

Linear regression model development using demographic features:

The result of 1st regression model revealed that demographic characteristics of participants and children significantly influenced maternal distress (Adjusted R^2 =24%, F=2.23, P=0.02). Out of all demographic variables following variables were considered as potential predictors of dependent variable. (Table 16)

1. Place of living:

The β coefficient for Place of living is -0.292 with p-value -0.036 suggesting a significant but negative correlation with total distress score.

2. Family situation:

The β coefficient for Family situation is -0.302 suggesting a negative correlation with outcome variable. The p-value (0.031) indicates that Family situation is statistically significant in predicting the outcome.

3. Educational qualification:

The β coefficient for Educational qualification is -0.356, indicating that changes in this variable lead to an average decrease in the outcome variable. The p-value (0.038) is less than 0.05, suggesting that Educational qualification is statistically significant.

4. Family Monthly income:

The β coefficient for Family Monthly income is 0.402, implying that changes in Family Monthly income are associated with an average increase in the outcome variable. The p-value (0.023) is less than 0.05, showing statistical significance.

5. Severity of Symptoms

The β coefficient for Severity of Symptoms is 0.479, implying that changes in Severity of symptoms are associated with an average increase in total distress score. The p-value (0.023) is less than 0.05, showing statistical significance.

Table 16: Outcome of the regression model using demographic features

Sr#	Variables	B	Beta	T	P
1	Participant Gender	-5.626	-0.265	-0.954	0.346
2	Participant's Age	-0.277	-0.271	-1.337	0.189
3	Place of living	-8.402	**-0.292**	-2.180	**0.036**
4	Family situation	-5.931	**-0.302**	-2.242	**0.031**
5	Relationship with child	7.389	0.389	1.422	0.164
6	Educational qualification	-5.469	**-0.356**	-2.146	**0.038**
8	Family Monthly income	6.968	**0.402**	2.369	**0.023**
9	Total children	-1.696	-0.174	-1.181	0.245
10	Child's Age	-0.060	-0.029	-0.138	0.891
11	Child's gender	-4.939	-0.262	-1.722	0.094
12	Child's educational status	1.119	0.070	0.501	0.619
13	Severity of Symptoms	4.109	**0.479**	2.038	**0.049**
14	Type of therapy child receiving	-4.413	**-0.802**	-3.630	**0.001**

Note: R^2 = 0.44 , Adjusted R^2 =0.244

F = 2.239 , p= 0.028

Linear regression model development using Group label (ASD vs. TD):

In the 2nd regression model the predictor variable was the group label (ASD vs. TD) and the outcome was parental distress score. Results in Table 17 indicates that Group or Data label showed positive and significant association with total distress score.

Table 17: Outcome of linear regression model using Group label (ASD vs. TD)

Sr#	Variables	B	Beta	T	P
1	Group	6.597	**.350**	2.618	**.012**

R^2 = 0.12 , Adjusted R^2 =0.10

F = 6.856 , p= 0.012

Linear regression model development using PE and impacts of COVID-19:

The 3rd linear regression model was tested with Parental Exposure to COVID-19 and Impact of COVID-19 lockdown on Daily routines, Educational conditions, Social development, Behavior issues as well as Child's physiological distress. The results estimated that these covariates were significant predictor to total Distress score ($p<0.05$). Standardized coefficient Beta value shows that the following independent variables significantly and positively correlated to "Total distress Score" (Table 18).

1. Parental Exposure Score

The β coefficient for Parental Exposure Score is 0.301, implying that changes in Parental Exposure Score are associated with an average increase in total distress score. The p-value (0.032) is than 0.05, showing statistical significance.

2. Daily Routine

Despite the fact that p-value of Daily routine is greater than 0.05 (0.084), it shows highest positive correlation (β=0.320) with outcome variable. Therefore, it can be consider as potential factor for greater parental distress

Table 18: Outcome of the linear regression model using PE and impacts of COVID-19

Sr#	Variables	B	Beta	T	P
1	Parental Exposure Score	1.776	**.301**	2.210	**.032**
2	Daily routines	1.302	**.320**	1.769	.084
3	Educational condition	-.242	-.043	-.253	.801
4	Social development	.711	.079	.433	.667
5	Economic/ working condition	.281	.061	.400	.691
6	Behavior issues	.570	.107	.563	.577
7	Child's physiological distress	-.131	-.021	-.136	.892

R^2 = 0.29 , Adjusted R^2 =0.17

F = 2.512 , p= 0.029

Development of logistic Regression models:

Three binary logistic Regression models were also developed using Enter method in SPSS software. Enter method means all the predictors are entered in a block in a single move. The significance and insignificance of variables were estimated using Wald value, Wald significance value (p value) and odd ratio (Exp (B)). The details of the development of logistic regression models to determine the association of predictor variables with dependent variable (Binary level of distress) are discussed below.

Logistic regression model development using demographic features:

The first binary logistic model was developed using all the demographic features as independent variables to find out their association with binary level of distress. The results shows that the model was statistically significant (Accuracy= 82.4 , X^2 = 24.410 , p= 0.028) .Details of estimates of coefficients, their significance using Wald's method and odd ratios of the final model are provided in Table 19.

1. **Educational qualification:**

The results shows that "Educational qualification" of participant is statistically significant (p = 0.020). While value of odd ratio (0.053) shows negative association with level of parental distress i.e. indicating that participants with lower Educational qualification have significantly lower odds of higher parental distress.

