LISA LCWU

2025

1st International Conference

on

STATISTICS AND AI:

Bridging the Gap with Data-Driven Innovations

Hosted By

Department of Statistics

Lahore College for Women University, Lahore

PROF. DR. UZMA QURAISHI

Vice Chancellor, LCWU

Patron-in-Chief

The Department of Statistics, one of the oldest departments at LCWU, has long upheld a tradition of academic excellence. Over the years, it has cultured a dynamic learning environment, equipping students with essential statistical skills to tackle complex challenges in diverse fields. With a strong emphasis on interdisciplinary research, the department has collaborated effectively with disciplines such as health sciences, natural sciences and social sciences, making notable contributions to the development of data-driven solutions.

The Department of Statistics is going to organize its first international conference on Statistics and AI: Bridging the Gap with Data-Driven Innovations on December 3rd to 5th, 2025 at Lahore College for Women University, Lahore. The conference underscores the importance of interpretability, uncertainty quantification, robustness, and validity, ensuring that AI models are built on strong statistical principles. It promotes statistical literacy within the AI community, encouraging more responsible model development and evaluation.

The Department of Statistics has built strong international collaborations that offer students and faculty valuable opportunities to learn global best practices and gain practical experience in addressing contemporary challenges through statistical methods. This broad partnership enables us to integrate diverse perspectives, research traditions, and innovative practices from across the world, enriching both the scientific depth and practical relevance of our discussions. We are especially pleased to welcome a distinguished member of our international network who will be joining us at the conference. Her participation reflects the strong bonds we have built across borders and underscores our shared vision of fostering data-driven innovations that benefit the global community.

I would like to especially commend Dr. Asifa Kamal, Chairperson of the Department of Statistics, for her unwavering efforts to the department's growth and advancement, which has been central to its success. Through her vision rooted in academic excellence and innovation, she has continually inspired both faculty and students to achieve new milestones.

DR. ASIFA KAMAL

Patron/Chairperson,
Department of Statistics, LCWU

It gives me immense pleasure to welcome you to the First International Conference on "***Statistics and AI: Bridging the Gap with Data-Driven Innovation***," hosted by the Department of Statistics, Lahore College for Women University, Lahore Pakistan under the kind patronage of Vice Chancellor, **Professor Dr. Uzma Quraishi**.

This three-day event marks a major milestone for our department as we bring together scholars, researchers, practitioners, and students to explore the evolving synergy between statistical science and artificial intelligence.

The conference features distinguished **keynote speakers from leading universities in America, Brazil, and Africa**, whose contributions will enrich our understanding of emerging trends in data-driven methodologies. We are also honored to host a **panel discussion with renowned statisticians and experts from across Pakistan**, providing a valuable platform for dialogue, collaboration, and critical reflection on current challenges and future opportunities.

At Women University, we firmly believe that empowering academic communities especially women scholars through knowledge, innovation, and global engagement is essential for shaping a data-driven future. This conference embodies that vision, offering an avenue for learning, networking, and advancing research that can create meaningful impact.

PROF. ERIC VANCE

Director of the LISA 2020 Global Network

The LISA 2020 Global Network is a connected network of 37 independently run statistics and data science collaboration laboratories ("stat labs") that share a common mission. Our mission is to build local capacity to transform evidence into action for the benefit of society.

Started in 2012, the LISA 2020 Global Network has grown from zero stat labs in developing countries to two in 2014 to 28 in 2020 and now 37 in 2025 (see chapter 2 of our first book for more details). The LISA 2020 Global Network builds partnerships among the University of Colorado Boulder Laboratory for Interdisciplinary Statistical Analysis (LISA) and universities in developing countries to create stat labs that simultaneously develop capacity in statistics and data science and leverage it to solve local development challenges. Shared learning from the stat labs strengthens and helps grow the LISA 2020 Global Network. Each stat lab acts as an engine for development by progressing toward three missions:

- Train statisticians and data scientists to become effective, interdisciplinary collaborators who can move between theory and practice to solve problems for real-world impact;
- Serve as research infrastructure for researchers and decision-makers to collaborate with statisticians and data scientists to enable and accelerate research and data-based decisions that make a positive impact on society;
- Teach short courses and workshops to improve statistical skills and data literacy widely.

Between 2019 and 2024, 36 LISA 2020 labs reported training 4,752 students to become collaborative statisticians and data scientists. The labs worked on more than 2,772 projects resulting in at least 345 peer-reviewed publications that included stat lab faculty and students as co-authors. These labs taught 724 short courses, workshops, or multi-day workshops taught to 23,426 attendees.

The Laboratory for Interdisciplinary Statistical Analysis Lahore College for Women University (LISA-LCWU) became the 15th member of the LISA 2020 Global Network in 2020. LISA-LCWU is one of the shining stars of the network! Some things that LISA-LCWU does that makes them so successful are:

- LISA-LCWU has established fruitful collaborations with the Office of Research, Innovation, and Commercialization (ORIC) as well as the Directorate of Faculty Development and Internationalization (DFDI), LCWU. These partnerships streamline the organization of workshops and other statistical events.
- LISA-LCWU regularly seeks biannual approval from relevant authorities, ensuring the smooth execution of activities throughout each quarter.
- To enrich their training and research endeavors, LISA-LCWU actively invites experts from outside the university, particularly in areas where the Statistics department lacks specialized knowledge.
- LISA-LCWU hosts a regular data analysis consultancy desk, led by statistics students under faculty mentorship. This initiative fosters collaboration on research projects and enhances practical skills.
- LISA-LCWU entrusts young lecturers from the statistics department with organizing responsibilities, and their enthusiasm and dedication significantly contribute to the success of the lab's activities.

We welcome you to learn more about and eventually join the LISA 2020 Global Network. Visit www.lisa2020.org for ways to become involved.

PLENARY & GUEST SPEAKERS

PROF. ERIC VANCE

Associate Professor, Applied Mathematics, University of Colorado Boulder, US

Dr. Eric A. Vance is an Associate Professor of Applied Mathematics, the Director of the Laboratory for Interdisciplinary Statistical Analysis (LISA) at the University of Colorado Boulder USA, and the Global Director of the LISA 2020 Global Network, which comprises 37 statistics and data science collaboration laboratories in 11 developing countries. He is a Fellow of the American Statistical Association (ASA), an elected member of the International Statistical Institute, a two-time winner (2020 and 2022) of the ASA Jackie Dietz Award for the Best Paper of the Year in the Journal of Statistics and Data Science Education, the 2023 ASA W.J. Dixon Winner for Excellence and Lifetime Achievement in Statistical Consulting, and was a 2023-24 U.S. Senior Fulbright Scholar in Indonesia.

Dr. Vance's research spans many disciplines. He is especially interested in researching how to better educate and train statistics and data science students to become effective interdisciplinary collaborators. He also researches how institutions can create statistics and data science collaboration laboratories ("stat labs") to increase the positive impacts of statistics in society.