2. **Family Monthly income:**

The results shows that "Family Monthly income" of participant is statistically significant (p = 0.036). While value of odd ratio (34.44) shows positive association with level of parental distress making it the strongest feature in predicting higher parental distress.

3. **Severity of Symptoms**

Despite the fact that "Severity of Symptoms" is statistically insignificant (p = 0.253), it can be considered as potential factor as its odd ratio (2.165) tended to be positively associated with increased likelihood of exhibiting higher level of parental distress.

4. **Type of therapy child receiving**

The results shows that "Type of therapy child receiving" of participant is statistically significant (p = 0.029). While value of odd ratio (0.314) suggesting that receiving a certain type of therapy is associated with a reduction in level of parental distress.

Table 19: Outcome of Binary Logistic Regression using demographic variables.

Sr#	Variables	B	Wald	Sig.	Exp(B)
1	Participant Gender	-20.688	.000	.999	.000
2	Participant's Age	-.062	.250	.617	.940
3	Place of living	-1.821	1.159	.282	.162
4	Family situation	-.547	.250	.617	.578
5	Relationship with child	21.889	.000	.999	3207993821.357
6	Educational qualification	-2.936	5.421	**.020**	**.053**
8	Family Monthly income	3.539	4.407	**.036**	**34.446**
9	Total children	.047	.005	.944	1.048
10	Child's Age	.002	.000	.991	1.002
11	Child's gender	-2.554	2.819	.093	.078
12	Child's educational status	.477	.338	.561	1.611
13	Severity of Symptoms	.773	1.307	.253	**2.165**
14	Type of therapy child receiving	-1.159	4.777	**.029**	**.314**

Accuracy= 82.4 , X^2 = 24.410 , p= 0.028

Logistic regression model development using Group label (ASD vs. TD):

The results of 2nd model with 74.5% accuracy indicates that group or data label play important role in (Exp (B) = 4.875) determining higher level parental distress (Table 20).

Table 20: Outcome of Logistic Regression model using Group (ASD vs. TD)

Sr#	Variables	B	Wald	Sig.	Exp(B)
1	Group	1.584	5.197	**.023**	**4.875**

Accuracy= 74.5% X^2 = 5.658 , p= 0.017

Logistic regression model development using PE and impacts of COVID-19:

Based on provided results in table 21 only one variable i.e. Daily Routine has p value of Wald test less than 5 % level of significance (0.010) and odd ratio (2.041). This implies that according to logistic model only this independent variable played important role in determining higher level of distress in parents.

Table 21: Results of logistic regression model using PE and impacts of COVID-19

Sr#	Variables	B	Wald	Sig.	Exp(B)
1	Parental Exposure Score	.331	1.277	.258	1.392
2	Daily routines	.714	6.703	**.010**	**2.041**
3	Educational condition	-.015	.003	.959	.985
4	Social development	-.258	.178	.673	.773
5	Economic/ working condition	.142	.341	.559	1.153
6	Behavior issues	.031	.010	.920	1.031
7	Child's physiological distress	-.191	.329	.566	.826

Accuracy= 82.4 X2 = 15.569 , p= 0.029

Development of Decision tree models:

Three different subsets of features have been used for the development of decision tree models for target feature (binary level of distress). The significance of all individual features were identify using feature importance. The data set was randomly dividing into 75%% training data, 25% test data for better accuracy with the help of Google Collab. Detail outcomes of all three decision tree models are discussed below

Decision tree model development using demographic features:

In this decision tree model all the demographic features were used as predictors against binary level of distress. Top five features, with highest features importance were selected as best features. The results in Table 22 and Figure shows that only four features i.e. Participant's Age, Child's educational status, Severity of Symptoms and Child's Age that shows feature importance in developing machine learning model with 69% accuracy.

Table 22: Outcome of decision tree model using demographic features

Sr #	Name	Importance
1	Participant's age (years)	**0.43**
2	Child's educational status	**0.33**
3	Symptoms	**0.13**
4	Child's age	**0.09**
5	Gender	0
6	Place of living	0
7	Family situation	0
8	Relationship with child	0
9	Educational qualification	0

10	Family monthly income (PKR)	0
11	Total children	0
12	Child's gender	0
13	Type of therapy child receiving	0
Accuracy = 0.69		

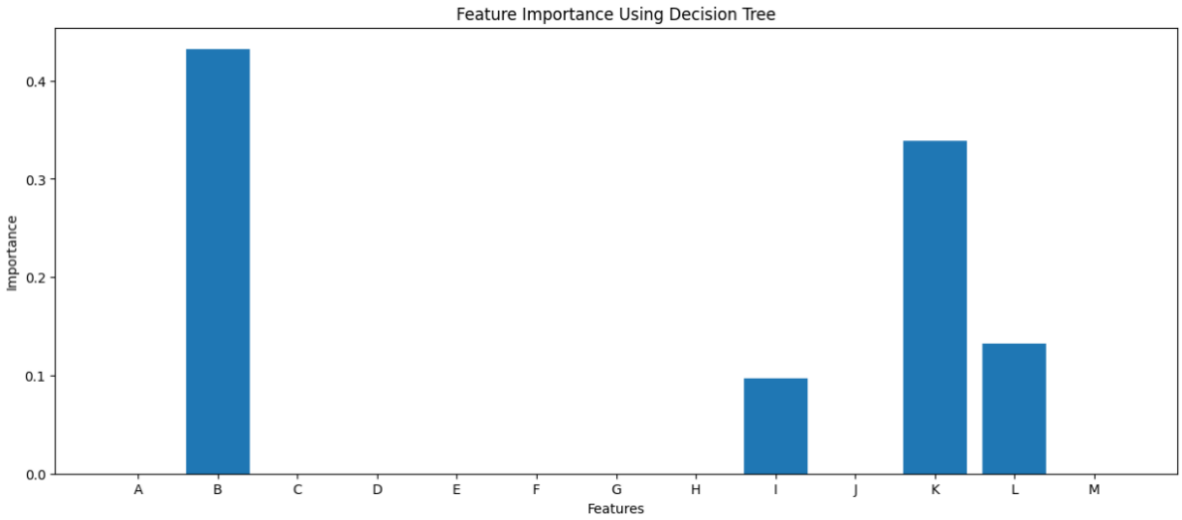


Figure 6: Bar chart illustrating feature importance of demographic features using Decision Tree