PROF. ATINUKE OLUSOLA ADEBANJI

Professor of Practice (Statistics) at the Department of Statistics, Purdue University, USA

Atinuke Adebanji is a professor of statistics whose research interests transcends applied multivariate methods, statistical modeling of public health data, multidisciplinary statistical collaboration, and promoting statistical literacy. She has over 80 co-authored publications in refereed journals and given numerous scientific talks and keynote addresses at forums and international conferences worldwide, her work continues to inform policy and decision-making across sectors. Adebanji is a fellow of the Ghana Academy of Arts and Sciences, she is an Elected Member of the International Statistical Institute (ISI), a Member of the Representative Council of the International Biometric Society (IBS), she serves on the IBS Search Committee for Executive Officers (2024–date). Professor Adebanji holds a Ph.D. and M.Sc. in Statistics from the University of Ibadan and an M.Phil. in Public Health from KNUST. She is a recipient of the Organization for Women in Science for the Developing World (OWSD) Postgraduate Fellowship and the Mujeres Por África Senior Research Scientist Fellowship. Her

career reflects a lifelong dedication to using statistics as a bridge between data and development, transforming evidence into action through research, education, and international collaboration. She is currently at the Department of Statistics, Purdue University, USA.

PROF. CARLA VIVACQUA

Professor of Philosophy at Federal University of Rio Grande do Norte, Brazil

Prof. Carla A. Vivacqua is a Full Professor in the Department of Statistics at the Federal University of Rio Grande do Norte (UFRN), Brazil. She holds a Ph.D. and M.Sc. in Industrial Engineering from the University of Wisconsin–Madison (USA), an M.Sc. in Statistics from the University of Campinas (Unicamp), and a B.Sc. in Statistics from the National School of Statistical Sciences (ENCE), Brazil. With more than two decades of interdisciplinary research experience, Prof. Vivacqua specializes in experimental design, statistical modeling, and data-driven innovation applied to climatology, meteorology, education, human and animal behavior, health, energy, and industry. She served as Director of the Laboratory of Applied Statistics (LEA/UFRN) for over 10 years and contributed actively to the LISA2020 Global Network. Her current research includes the application of artificial intelligence to industrial processes, with a strong focus on the mining sector. She collaborates on a funded project, Application of Artificial Intelligence (AI) for Optimization of Particle Separation Processes in Mining, developed with mining partners in the Atacama region of Chile. Prof. Vivacqua has been recognized as a finalist for the Santander Science and Innovation Award and is also a Fulbright Scholar. She maintains active international collaborations with Virginia Tech, the National Center for Atmospheric Research (NCAR), the Norwegian Research Centre (NORCE), and the Universidad de Atacama (Chile).

PROF. DR. SOHAIL CHAND

Principal/Professor of Statistics at College of Statistical Sciences, Punjab University, Lahore, Pakistan

Prof. Dr. Sohail Chand is working as Professor of Statistics at the University of the Punjab, Lahore. He got his M.Sc. in Statistics from the University of the Punjab, an M.Phil. in Statistics from Government College, Lahore. Later, he was awarded HEC scholarship for higher studies from abroad. He went to England and got his Ph.D. in Statistics degree from the University of Nottingham, UK. He worked under the supervision of renowned statisticians Prof. Andrew Wood and Prof. Chris Brignell. His research expertise covers areas related to statistical modeling, machine learning, penalized and robust regression methods, bootstrapping, spatio-temporal analytics, and statistical computing. Dr. Sohail's work integrates modern computational tools with classical statistical theory, contributing to advancements in regression methodology, data-driven penalty selection, and applied data analysis.

With a strong record in teaching, supervision, and curriculum development, he has played a leading role in promoting high-quality statistical education and fostering interdisciplinary applications of data science. He is regularly invited to speak at academic and professional forums, and his contributions continue to strengthen the field of statistical sciences.

PROF. DR. JAMAL ABDUL NASIR

Chairperson/Professor of Statistics at Government College University, Lahore, Pakistan

Jamal Abdul Nasir first graduate degree was in MSc Statistics. Then he earned a Post graduate Diploma in computer Programing and computing Statistics. Then he completed MPHIL in statistics. These three degrees earned from BZ University Multan, Punjab Pakistan. Being the overseas scholarship winner of Higher Education Commission (HEC) of Pakistan he did MSc Demography and PHD in Statistics from the University of Southampton United Kingdom which is globally a top 100 QS ranked university. Dr Jamal has more than 25 years of teaching experience at university level. He has more around 100 research publications. Currently he is serving as the Professor and Chairperson of the department of Statistics, GC University Lahore.

PROF. DR. REHAN AHMAD KHAN SHERWANI

Professor of Statistics at College of Statistical Sciences, Punjab University, Lahore, Pakistan

Dr. Rehan Ahmad Khan Sherwani is a renowned academician and researcher in the field of Statistics in Pakistan, currently serving as Professor of Statistics (BPS-21) at the College of Statistical Sciences, University of the Punjab. With over 20 years of experience in teaching and research, he has established himself as a leading figure in statistical sciences, combining academic excellence with innovation and leadership. His scholarly portfolio includes more than 90 peer-reviewed publications in prestigious international journals, underscoring his expertise in statistical modeling, applied statistics, data mining, distribution theory, control charts, and the emerging domain of quantum computing. Dr. Sherwani earned his Ph.D. from the University of the Punjab in 2013, with a focus on generalizing multilevel models. His research spans a diverse range of fields, including public health, economics, education, environmental science, and technology. His commitment to interdisciplinary research reflects a forward-thinking vision, where classical statistical tools integrate with modern computational methods such as machine learning and quantum algorithms. Dr. Sherwani has led and contributed to numerous research projects funded by major organizations, including the HEC, the NIH, Oxford University, and GAIN. His multidimensional contributions position him not only as a prominent statistician but as a national academic asset, deeply committed to fostering analytical thinking and data literacy in Pakistan.

PANEL DISCUSSION MEMBERS

PROF. DR. MAHNAZ MAKHDUM

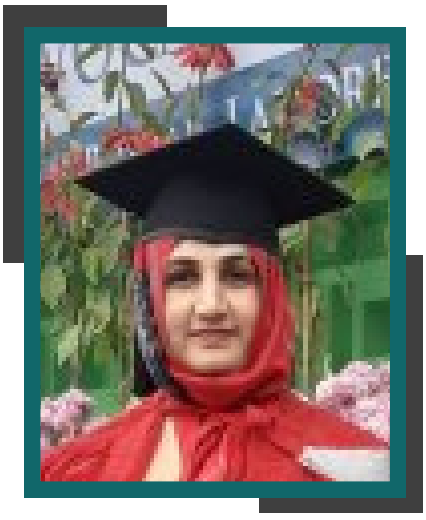
Chairperson/Professor of Statistics, Govt. Graduate College for Women Gulberg, Lahore, Pakistan

Prof. Dr. Mahnaz Makhdum is a senior academic and accomplished researcher in the field of Statistics, currently serving as the Head of the Statistics Department and Professor at Government Gulberg College for Women, Lahore. She holds a Ph.D. in Statistics and has been actively engaged in teaching, research, and academic leadership since 1994, marking more than three decades of contribution to higher education.

Throughout her extensive career, Prof. Dr. Makhdum has taught a wide range of courses in statistics and quantitative methods, mentoring countless undergraduate, graduate, and doctoral students. Her academic work is centered on advancing statistical methodologies, with a particular focus on survey sampling, measurement error models, and techniques for handling complex and sensitive datasets.

A significant part of her research portfolio includes the study "Generalized Mean Estimators for Sensitive Variables in the Presence of Non-Response and Measurement Errors," which proposes innovative solutions to challenges commonly faced in empirical data collection. Her research reflects a commitment to enhancing the accuracy and robustness of statistical inference in real-world scenarios.

Respected for her scholarly insight, teaching excellence, and dedication to academic development, Prof. Dr. Mahnaz Makhdum continues to contribute meaningfully to the discipline of statistics and to the academic community at large.