Gender = A

Age in years = B

Place of living = C

Family situation = D

Relationship with child = E

Educational qualification = F

Family monthly income PKR = G

Total children = H

Child's age years = I

Child's gender = J

Child's educational status = K

Severity of Symptoms = L

Type of therapy child receiving = M

Decision tree model development using Group label (ASD vs. TD):

For the development of 2nd decision tree model Group (ASD vs. TD) was used as covariate. The data is divided into 75% training set and 25% test set to develop model against binary target variable. The independent variable shows 100% feature importance with 92% model accuracy.

Decision tree model development using PE and impacts of COVID-19:

The 3rd decision tree model used Parental Exposure to COVID-19, impacts of COVID-19 lockdown on Daily routines, educational conditions, social development, behavior issues as well as child's physiological distress as covariates. The results estimated that these covariates were significant predictor to target variable with 76% Accuracy at 75% training data and 25% test data. Top four features with highest feature importance were

selected as significant predictor of outcome variable. Feature importance value of the independent variables shown in Table 23 and Figure 7 tells about that relevant feature role in signifying binary distress level in parents.

Table 23: Outcome of decision tree model using PE and impacts of COVIID-19

Sr#	Name	Importance
1	Daily routine	**0.34**
2	Social development	**0.18**
3	Parental Exposure Score	**0.15**
4	Child's physiological distress	**0.12**
5	Educational condition	0.10
6	Behavior issues	0.08
7	Economic/ working condition	0
Accuracy =0.76		

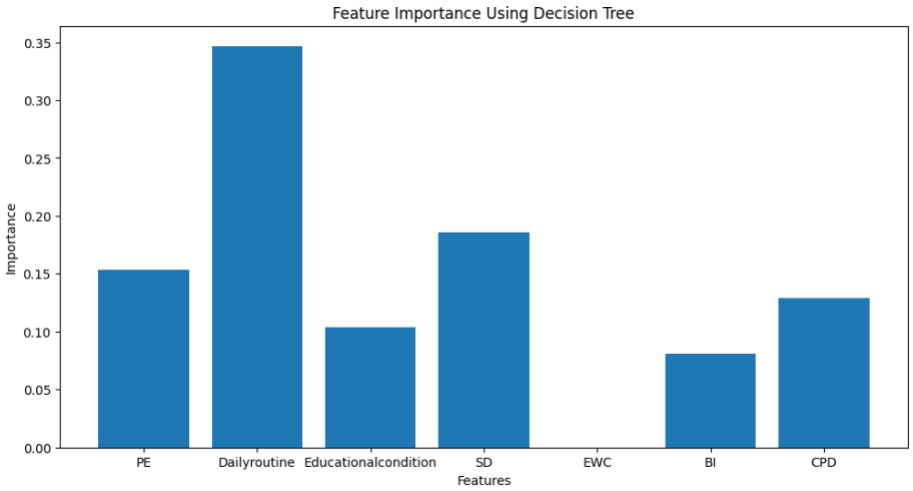


Figure 7 : Bar chart illustrating feature importance of PE and Impacts of COVID-19 using Decision Tree

Parental exposure score =PE

Social development = SD

Economic/ Working condition = EWC

Behavior issues =BI

Child's physiological distress =CPD

Development of Random Forest models:

Similarly, three random forest models were developed using three features subsets as covariate against dependent variable. The data was randomly split into 75% training set and 25% test set using Google Collab. Detail outcomes of all three decision tree models with feature importance are discussed below

Random forest model development using demographic features:

The results of 1st model showed that nearly all the demographic characteristics significantly influenced distress level in parents (Accuracy= 69%). Out of all demographic variables top five features with highest feature importance were selected as most relevant predictors (Table 24 and Figure 8)

Table 24: Outcomes of Random Forest model using demographic features

Sr#	**Name**	**Importance**
1	Childs educational status	**0.24**
2	Child's age	**0.18**
3	Participant's Age	**0.14**
4	Type of therapy child receiving	**0.08**
5	Severity of Symptoms	**0.07**
6	Total children	0.06
7	Educational qualification	0.03
8	Child's gender	0.04
9	Relationship with child	0.03
10	Family monthly income	0.02
11	Family situation	0.02
12	Participant's Gender	0.03
13	Place of living	0.01
Accuracy= 0.69		