DR. SHARQA HASHMI

Principal/Associate Professor of Statistics, Government Graduate College for Women, Rakh Chabeel Manawan, Lahore, Pakistan

Dr. Sharqa Hashmi is an accomplished academic and educational leader, currently serving as the Principal and Associate Professor at Government Graduate College for Women, Rakh Chabeel Manawan, Lahore, Pakistan. She earned her Ph.D. from the University of the Punjab in 2019, where her research strengthened her expertise in statistical theory, particularly in probability distributions, which remains her primary area of academic interest.

As Principal, Dr. Hashmi has been dedicated to strengthening the college's academic standards,

administrative structures, and student-centered initiatives. Her leadership is characterized by strategic planning, organizational discipline, and a strong focus on creating an enriching and inclusive learning environment for young women.

In her capacity as Associate Professor, Dr. Hashmi continues to contribute significantly to teaching, curriculum development, and academic mentoring. She emphasizes intellectual growth, critical thinking, and the use of effective pedagogical methods that foster student engagement and success.

Throughout her career, she has worked actively to promote educational excellence, professional development, and community-oriented values. Recognized for her competence, integrity, and vision, Dr. Sharqa Hashmi continues to play a vital role in empowering women through education and guiding the institution toward sustained academic progress.

PROF. DR. SALEHA NAGHMI HABIBULLAH

Professor of Statistics, Former Director Research at Kinnaird College for Women, Lahore, Pakistan

Dr. Saleha Naghmi Habibullah is Professor of Statistics at Kinnaird College for Women, Lahore. During the very first decade of her professional career, she initiated a number of projects and programs for the enhancement of statistical education in Pakistan, and this endeavor continues to this day. Her initiatives in the 1980's and 1990's include the Kinnaird Annual Statistical Exhibition (KASE), the Kinnaird Intercollegiate Statistical Competition (KISC), Kinnaird's Visiting Statistical Exhibition (KVSE), the Statistics Teachers' Educational Program (STEP), the Kinnaird College Statistics FESTIVAL (Forum for the Enlightenment of Students, Teachers, Innovators, Veterans, Amateurs and Learners) and the Data Analysis Talent Award (DATA) which attracted entries from different countries of the world.

In her capacity as Head of the Statistics Department at Kinnaird College, Dr. Naghmi was instrumental in the launch of the MSc Program in Statistics in 2003 which was replaced by the MPhil Statistics Program in the year 2009. During her tenure as Director Research at Kinnaird during the period 2011 to 2017, she played an important role in streamlining research mechanisms at the BS level and, more importantly, in motivating colleagues from various departments to engage in research-work and to enroll in MPhil and PhD Programs in their respective disciplines.

Dr. Naghmi is very well-travelled and, in addition to her Masters in Statistics from the University of Toronto (Canada) in 1983-84 under the Central Overseas Training (COT) Scholarship Program of the Government of Pakistan, and her research-work at the University of Washington (USA) in 2011 under the HEC Sabbatical Leave Fellowship Program, she has presented papers at a large number of international conferences in approximately 35 countries of the world.

To date, Dr. Naghmi has supervised 18 M.Phil. students and has encouraged them to present their work at conferences and to submit research-papers to journals. She has more than 75 publications to her credit including 7 journal publications and 63 papers/articles in conference proceedings out of which 30 are proceedings of international conferences hosted by multiple countries around the

world. In addition to her dedicated services at Kinnaird College, Dr. Naghmi has held a number of prestigious positions at various forums. She was selected Educational Ambassador for Pakistan by the highly prestigious American Statistical Association in February 2018, rendered services as Vice President of the International Association for Statistical Education for the year 2018-19, and was Chair and Chief Organizer of the first-ever International Day of Statistical Literacy (a 10-hour-long online conference (including a Pre-Conference Workshop)) held on May 21, 2024). She is rendering voluntary services as Honorary Executive Director, Pak Institute of Statistical Training And Research (PISTAR), as Deputy Director at the International Statistical Literacy Project (ISLP), and as a member of the Advisory Board on Ethics (ABE) of the International Statistical Institute, Dr. Naghmi is the recipient of numerous national and international honors and awards. In September 1989, she was awarded the First Prize of Rs. 25,000/- by the National Book Council of Pakistan on account of the research paper "On the Modes of the Inverted Bivariate Normal Distribution" that appeared in the April 1987 issue of the Pakistan Journal of Statistics. In January 1994, she was awarded the Third Prize by the Common-Wealth Association of Sciences, Technology and Mathematics Educators on account of the paper entitled "Efforts to Promote Project-Based Teaching of Introductory Statistics in the City of Lahore". In April 2000, the 10th Star Award was bestowed upon her by South Asia Publications, Karachi on account of outstanding performance in the field of Education. In 2007, she was selected for the Complex Systems Summer School 2007 organized by the world–renowned Santa Fe Institute (Santa Fe, New Mexico, USA). In December 2010, she was awarded the Best University Teacher Award by the Higher Education Commission of Pakistan (HEC). In August, 2023, she has been awarded the Societal Impact Award by the Caucus of Women in Statistics and Data Science (CWS) during a prestigious international conference held in Toronto, Canada. In February 2025, she has been awarded the Lifetime Achievement Award by Kinnaird College on account of her dedicated service and exceptional significant contributions for more than 45 years, this being the first-ever such award in the 112-year history of the College.

PROF. DR. MUHAMMAD AZAM

Professor of Statistics and Computer Science, University of Veterinary & Animal Sciences, Lahore, Pakistan

Prof. Dr. Muhammad Azam is a distinguished statistician and academic leader serving as Professor and Dean of the Department of Statistics and Computer Science at the Faculty of Life Sciences Business Management, University of Veterinary and Animal Sciences (UVAS), Lahore. A gold medallist in his Master's program from Islamia University Bahawalpur, he continued to advance academically with an MPhil from Quaid-e-Azam University and a PhD from the University of Innsbruck, Austria. Dr. Azam's career spans more than two decades, beginning with 13 years of service as a lecturer in the Punjab Education Department before moving to Forman Christian College University as an Assistant Professor. He joined UVAS in 2015, eventually becoming Professor and later Dean of the faculty. A prolific researcher with over 80 publications, he specializes in survey sampling, statistical quality control,

and classification techniques, particularly decision trees and ensemble methods. He has supervised numerous postgraduate students and frequently delivers training workshops on statistical methods and data analysis, contributing significantly to capacity building in the academic community. Through his leadership, scholarship, and commitment to teaching, Dr. Azam continues to play a vital role in advancing the fields of statistics and computer science at UVAS and beyond.

PROF. DR. MUHAMMAD MOHSIN

Professor of Statistics, College of Statistical Sciences, University of the Punjab, Lahore, Pakistan

Dr. Muhammad Mohsin is working as the Professor of Statistics in the College of Statistical Sciences, University of the Punjab, Lahore, Pakistan since June 27, 2022. He has been working as the Chairman and the Head of the department of Statistics at COMSATS University Islamabad, Lahore Campus. His areas of interest are Distribution theory, Mathematical statistics, Statistical modeling, Bayesian Inference, Meta-analysis and Statistical Inference. He has done his Postdoc from École Polytechnique Fédérale de Lausanne (EPFL), Switzerland in 2016. He completed his PhD from Alpen-Adria University, Klagenfurt, Austria in 2013. He won different awards such as Ernst Mach-Nachbetreuungsstipendium (EZA) fellowship from OEAD, Austria in 2018, Swiss Excellent Scholarship from the Swiss Government in 2015, Overseas Scholarship for Doctoral Studies from HEC in 2009 etc. He completed an NRPU project titled “Modeling and forecasting of drought duration and interarrival time" awarded by HEC and two others awarded by the University of the Punjab. He has been a member of HEC Curriculum Development Committee for BS, MS and PhD courses as well. There are more than 55 national and international research publications on his credit. He is also serving as a reviewer of several national and international statistics journals as well.