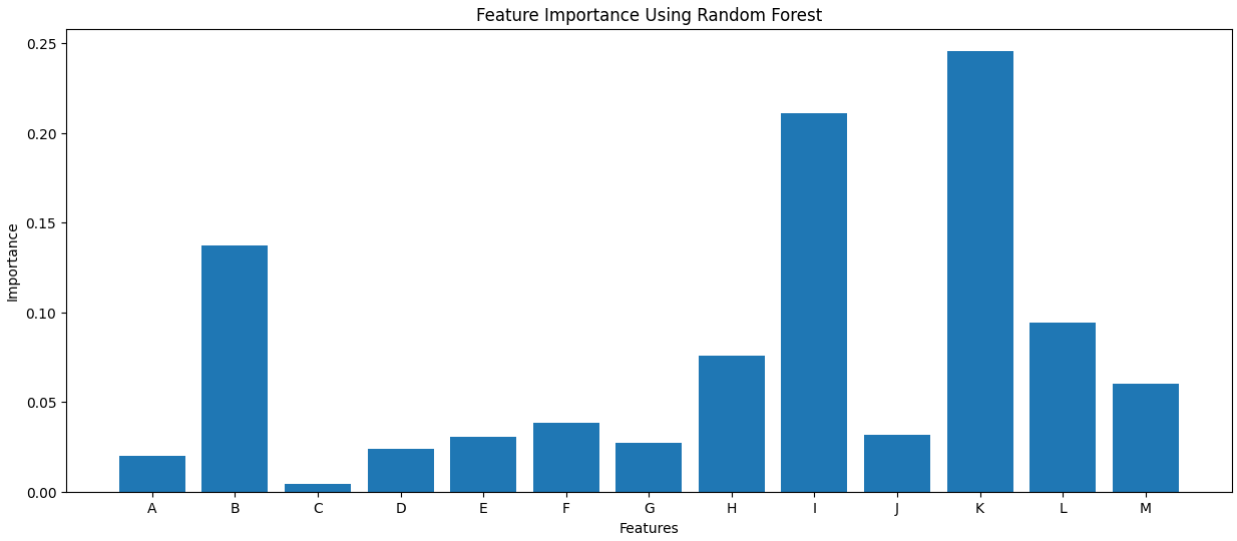


Figure 8 : Bar chart illustrating feature importance of demographic features using Random Forest

Gender = A	**Educational qualification =F**	**Child's educational status =K**
Age in years = B	**Family monthly income PKR =G**	**Severity of Symptoms =L**
Place of living = C	**Total children =H**	**Type of therapy child receiving =M**
Family situation = D	**Child's age years =I**	
Relationship with child = E	**Child's gender = J**	

Random forest model development using Group label (ASD vs. TD):

The results of 2nd random forest model with 92% accuracy indicates that group or data label (ASD vs. TD) play important role in determining higher level parental distress with 100% feature importance, when the data is divided into 75% training set and 25% test set.

Random forest model development using PE and impacts of COVID-19:

The 3rd Random forest model used Parental Exposure to COVID-19, impacts of COVID-19 lockdown on Daily routines, educational conditions, social development, behavior issues as well as child's physiological distress as covariates. The results estimated that these covariates were significant predictor to target variable with 76% Accuracy at 75% training data and 25% test data. Top four features with highest feature importance were selected as significant predictor of outcome variable. Feature importance value of the independent variables shown in Table 25 and Figure 9 tells about that relevant feature role in signifying binary distress level in parents.

Table 25: Outcome of random forest model using PE and impacts of COVID-19

Sr#	Name	Importance
1	Daily routine	**0.31**
2	Parental Exposure Score	**0.16**
3	Child's physiological distress	**0.15**
4	Educational condition	**0.10**
5	Economic/ working condition	0.09
6	Social development	0.08
7	Behavior issues	0.07
Accuracy=0.76		

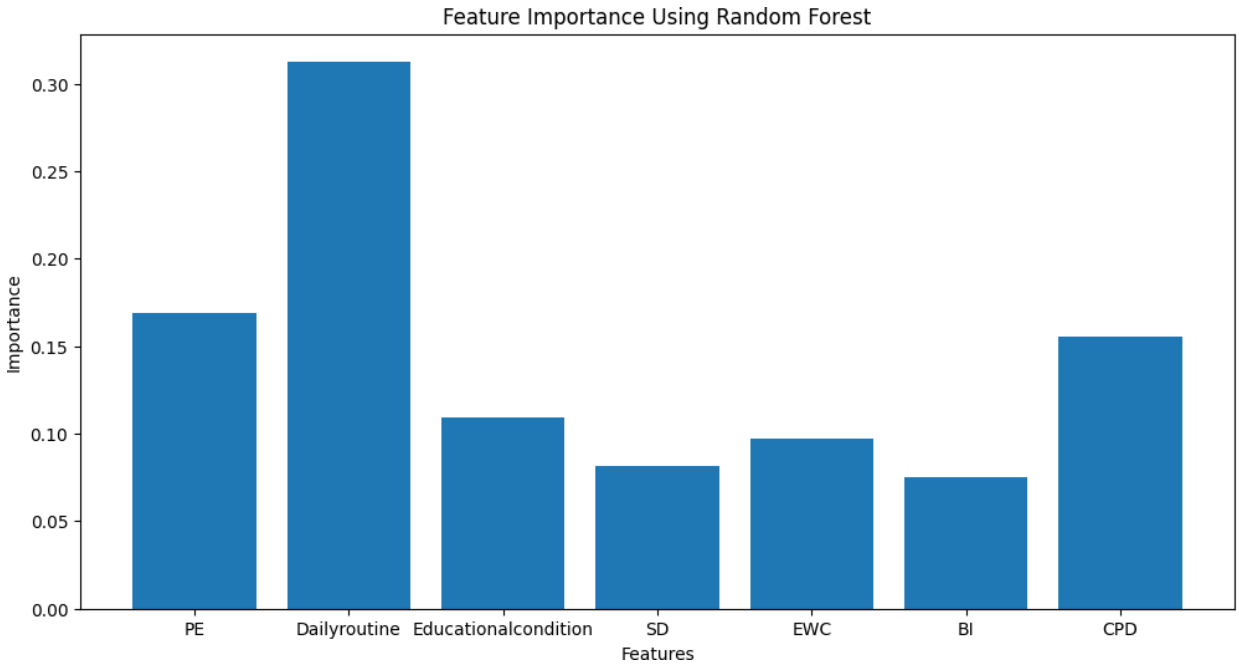


Figure 9 : Bar chart illustrating feature importance of PE and Impacts of COVID-19 using Random Forest