DR. SHAROON HANOOK

Chairperson/Associate Professor of Statistics at Forman Christian College University, Lahore, Pakistan

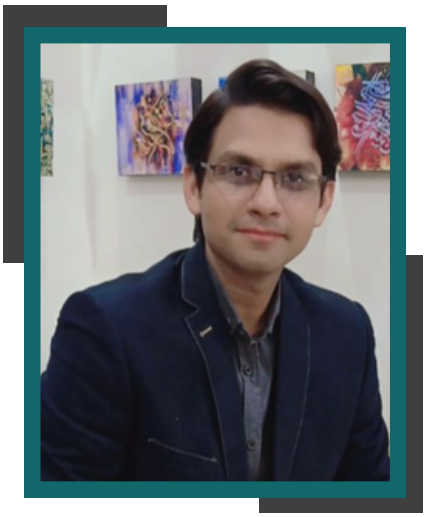
Dr. Sharoon Hanook is an accomplished biostatistician and academic leader, currently serving as the Head of the Department of Statistics at Forman Christian College (A Chartered University), Lahore. He holds a Ph.D. in Biostatistics from Case Western Reserve University (CWRU), USA, where he also served as Chair of the Student Organizations and Allocations Committee from 2011 to 2013 and worked on various committees within the Graduate Student Senate to enhance the student experience.

Before joining FCC, Dr. Hanook taught Statistics at GC University Lahore for 11 years, contributing significantly to the academic growth of the department and mentoring numerous

students. His international academic involvement includes being a Fulbright Fellow (2009–2014) and a Member of the American Statistical Association (2013–2015).

Dr. Hanook's research focuses on biostatistical methodologies and their applications in public health and biomedical sciences. He has published in internationally reputed journals, reflecting strong scholarly engagement and methodological rigor. An enthusiast of R-programming, he emphasizes modern data analysis tools, reproducible research practices, and computational statistics in his teaching and research.

Known for his commitment to promoting academic excellence and student development, Dr. Sharoon Hanook continues to lead the Statistics Department at FCC with vision, innovation, and a dedication to high-quality education.



DR. MUHAMMAD NOOR UL AMIN

Head/Associate Professor of Statistics at COMSATS, Lahore, Pakistan

Dr. Noor ul Amin is a distinguished statistician and academic leader, currently serving as the Head of the Department of Statistics and a Tenured Associate Professor at COMSATS University Islamabad, Lahore Campus. With a strong commitment to teaching, research, and departmental development, he has significantly contributed to elevating the academic standards and research culture within the department.

Dr. Amin has an extensive research portfolio, with more than 100 publications in reputable national and international journals. His work spans a range of areas within statistical modeling, data analysis, and applied statistics, reflecting both academic depth and practical relevance. His contributions are widely recognized within the statistical community for their methodological rigor and scholarly impact.

In addition to his research achievements, Dr. Noor ul Amin has successfully secured two funded research projects from the Higher Education Commission (HEC) of Pakistan, demonstrating his ability to translate research ideas into impactful funded initiatives. These projects have strengthened research capacity and enhanced opportunities for student involvement in high-quality research.

As an academic leader, he is committed to fostering an environment of innovation, critical thinking, and academic excellence. Through dedicated mentorship and strategic vision, Dr. Amin continues to shape the future of the Statistics Department at COMSATS University Lahore.

DR. SYED WASIM ABBAS

Director, Pakistan Bureau of Statistics, Lahore, Pakistan

Dr. Waseem Abbas is a distinguished statistician and public servant, currently serving as the Director of the Pakistan Bureau of Statistics (PBS). In his leadership role, he oversees the collection, analysis, and dissemination of national statistical data, playing a critical role in supporting evidence-based policy-making and socio-economic planning in Pakistan. His statistical skills includes survey sampling, survey design, questionnaire designing, pilot testing, data quality assurance, data analysis, tabulation and report writing. With extensive experience in statistics and data management, Dr. Abbas has been instrumental in modernizing statistical processes, ensuring data accuracy, and promoting transparency across federal and provincial statistical systems. His work emphasizes the importance of reliable and timely statistical information for government planning, economic development, and research. He has been engaged in many census and survey projects including 7th Population & Housing Census 2022, Pakistan Mouza Census 2020, Punjab Child Labour Survey (2019), Multiple Indicator Cluster Survey Punjab (2017-18), (2014), (2007-08), Baseline Child Labor Survey (2016) and many more. He has also been involved in many local and foreign trainings and workshops.

Dr. Abbas is known for his strategic vision, analytical expertise, and commitment to capacity building within the statistical community. Under his leadership, PBS continues to enhance methodologies, adopt international best practices, and foster collaboration with national and international stakeholders.

Throughout his career, he has contributed to advancing the use of statistical science for practical decision-making, policy evaluation, and research purposes. Dr. Waseem Abbas remains dedicated to strengthening Pakistan's statistical infrastructure and promoting a culture of data-driven governance across the country.

CONFERENCE SCIENTIFIC PROGRAM

Day 1 (3rd December, 2025)

8:30 am – 10:00 am	Registration	
10:00 am – 10:30 am	Inaugural Ceremony • Vice Chancellor's Address • Convener Address	
10:30 am – 11:00 am	• Keynote Speech on "The Importance of Collaboration Skills for Statisticians in the Age of AI" by **Prof. Eric Vance**, Associate Professor, Applied Mathematics, University of Colorado Boulder, US.	
11:00 am – 11:30 am	• Keynote Speech on "Empowering Change: Statistical Insight, Artificial Intelligence, and Women's Roles in the Mining Economy" by **Prof. Carla Vivacqua**, Professor of Philosophy at Federal University of Rio Grande do Norte, Brazil.	
11:30 am – 12:00 noon	• Keynote Speech on "Data Driven Penalty Selection in Ridge and Lasso Regression" by **Prof. Dr Sohail Chand**, Principal/Professor of Statistics at College of Statistical Sciences, Punjab University, Lahore	
12:00 noon – 12:30 pm	• Keynote Speech on "Statistics, Policy Making and AI" by **Prof. Dr. Jamal Abdul Nasir**, Chairperson/Professor of Statistics at Government College University, Lahore.	
12:30 pm – 1:00 pm	Certificate Distribution	
1:00 pm – 2:00 pm	**PRAYER AND LUNCH**	
2:00 pm – 3:30 pm	**Session 1 Iqra Auditoriam**	**1. Mathematical & Probabilistic Models**
	Session 2 Committee Room	**2. Statistics and Public Health**
	Session 3 G-34 SS Block	**3. Bio-Statistics**
	Session 4 G-35 SS Block	**4. Spatial Statistics and Random Fields**
3:30 pm – 3:45 pm	**Tea**	

Day 2 (4th December, 2025)

9:00 am – 10:00 am	Registration
10:00 am – 10:30 am	• Keynote Speech on "Beyond Algorithms: The Role of Statistical Thinking in Shaping Reliable AI" by **Prof. Atinuke Olusola Adebanji**, Professor of Statistics at Kwame Nkrumah University of Science and Technology, Kumasi, Ghana.
10:30 am – 11:00 am	• Keynote Speech on "Quantum Computing" by **Prof. Dr. Rehan Ahmad Khan Sherwani**, Professor of Statistics at College of Statistical Sciences, Punjab University, Lahore.
11:00 am – 12:30 pm	Panel Discussion on ***"Statistics in the Age of Data Science and AI"*** **Moderator:** **Prof. Dr. Mahnaz Makhdum** Chairperson/Professor of Statistics, Govt. Graduate College for Women, Gulberg, Lahore, Pakistan **Co-Moderator:** **Dr. Sharqa Hashmi** Principal/Associate Professor of Statistics, Government Graduate College for Women, Rakh Chabeel Manawan, Lahore, Pakistan **Members:** • **Prof. Dr. Saleha Naghmi Habibullah** Professor of Statistics, Former Director Research at Kinnaird College for Women, Lahore, Pakistan • **Prof. Dr. Muhammad Azam** Head, Department of Statistics and Computer Sciences, University of Veterinary and Animal Sciences, Lahore • **Prof. Dr. Muhammad Mohsin** Professor of Statistics, College of Statistical Sciences, University of the Punjab, Lahore, Pakistan • **Dr. Sharoon Hanook** Chairperson/Associate Professor of Statistics, FCC University, Lahore, Pakistan. • **Dr. Muhammad Noor ul Amin** Head/Associate Professor of Statistics, COMSATS, Lahore, Pakistan • **Dr. Syed Wasim Abbas** Director, Pakistan Bureau of Statistics, Lahore, Pakistan
12:30 pm – 1:00 pm	Certificate Distribution
1:00 pm – 2:00 pm	**PRAYER AND LUNCH**

2:00 pm – 3:30 pm	**Session 1 Committee Room**	**5. Mathematical & Probabilistic Models**
	Session 2 Iqra Auditorium	**6. Application of Statistics**
	Session 3 G-34 SS Block	**7. Statistics & Machine Learning**
	Session 4 G-35 SS Block	**8. Bio-Statistics**
	Session 5 F-13 Lab SS Block	**9. Statistical Education**
	Session 5 IT Video Conference Room	**10. Application of Statistics (12:00 noon - 1:30 pm)**
3:30 pm – 3:45 pm	**Tea**	

Day 3 (5th December, 2025)

10:00 am – 12:00 noon	Workshop on ***"Data Analytics in Python: Tools & Techniques"*** **Resource Persons:** • **Dr. Naila Amjad** Assistant Professor, Department of Statistics, Lahore College of Women University, Lahore, Pakistan • **Ms. Noor Shahid** Lecturer, Department of Statistics, Lahore College for Women University, Lahore, Pakistan **(Separate Registration Required)**	
10:00 am – 11:30 pm	**Session 1 F-12 Lab SS Block**	**11. Application of Statistics**
	Session 2 F-13 Lab SS Block	**12. Statistics & Machine Learning**

INAUGURAL SESSIONS

Date/Time	Description
3rd December, 2025	**Session 1: Mathematical & Probabilistic Models**
Chair	**Dr. Zahoor Ahmad, Sargodha University, Sargodha**
Moderator	**Dr. Shakila Bashir, FCCU, Lahore**

Sr. No.	Paper Title	Author(s)
1	**01:** Forecasting the Air Quality of Lahore: A Comparison between Bayesian Neural Network and Autoregressive Integrated Moving Average Model	Rabia Manzoor Sajal Hassan
2	**02:** Transmuted Unit Moment Exponential Distribution with Theory and Applications	Muhammad Ibrahim Maryam Waseem Muhammad Ahsan-ul-Haq Junaid Talib
3	**04:** Approximation of parabolic partial differential equations using haar wavelet	Amina Iqbal Shazia Javed Sidra Saleem
4	**05:** Stein's Method for Exponentiated Exponential Distribution	Maham Mahmood Naila Amjad Anum Fatima
5	**35:** Sin-DUS Class of Distributions: Theory and Applications for Infection Times of CKD Dialysis Patients	Ishmal Shahzadi Shakila Bashir
6	**60:** Development and Statistical Analysis of Modified Kies Perks Distribution	Sarwat Rashid Shakila Bashir

Date/Time	Description
3rd December, 2025	**Session 2: Statistics and Public Health**
Chair	**Dr. Uzma Ashiq LCWU, Lahore**
Moderator	**Dr. Hina Khan, GCU, Lahore**

Sr. No.	Paper Title	Author(s)
1	**07:** Socio- Economic Determinant of Housing Occupancy Status in Pakistan: A Comprehensive Analysis using PSLM Data 2019-2020	Samavia Kashif Jiya Amir Aqsa Atiq
2	**08:** Impact of Social Support of Geriatric Conditions and Health Outcomes among Older People	Kinza Akhtar Hina Khan
3	**09:** Comparative Survival Modeling of Early Marriage in Pakistan: Evidence Across Two PDHS Waves	Sajida Nazir Hina Khan
4	**10:** Awareness and Attitude of Males toward People Living with HIV (PLWH) in Punjab, Pakistan: A Statistical Analysis using MICS (2017-18)	Nagina Sehar Sameena Irfan Afza Rasul
5	**11:** Socioeconomic and ICT Impact on Income in Urban and Rural Areas of Pakistan	Maria Aslam Warda Mukhtar Saira
6	**12:** Determinants of Household Wealth and Socioeconomic Disparities: Evidence from the Multiple Indicator Cluster Survey (MICS) in Punjab, Pakistan	Ayesha Sheikh Jiya Amir Haleema Ahsan
7	**13:** Determinants of Early Childhood Development in Punjab using MICS (2017-18)	Ayesha Tamoor Tahira Bano Hajra Muzammil

Date/Time	Description
3rd December, 2025	**Session 3: Bio-Statistics**
Chair	**Dr. Zohra Kiyani, LCWU, Lahore**
Moderator	**Dr. Abdur Razzaque Mughal, GCU, Lahore**

Sr. No.	Paper Title	Author(s)
1	**14:** Modeling the Length of Patient Stay in Hospitals using Birnbaum-Saunders Distribution	Waqas Makhdoom Muhammad Kashif Ali Shah Nighat Zahra

Sr. No.	Paper Title	Author(s)
2	**15:** A Structured Data Preprocessing Framework for Hormonal Imbalance Analysis	Alina Sajid Shazia Javed
3	**16:** BMI (Body Mass Index) in Patient's Preferences for Knee Replacement: A Systematic Review and Meta-Analysis	Farwa Ikram Rehan Ahmad Khan Sherwani
4	**17:** Factors Associated with Knowledge and Determinants of Acute Gastroenteritis Using Statistical Modeling: A Study of Tehsil Ferozewala (Punjab)	Rubab Tariq Jamal Abdul Nasir
5	**18:** Socio-Economic Factors Associated with Food Insecurity in Pakistan: PSLM Survey 2019-20	Maryum Zulfiqar Sameena Irfan Afza Rasul
6	**19:** Predictors of Resilience in Young Adults	Komal Hassan
7	**20:** Predicting the Impact of Sleep Disorders on Academic Performance among University Students, STEM vs Non-STEM Majors. A Comparative Study in Lahore	Muskan Siddiqui Mariyam Hafeez

Date/Time	Description
3rd December, 2025	**Session 4: Spatial Statistics and Random Fields**
Chair	**Dr. Fakhra Aziz LCWU, Lahore**
Moderator	**Dr. Zulfiqar Ali, PU, Lahore**