Parental exposure score =PE

Behavior issues =BI

Social development = SD

Child's physiological distress =CPD

Economic/ Working condition = EWC

Development of XGBoost models:

A total of three XGBoost models were also developed with three subsets of features using Google Collab. The importance of individual variable was estimated using feature importance when the data is divided at 75% training set and 25% test set. Detail outcome of all three models are discussed below

XGBoost model development using demographic features:

In the first model a total of 13 demographic features have been used as predictors in determining parental distress. Table 26 and Figure 10 Represents the results showing the importance of all the demographic features when the data is divided into 75% training and 25% test set. Variable's including Family situation, Child's gender, Child's age, Severity of symptoms and type of therapy child receiving all shows same significance i.e. 0.04. Hence, they all are ranked among top five features along with Child's educational status, Family monthly income and relationship with child.

Table 26: Outcomes of XGBoost model using demographic features

Sr#	**Name**	**Importance**
1	Child's educational status	**0.45**
2	Family monthly income	**0.14**
3	Relationship with child	**0.11**
4	Family situation	**0.04**
5	Child's gender	**0.04**
6	Type of therapy child receiving	**0.04**
7	Child's age	**0.04**
8	Severity of Symptoms	**0.04**
9	Total children	0.03
10	Participant's Age	0.03
11	Gender	0
12	Place of living	0
13	Educational qualification	0
Accuracy= 0.84		

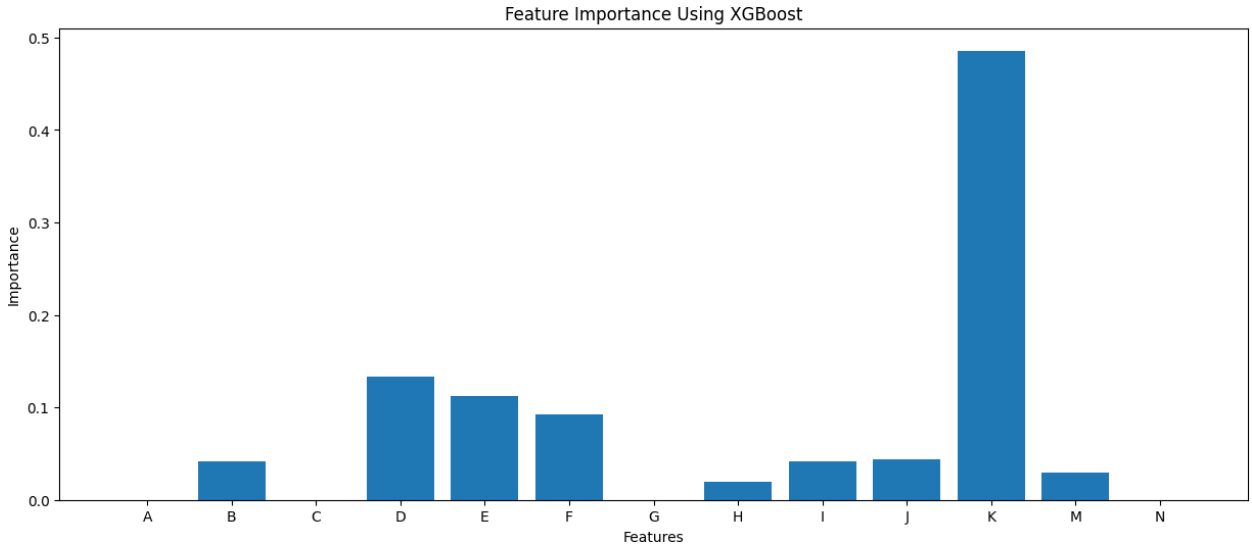


Figure 10 : Bar chart illustrating feature importance of demographic features using XGBoost

Gender = A
Age in years = B
Place of living = C
Family situation = D
Relationship with child = E
Educational qualification =F
Family monthly income PKR =G
Total children =H
Child's age years =I
Child's gender = J
Child's educational status =K
Severity of Symptoms =L
Type of therapy child receiving =M

XGBoost model development using Group label (ASD vs. TD):

The 2nd XG-Boost model were developed using Group (ASD vs. TD) was used as covariate. The dataset when the divided into 75% training set and 25% test set gives best accuracy i.e.92% with 100% feature importance.

XGBoost model development using PE and impacts of COVID-19:

Results demonstrated in Table 27 and Figure 10 shows the feature importance of all the independent variables tested against binary distress level. The data set when divided into 75% training set and 25% test set gives the best accuracy i.e.69%.