Sr. No.	Paper Title	Author(s)
1	**21:** Spatial Heterogeneity in Parity Specific Son Preference Across Pakistan's Districts; A Design Based Small Area Estimation Study	Hajira Muzammal Asifa Kamal
2	**22:** Spatial Analysis of Earthquake Patterns and Risk Assessment of Khyber Pakhtunkhwa, Pakistan	Ayesha Siddique Hina Khan
3	**23:** Improving Spatial Predictions through Calibrated Machine Learning and Spatial Blocking Framework	Faiza Jabeen Sohail Chand
4	**24:** Determinants of Injury Severity in Road Traffic Crashes Using Binary Logistic Regression: A Data-Driven Safety Analysis	Mudassira Munir Amjad Pervez
5	**25:** The Salient Features of Official Statistics	Muhammad Younis
6	**26:** Spatial Analysis of Socio-Economic Determinants of School Dropouts in Pakistan	Shabnam Iftikhar Asifa Kamal

Date/Time	Description
4th December, 2025	**Session 1: Mathematical & Probabilistic Models**
Chair	**Dr. Maria Hussain, LCWU, Lahore**
Moderator	**Dr. Sehrish Iftikhar, LCWU, Lahore**

Sr. No.	Paper Title	Author(s)
1	**03:** Unit Inverse Weibull Distribution with Properties Estimation and Application	Zunaira Azam Mariyam Hafeez Tahira Bano
2	**36:** The Kumaraswamy Exponentiated Inverse Weibull Distribution	Farwa Willayat Naz Saud
3	**37:** An Efficient Partial and Optional Randomized Response Model for Estimating the Sensitive Attribute Using Negative Binomial Distribution	Neeha Aamer Butt Asifa Kamal
4	**38:** Quantifying and Correcting Trust Deficiencies and Measurement Errors in Mixture Binary RRT Models	Bailey Meche Venu Poruri Sat Gupta Sadia Khalil
5	**39:** Fair Curve Construction Using Rational Cubic Bézier Curves with Minimum Strain Energy	Nazish Arshad Maria Hussain
6	**40:** Impact of Plasma on the Shadow of a Charged Spherically Symmetric Black Hole	Sadia Karim Sehrish Iftikhar
7	**41:** Predicting Under-five Mortality in Pakistan using Supervised Machine Learning Models: Evidence from Pakistan Demographic and Health Survey 2017-18	Sumbal Amjad Rehan Ahmad Khan Sherwani

Date/Time	Description
4th December, 2025	**Session 2: Statistical Applications**
Chair	**Dr. Saima Farhan, LCWU, Lahore**
Moderator	**Dr. Azaz Ahmed, Govt. Islamia Gradutae College, Lahore**

Sr. No.	Paper Title	Author(s)
1	**42:** Impact of Rapid Urbanization on Agricultural Farmland in Major Cities of Pakistan: A Comparative GIS-Based Analysis	Ali Haider Asad Ali

Sr. No.	Paper Title	Author(s)
2	**43:** Predicting the Health Burden due to Air Pollution in South Asian Countries	Tehmina Latif Muhammad Noor-ul-Amin
3	**44:** Industrial Process Monitoring Using Adaptive Variable Sample Size EWMA Control Charts with Sigmoid Functions	Abdul Rauf Abbasi Muhammad Noor-ul-Amin
4	**45:** Artificial Neural Network-Based Adaptive Cumulative Sum Control Charts for Enhanced Process Monitoring	Muhammad Waqas Kazmi Muhammad Noor-ul-Amin
5	**46:** A Comparative Approach to Modeling Stomach Cancer Burden across Saarc Nations	Fiza Saleem Muhammad Noor-ul-Amin
6	**47:** Factors Affecting Women Entrepreneurship in Punjab Using Women's Economic and Social Well Being Survey, Punjab (2017-18)	Uswa Majeed Asifa Kamal Afrah Hafeez
7	**48:** Advancing Sustainable Education of Statistics in Pakistan: Innovations, Challenges, and Opportunities	Asifa Kamal Eric Vance Jiya Amir

Date/Time	**Description**
4th December, 2025	**Session 3: Statistics & Machine Learning**
Chair	**Dr. Ghazala Noreen, LCWU, Lahore**
Moderator	**Dr. Qurat ul Ain Rana, Lahore Garrison University, Lahore**

Sr. No.	Paper Title	Author(s)
1	**49:** Unraveling the Impact of Marriage and Children on Women's Occupational Growth using Multinomial Regression and Machine Learning Approach: Insights from the Women's Economic and Social Wellbeing Survey, Punjab 2017-18	Sehar Imran Sehar Saleem
2	**50:** Assessing the Impact of Household Fuel Choices on Household Energy Expenditures using Machine Learning and Classical Approach: Evidence from Household Integrated Economic Survey (HIES) 2018-2019, Pakistan	Sehar Saleem Warda Mukhtar
3	**51:** Hybrid Deep Learning and Signal Decomposition Models for Predictive Analytics in Renewable Energy and Financial Markets of Pakistan	Ayesha Pari Sana Saeed Rehan Ahmad Khan Sherwani

Sr. No.	Paper Title	Author(s)
4	**52:** Structural Equation Models for the Estimation of Psychological Well-being of COVID-19 Caregivers in Pakistan	Maham Rafique Rehan Ahmad Khan Sherwani
5	**53:** Data Mining of Non-Communicable Diseases Indicators in Pakistan and Associated Countries	Muhammad Abdullah Arshad Rehan Ahmad Khan Sherwani
6	**54:** A Statistical study on Branded Shoes and Customer Satisfaction	Alishba Sheikh Rehan Ahmad Khan Sherwani
7	**55:** Quantum Computing in Healthcare: Current Status and Future Prospects – A Comprehensive Review	Amna Riaz Rehan Ahmad Khan Sherwani

Date/Time	**Description**
4th December, 2025	**Session 4: Bio Statistics**
Chair	**Dr. Itrat Naqvi, FCCU, Lahore**
Moderator	**Dr. Naila Alam, KC, Lahore**

Sr. No.	Paper Title	Author(s)
1	**56:** Modeling Longitudinal Trajectories of Clinical Markers to Estimate the Risk of Stage Shift among CKD Patients	Aleena Shafqat Butt Sharoon Hanook
2	**57:** Connected but Strained: Data-Driven Perspectives on Technology, Lifestyle and Mental Health	Mamoon Sikander Itrat Batool Naqvi
3	**58:** Deep Learning Approaches for Climate Driven Crop Yield Forecasting in Pakistan	Mahnoor Irfan Nadia Mushtaq
4	**59:** The Impact of Personality Type on Social Engagement Behaviors - A Data Driven Approach	Novera Jamil Itrat Batool Naqvi
5	**61:** White Coat Preferences for Physicians' Attire: Fixed Effect Meta-Analysis	Eman Waseem Rehan Ahmad Khan Sherwani
6	**27:** Spatio-Temporal Analysis of Vegetation Dynamics in Punjab: Exploring the Role of Rainfall	Fatima Abdullah Shaista Shumaila Zunaira Khurram

Date/Time	Description
4th December, 2025	**Session 5: Statistical Education**
Chair	**Dr. Aisha Shahzad, LCWU, Lahore**
Moderator	**Dr. Shaista Shumaila, KC, Lahore**

Sr. No.	Paper Title	Author(s)
1	**62:** Analyzing Spatial Patterns and Factors Influencing Poor Tetanus Toxoid Immunization Among Pregnant Women in Pakistan: A Spatial and Multilevel Analysis	Warda Khan Tahira Bano Mariyam Hafeez
2	**63:** Determinants of Household Poverty in Punjab: A logistic Regression Analysis Using MICS (2017-2018)	Fatima Fazal Tahira Bano Warda Khan
3	**64:** Analyzing the Relationship between Workforce Demographics and Labor Market Challenges in Pakistan	Waleeja Jamshaid Naila Alam Tooba Khan
4	**65:** Modeling the Relationship between Arabian Sea Surface Temperature and Precipitation in Pakistan Using Multivariate Time Series Techniques	Zainab Abid Tooba Khan Naila Alam
5	**66:** Critical Review of the Evolution of Economic Survey of Pakistan	Fareeha Nasim Mutahir Iqbal
6	**67:** Predicting the Impact of Antiretroviral Therapy on Viral Load Among HIV/AIDS Patients in Lahore: A Machine Learning Approach	Areeba Allah Ditta Maryam Hafeez Noor Shahid
7	**68:** Effect of Bay of Bengal Sea Surface Temperature on Precipitation in Bangladesh, India and Pakistan	Dua Saleem Khazaima Mushtaq Shaista Shumaila

Date/Time	Description
4th December, 2025	**Session 6: Application of Statistics (Online)**
Chair	**Dr. Moneeba Iftikhar, LCWU, Lahore**
Moderator	**Dr. Maryam Siddiqa, IIU, Islamabad**

Sr. No.	Paper Title	Author(s)
1	**06:** Adaptive Dominant Component Analysis for Speech Enhancement in White Noise	Rabia Sharif Shazia Javed
2	**28:** Early Childhood Anemia in Ghana: Prevalence and Predictors Using Machine Learning Techniques	Mahnoor Shahid Butt Maryam Siddiqa
3	**29:** Healthy Housing in South Asia: Characterization and Determinants Based on Multinomial Logistic Regression Analysi	Maryam Siddiqa Sammiya Tahir
4	**30:** Double Burden of Malnutrition Puzzle: Decoded by Classical Logistic Framework	Zara Ali Maryam Siddiqa
5	**31:** Determinants of Childhood Anemia in Burkina Faso: A Multivariate Decomposition Analysis	Sundas Abbasi Maryam Siddiqa
6	**32:** A Pure Hypothesis Test for Inhomogeneous Random Graph Models Based on a Kernelised Stein Discrepancy	Anum Fatima Gesine Reinert
7	**33:** A Case Study based on POST-COVID Health Complications in Patients of Fatima Memorial Hospital Lahore	Nayyer Waseem
8	**34:** Storytelling Technique in Influencer Marketing and its Effect on Digital Consumer	Soha Naveed Moneeba Iftikhar

Date/Time	Description
5th December, 2025	**Session 1: Application of Statistics**
Chair	**Ms. Uzma Noman, Govt. College for Women, Samanabad, Lahore**
Moderator	**Dr. Salma Kanwal, LCWU, Lahore**

Sr. No.	Paper Title	Author(s)
1	**69:** Rural-Urban Gaps in Early Childhood Education and Development in Pakistan: Evidence from the Multiple Indicator Cluster Survey (MICS) in Pakistan	Khadija Ashraf Jiya Amir Maira Asif

Sr. No.	Paper Title	Author(s)
2	**70:** Factors Associated With Child Maltreatment In Punjab, Pakistan Using MICS (2017-18)	Kiran Fatima Sameena Irfan Asifa Kamal
3	**71:** Statistical Analysis of Cereal Production and Cultivated Area in Pakistan: A Provincial and National Perspective	Maryam Waheed Saher Saleem
4	**72:** Factors Affecting Women's Perception of Safety (Inside or Outside Home) in Punjab Using Women's Economic and Social Well Being Survey, Punjab (2017-2018)	Aiza Farooq Asifa Kamal Maria Khalid
5	**73:** A comprehensive Analysis on Vitamin D supplements and Intake on Body Mass Index	Areeba Riaz Noor Shahid
6	**74:** Assessing the Relationship Between Social Media Usage and Depression Among Female University Students	Aqsa Atiq Ayisha Shafiq

Date/Time	**Description**
5th December, 2025	**Session 2: Statistics & Machine Learning**
Chair	**Prof. Dr. Mahnaz Makhdum, Govt. College for Women, Gulberg, Lahore**
Moderator	**Dr. Sadia Khalil, LCWU**

Sr. No.	Paper Title	Author(s)
1	**75:** Relationship between Maternal knowledge and Demographic Factors in the Home management of childhood Diarrhea: A statistical analysis from Shaikh Zayed hospital, Lahore	Aleeha Rasheed Ayisha Shafiq Indullah Saleem
2	**76:** Risk Factors of Multidrug-Resistant Tuberculosis in The South Asia: A Meta-Analysis	Faiza Faisal Asifa Kamal Hamda Batool
3	**77:** Effect of Social Media Advertisement on Purchasing Behavior: A Response from Female University Students and Female Faculty Members	Sehar Imran Sehar Saleem
4	**78:** Global Patterns of Antimicrobial Resistance through Statistical and Machine Learning Insights	Rabia Akbar Noor Shahid
5	**79:** Statistical and Machine Learning Approaches to Childhood Diarrhea and Wash-Related Risk Factors in Punjab, Pakistan	Rameen Asif Naila Amjad

Sr. No.	Paper Title	Author(s)
6	**80:** Machine Learning Models and Bootstrap Methods for Predicting School Enrollment with Missing Data	Syeda Fatima Naqvi Naila Amjad Sawera Farooq
7	**81:** Impact of Water, Sanitation, and Hygiene (WASH) Factors on Childhood Diarrhoea in Pakistan: A Statistical Analysis Using PSLM Data	Attiqa Urooj Mariyam Hafeez Afza Rasul

CONFERENCE INVITED TALKS

THE IMPORTANCE OF COLLABORATION SKILLS FOR STATISTICIANS IN THE AGE OF AI

Prof. Eric Vance
Associate Professor, Applied Mathematics, University of Colorado Boulder, US

ABSTRACT

Statistics and data science have extraordinary potential to drive innovations and impactful research. But as generative AI provides more people with access to advanced analytical tools and capability, the role of the statistician as a data analyst must evolve. For today's statisticians and data scientists, collaboration is a necessity to achieve impact. Based on experience collaborating on more than 1000 statistics and data science projects with many domain experts, Vance & Smith developed a framework for learning and teaching collaboration skills. This framework is called the ASCCR framework and is comprised of five principal components of collaboration: Attitude, Structure, Content, Communication, and Relationship. I will discuss how this framework can help statisticians become effective collaborative statisticians to work with people in the Age of AI. The path toward increased impact is one in which statisticians learn to become effective interdisciplinary collaborators and then ensure that they are working on impactful problems. By collaborating with experts in domains outside of statistics and data science, statisticians can transform evidence into action for the benefit of society.