Table 27: Feature importance of XGBoost model using PE and impacts of COVID-19

Sr #	Name	Importance
1	Daily routine	**0.29**
2	Social development	**0.17**
3	Educational condition	**0.15**
4	Child's physiological distress	**0.13**
5	Parental Exposure Score	0.10

6	Economic/ working condition	0.07
7	Behavior issues	0.04
Accuracy =0.69		

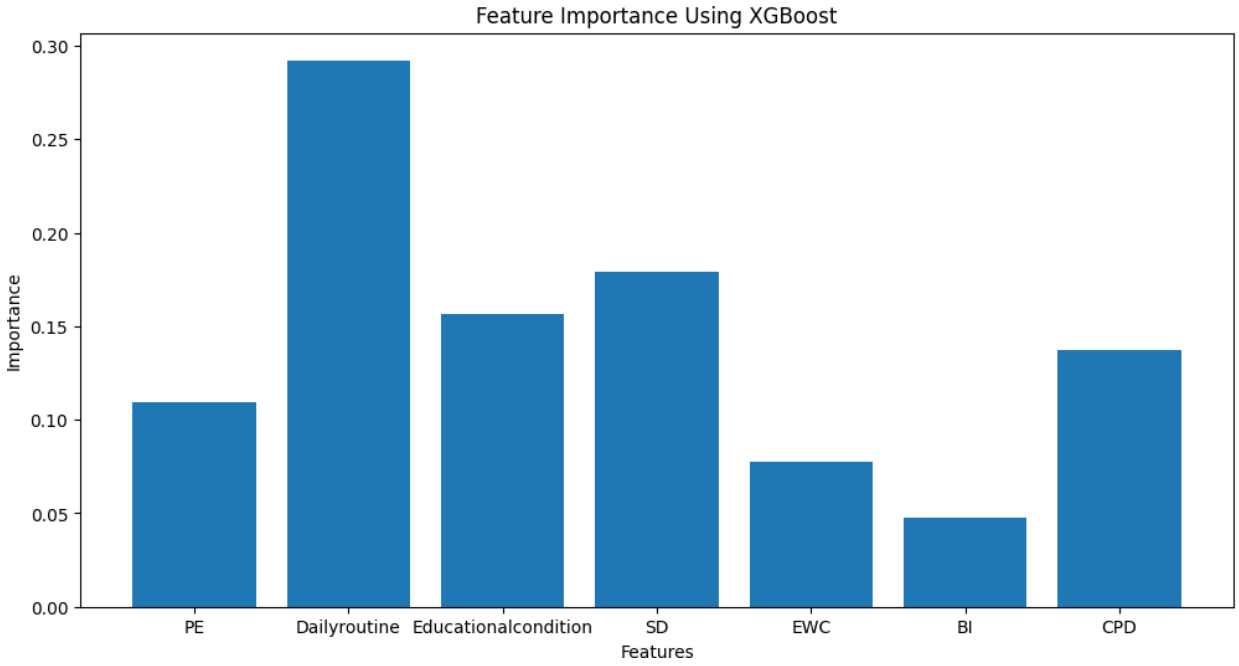


Figure 11:Bar chart illustrating feature importance of PE and Impacts of COVID-19 using XGBoost

Parental exposure score =PE **Behavior issues =BI**

Social development = SD **Child's physiological distress =CPD**

Economic/ Working condition = EWC

Comparative analysis

A comparative analysis of all the developed models, including linear regression, logistic regression, decision tree, random forest, and XG-Boost, has been performed to identify the survey features which significantly associated with parental distress. Table 28 presents the demographic variables that are both statistically significant and have high feature importance. The comparison of all models for the significance of the Group variable (ASD vs. TD) is shown in Table 29. Lastly, Table 30 demonstrate the significance of the third subset of features used in the development of the models.

Table 28: Demonstrate the significance of demographics features used in the development of the models

Sr#	Variables	Linear Regression	Logistic Regression	Decision Tree	Random Forest	XGBoost	Selected
1	Participant Gender	×	×	×	×	×	0/5
2	Participant's Age	×	×	➹	➹	×	2/5
3	Place of living	➹	×	×	×	×	1/5
4	Family situation	➹	×	×	×	➹	**2/5**
5	Relationship with child	×	×	×	×	➹	**1/5**
6	Educational qualification	×	➹	×	×	➹	**2/5**
8	**Family Monthly income**	➹	➹	×	×	➹	3/5
9	Total children	×	×	×	×	×	0/5
10	**Child's Age**	×	×	➹	➹	➹	3/5
11	Child's gender	×	×	×	×	➹	1/5
12	**Child's educational status**	×	×	➹	➹	➹	**3/5**
13	**Severity of Symptoms**	➹	➹	➹	➹	➹	5/5
14	**Type of therapy child receiving**	➹	➹	➹	➹	➹	5/5

Table 29: Demonstrate the significance of Group (ASD vs TD) used in the development of the models

Sr#	Variables	Linear Regression	Logistic Regression	Decision tree	Random Forest	XGBoost	Selected
1	Group	➹	➹	➹	➹	➹	5/5

Table 30: Demonstrate the significance of Parental Exposure Score and Impacts of COVID-19 used in the development of the models

Sr#	Variables	Linear Regression	Logistic Regression	Decision tree	Random Forest	XGBoost	Selected

1	**Parental Exposure Score**	➶	. ×	➶	➶	×	3/5
2	**Daily routines**	➶	➶	➶	➶	➶	**5/5**
3	Educational condition	×	×	×	➶	➶	**2/5**
4	Social development	×	×	➶	×	➶	2/5
5	Economic/ working condition	×	×	×	×	×	0/5
6	Behavior issues	×	×	×	×	×	0/5
7	Child's physiological distress	×	×	➶	➶	➶	**3/5**

After the comparison of all tested machine learning models the selected features for parental distress are

Family Monthly income

Out of all five models, linear regression, logistic regression, and Random forest shows "Family Monthly income" as significant feature for outcome variable. This variable shows significant, positive association and high feature importance with the dependent variable .Therefore, it can be concluded as potential factor in determining parental distress.

Child's Age

Out of all five models, decision tree, Random forest and XG-boost suggest that increasing age of child correspond to increased parental distress. This variable shows significant, positive association and high feature importance with the dependent variable Therefore, it can be concluded as potential factor in determining parental distress.

Child's educational status

Out of all five models, decision tree, Random forest and XG-boost shows "Child's educational status" as significant feature for parental distress. This variable shows high feature importance with the dependent variable Therefore, it can be concluded as potential factor in determining parental distress.

Severity of Symptoms:

All the developed models shows “Severity of Symptoms” as significant feature for parental distress except for logistic regression. This variable shows significant, positive association and high feature importance with the dependent variable Therefore, it can be concluded as potential factor in determining parental distress.

Type of therapy child receiving

Out of all five models, linear regression, logistic regression and Random forest shows “Type of therapy” as significant feature for parental distress. This variable shows significant, negative association and high feature importance with the dependent variable Therefore, it can be concluded as potential factor in determining parental distress.

Group / Data label:

All the five developed model shows group as potential factor, as it shows significant, positive association and high feature importance with the dependent variable.

Parental Exposure Score

All the developed models shows “Parental Exposure Score” as significant feature for parental distress except for logistic regression. This variable shows significant, positive association and high feature importance with the dependent variable .Therefore, it can be concluded as potential factor in determining parental distress.

Daily routines

All the developed models shows “Daily Routine” as significant feature for parental distress except for linear regression. This variable shows significant, positive association and high feature importance with the dependent variable .Therefore, it can be concluded as potential factor in determining parental distress.

Child's physiological distress

Out of all five models, decision tree, Random forest and XG-boost shows “Child’s physiological distress” as significant feature for parental distress. This variable shows high feature importance with the dependent variable Therefore, it can be concluded as potential factor in determining parental distress.

Open response Questions:

Nearly all the survey participants responded to the open-ended question about the additional challenges they encountered during the COVID-19 lockdown and what strategies could be beneficial in handling such global emergencies in the future. The predominant response, indicated by 37.3% of participants, was "Nothing," indicating that many participants did not perceive additional challenges other than those already mentioned in the questionnaire. This was followed by the response "Lack of financial family support" at 17.6%. Whereas, strategies to manage such global emergencies, the most frequent response was "Proper planning instead of a

complete lockdown," mentioned by 37.3% of participants. Tables 31 and 32 shows detailed presentation of participant's responses to these questions.

Table 31: Responses to the open response question about the additional challenges they encountered during the COVID-19 lockdown.

Responses	**N**	**%**
Lack of Financial family support	9	17.6
Nothing	19	37.3
Managing children daily situation due to COVID-19 restrictions and lack of support	7	13.7
Lack of guidance and school Support	5	9.8
Loneliness and anger issues	4	7.8
Health issues and children safety	4	7.8
Fear of virus exposure	3	5.9

Table 32: Responses to the open response question about what strategies could be beneficial in handling such global emergencies in the future.

Responses	**N**	**%**
Proper planning instead of complete lockdown	19	37.3
Awareness programs should be launched and proper planning to educate and train people helping them to deal with such Emergencies	18	35.3
Don't know	5	9.8
Strategies to keep the people mentally relaxed instead of making them terrified.	4	7.8
Proper ban on incomings flights and foreigners who might carry the virus or bacteria at right time	3	5.9
Government should support and help people in such situation	2	3.9

CHAPTER 5

Discussion and Conclusions:

The primary objectives of this research includes the collection of primary data from participants through a self - reported questionnaire. Another objective is the identifying and comparing parental distress levels between parents of children with ASD and TD children. Secondly, to investigate possible impact of lockdown on the behavior problems exhibited by ASD children, comparing them before and during the lockdown period. Thirdly, to identify significant features associated with parental distress during the pandemic by employing model development techniques. Lastly, to provide recommendations for parents/guardians, healthcare professionals, and government officials based on the study's findings.

Some of the major conclusions of this study are described below:

- To the best of our knowledge, this is the first study to comprehensively explore and compare the impacts of the COVID-19 pandemic on parents and individuals within the Autism Spectrum Disorder and Typically Developing.
- After data collection and pre-processing, 51 out of 66 survey responses were considered for further data analysis using IBM SPSS software and Google Collab.
- Data visualization and descriptive analysis revealed variations in the data, with mean values and percentages calculated for both ASD and TD group.
- Comparative analyses of different survey features were performed using chi-square tests and independent sample t-tests. These analyses demonstrated that, among demographic variables, only Child's Gender displayed a significant difference in distribution between the ASD and TD groups. Moreover, significant differences were observed in managing Daily Routine, Social Development, Economic/Working Conditions, Behavior Issues, Child's Physiological Distress, and Parental Distress between the two groups.
- A comparative analysis of children's behavioral problems using paired sample t-tests indicated a significant increase in ASD children behavior issues during the COVID-19 lockdown compared to before it.
- In the development of models to identify significant variables for parental distress, three different subsets of features were employed: all demographic features; group (ASD vs. TD); and parental exposure as well as the impacts of COVID-19 lockdown.

- All the developed models underwent evaluation using different estimators, with their comparison highlighting the factors that significantly contribute to parental distress.
- The comparison of the developed models borne the following insights:
    a. Among all demographic features, parental distress was affected by Family Monthly Income, Child's Age, Child's Educational Status, Severity of Symptoms, and Type of therapy the child received.
    b. In all five developed models, the Group variable (ASD vs. TD) showed potential significance in determining parental distress.
    c. Parental Exposure to COVID-19 and the impact of COVID-19 on Daily Routines and Child's Physiological Distress were also identified as significant predictors of parental distress.
- Lastly, the study narratively collect the needs and perception of parents during COVID-19 pandemic with the help of open response questions. Majority of participant reported the need of financial support, awareness and proper planning from government. Almost half of the parents showed disagreement towards stringent restrictions and lockdown during the pandemic

Overall, the results of the present research showed that complete/smart lockdown was less effective for children with Autism Spectrum Disorder and their families as they reported a higher frequency of challenges and difficulties over the course of the pandemic, accompanied by increased parental distress compared to typically developing group(ASD=17.56%,TD=7.84%). Furthermore, the most relevant finding of this study highlight the areas that significantly contribute to heightened parental distress. Consequently, the study insisted on the importance of interventions designed to assist parents in reducing distress and developing effective coping strategies, particularly for families with ASD, healthcare professionals, and government officials.

Recommended strategies for parents & caregiver:

In addition to the typical parenting demands, parents of children with ASD must provide extra attention due to the unpredictable behavior and emotional challenges often exhibited by their children. Consequently, they must manage their children's behavior, aggression, and tantrums, all while balancing their existing familial and professional responsibilities. This heightened caregiving pressure often leads to higher levels of stress and anxiety when compared to parents of typically developing children. Findings emphasize that during the COVID-19 pandemic and the subsequent emergency measures, these already high distress levels among parents have only gotten worse.

The following strategies offer potential assistance for parents in managing children with ASD. These approaches may help in decreasing parental distress and concerns, as well as help in managing behavioral issues in children with ASD.

- Focusing on token based activities, based on earned tokens or rewards. Children are required to complete preferred activities before they can "purchase" tokens or rewards during the day.
- Mixing more challenging tasks with easier ones can help children in performing less preferred tasks more effectively. For instance, a parent might ask their child to complete one page of homework in the morning and then they can play with their favorite toy.
- Consistency in children can be maintained by creating visual schedules and structuring the day into blocks of activities based on primary needs.
- High-functioning children with ASD may benefit from engaging in activities with inherent social goals, such as writing letters to peers, scheduling calls with relatives, or playing games that encourage turn-taking.
- It is also important for parents to provide their autistic children with appropriate but monitored media exposure and supervised screen time [9].
- There are several resources like "Help is in Your Hands," an app developed by Dr. Sally Rogers for coaching parents in supporting their ASD children [1]. Parents should take help from such resources for better handling the parent-child relationship.
- They should also consider joining therapies that promote psychological flexibility and self-care in them.

Recommendations for healthcare professionals and government officials:

Although ASD is a neurological condition, some family and environmental factors can influence outcomes [2]. For instance, the mental health of parents during the pandemic effects parenting behaviors and styles, potentially affecting their child's ASD symptoms and behavioral problems. Moreover, many of these families received little to no support during COVID-19 lockdown. Consequently, it is essential to provide mental health services, support from government and community stakeholders, to these families during times of crisis to ensure the overall well-being of the family. Below are some recommendations:

- The government and relevant organizations should focus on ways to improve the quality and standards of support provided to families with special children, especially those with ASD.
- The medical community, including doctors, nurses, and therapists, should collaborate efficiently to offer support and guidance to ASD families during these challenging times, empowering them with knowledge and resources.
- Governmental measures, including education campaigns to raise awareness about pandemic-related educational services such as online tutoring, and the implementation of mental health programs designed for both parents and children with ASD are required in times of such crisis.

- As the prolonged social isolation adversely effected ASD children, it is important for communities to strategize and prioritize the return to school for children with ASD when safe during such emergencies.
- Lack of funding's is another major issue faced by such families. Authorities should allocate maximum funding for material, financial, and mental health services to support distressed families.
- Schools should be equipped with the necessary tools and guidance that can help in convenient delivery of services to children with ASD to meet the demands of a pandemic.

Even though the COVID-19 pandemic emergency has compelled researchers to focus on specific pertinent issues relating to the psychological support of children with ASD and their families during this stressful time, in order to assist them in managing their distress and disrupted daily routines. Overall, it was concluded that children with ASD and their families had greater distress as a result of the outbreak, and the prevalence of stereotyped and repetitive behaviors among the children increased compared to the earlier time. The research in this area could highlight and contribute to the development of online parent-coaching interventions. The intervention programs might include advice to parents on how to play and engage with their children better, as well as how to speak to them more effectively. These interventions may lessen distress and aid in the development of effective coping mechanisms, and they may also indirectly influence children's adaptive behavior through their emotional regulation. Conclusively, **specific attention must be placed on the well-being of families with neurodevelopmental disorder, with a particular focus on parental mental health. Furthermore, long-term effective intervention programs that are targeted towards parents of children with ASD should be promoted around Pakistan especially during such global emergencies.**

Limitations

Certain limitations exist in the current study.

1. First, comparatively a small sample size has been used in this study, as the primary data was collected from participants of Islamabad and Rawalpindi only.
2. Secondly, the study is cross-sectional and of retrospective nature.
3. Thirdly, Less data on female children with ASD was collected, thus making it difficult to understand the impact of COVID-19 lockdown on ASD female individuals.

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