EMPOWERING CHANGE: STATISTICAL INSIGHT, ARTIFICIAL INTELLIGENCE, AND WOMEN'S ROLES IN THE MINING ECONOMY

Prof. Carla Vivacqua
Professor of Philosophy at Federal University of Rio Grande do Norte, Brazil

ABSTRACT

Artificial intelligence is redefining traditional industries, and mining is among the sectors experiencing transformation. This keynote explores how advanced statistical methods, machine learning models, and real-time data analytics are enabling safer operations, predictive maintenance, optimized resource allocation, and more sustainable extraction processes. These innovations not only enhance economic efficiency but also generate new layers of insight critical for strategic decisions, an essential intersection between statistics and economics emphasized by this conference. As technological change accelerates, so do opportunities for women to shape the future of the mining industry. Historically underrepresented, women are increasingly entering roles in data science, automation, environmental monitoring, and AI-driven decision support. Their participation is essential to drive inclusive innovation and to ensure that mining's digital transition reflects diverse perspectives and societal priorities. By highlighting case studies, emerging research, and real-world applications, this talk demonstrates how data-driven intelligence is transforming mining from an extractive enterprise into a knowledge-rich, technology-enabled sector. Ultimately, the synergy between statistics and artificial intelligence offers not only economic value, but also a pathway for empowering women to lead the next era of mining innovation.

DATA DRIVEN PENALTY SELECTION IN RIDGE AND LASSO REGRESSION

Prof. Dr. Sohail Chand
Principal/Professor of Statistics at College of Statistical Sciences, Punjab University, Lahore

ABSTRACT

Penalty selection is a critical step in ridge and lasso regression, directly influencing model performance and interpretability. Data-driven approaches to choosing these penalties enable more adaptive and objective tuning, balancing bias and variance effectively. Techniques such as cross-validation, information criteria, and stability selection guide the optimal penalty parameter, improving prediction accuracy and variable selection consistency. This talk put emphasize on key methods for penalty selection, highlighting their advantages and limitations in practical settings. By leveraging data-driven strategies, statisticians and data scientists can enhance model robustness and generalizability, ensuring more reliable outcomes in high-dimensional and complex regression problems.

STATISTICS, POLICY MAKING AND AI

Prof. Dr. Jamal Abdul Nasir
Chairperson/Professor of Statistics at Government College University, Lahore

ABSTRACT

Statistics are fundamental to policy making, providing evidence for identifying problems, allocating resources, and evaluating outcomes. The term artificial Intelligence (AI) introduced in mid 1980s. Invent of AI opens new ways to policy environment. This talk will highlight and initiate a debate how the role of AI is linked with evidence based policy particularly in developing countries by taking Pakistan as a case study. Globally, due to rapid advancements in AI the dynamics of policy making would undergo policy transformations. The following four questions are interesting to note for this talk: Is no-AI based policy making significant? Is no-AI based policy making insignificant? Is AI based policy making significant? Is AI based policy making insignificant? Answers to these questions will amplify the debate and may provide the actioner or professional a better view to decide on his/her own view to understand the use of statistics with policy and AI as optimistic or pessimistic.

BEYOND ALGORITHMS: THE ROLE OF STATISTICAL THINKING IN SHAPING RELIABLE AI

Prof. Atinuke Olusola Adebanji
Professor of Practics (Statistics) at the Department of Statistics, Purdue University, USA

ABSTRACT

Over the last few decades, algorithms have evolved from simple, rule-based instructions into complex systems that learn, adapt, and infer. Artificial Intelligence has become one of the defining instruments of modern inquiry, and it is changing the way we acquire, analyze and use data. But the power of AI depends on core statistical concepts of uncertainty quantification for model and system reliability, estimation, and learning from data. The quiet question is, can we trust the intelligence we are creating? In this talk I will attempt to show that reliability in AI is not a computational accomplishment; it is a statistical one. Statistical thinking is the core of every credible model, from study design through data measurement to model deployment. My goal is to show that when we incorporate good statistical knowledge into AI, we can shift the conversation from black-box performance to accountable intelligence. In doing so, we move toward systems that are not only impressive but also deserving of our trust.

QUANTUM COMPUTING

Prof. Dr. Rehan Ahmad Khan Sherwani
Professor of Statistics at College of Statistical Sciences, Punjab University, Lahore

ABSTRACT

Quantum computing represents a revolutionary paradigm that leverages quantum mechanics principles to perform computations beyond the reach of classical computers. Utilizing phenomena such as superposition and entanglement, quantum computers can solve certain problems exponentially faster, including optimization, cryptography, and simulation of quantum systems. Despite current technical challenges like error rates and qubit stability, ongoing advancements are rapidly progressing toward practical, scalable devices. The integration of quantum computing promises transformative impacts across fields such as materials science, medicine, and artificial intelligence. As research accelerates, understanding its principles and potential applications becomes essential for driving innovation in the digital era.

SESSION'S ABSTRACTS

01:
FORECASTING THE AIR QUALITY OF LAHORE: A COMPARISON BETWEEN BAYESIAN NEURAL NETWORK AND AUTOREGRESSIVE INTEGRATED MOVING AVERAGE

Rabia Manzoor and **Sajal Hassan**
Department of Statistics, Govt. Graduate College (W), Samanabad Lahore

ABSTRACT

Air Pollution imposes serious environmental and health related risks. Air Pollution is serious issue in major cities of Pakistan especially in Lahore which leads to poor Air Quality. This study was conducted to estimate and forecast the Air Quality Index of Lahore, Pakistan. In this study Bayesian Neural Network that is advancement of Traditional Neural Network, had been used to estimate the daily Air Quality Index. Contrarily, the Box-Jenkins Time Series ARIMA modeling had been used to forecast the Air Quality Index. The daily Air Quality data was sourced from Environmental Protection Agency from June 01, 2019, to May 31, 2026. The Influencing factors like Temperature, Humidity, Dew Drops, Pressure and Wind Speed were also considered to estimate the daily Air Quality Index, and data was sourced from Kaggle. The study concludes that Bayesian modeling provides more Robust and interpretable framework rather than Time Series modeling.

Keywords: *Data Analytics, Higher Education, Bayesian Neural Network, ARIMA Model, Forecasting.*

02:
TRANSMUTED UNIT MOMENT EXPONENTIAL DISTRIBUTION WITH THEORY AND APPLICATIONS

Muhammad Ibrahim[1], Maryam Waseem[2], Muhammad Ahsan-ul-Haq[3] and **Junaid Talib[2]**
[1]Department of Statistics, Government College University Lahore, Pakistan
[2]School of Statistics, Minhaj University Lahore, Pakistan
[3]Quality Enhancement Cell, National College of Arts, Lahore, Pakistan

ABSTRACT

In this paper, a new unit interval probability model named the transmuted unit moment exponential distribution is introduced and studied. The new model is meant to be an extension of improving the flexibility of the baseline model to represent real-life data, especially in reliability and lifetime data analysis. We derived various mathematical characteristics, including moments, moment generating function, incomplete moments, mean residual life function, stochastic ordering, order statistics, and entropy. The maximum likelihood estimation approach is utilized to estimate the model parameters. The behavior of these derived estimators is assessed using a detailed Monte Carlo simulation study. In the end, the proposed distribution is applied to real-life datasets to show flexibility and adaptability. It was found that the new model efficiently analyzed these datasets as compared to the considered competitive distributions.

Keywords: *Bounded Distribution, Transmuted Family, Moments, MLE, Unit Data Analysis.*

03:
UNIT INVERSE WEIBULL DISTRIBUTION WITH PROPERTIES, ESTIMATION, AND APPLICATION

Zunaira Azam, Mariyam Hafeez and **Tahira Bano**
Department of Statistics, Lahore College for Women University, Lahore

ABSTRACT

The exponential transformation is used to introduce the new lifetime distribution called Unit Inverse Weibull (UIW) distribution. Statistical properties of the proposed distribution are studied in feature, including survival function, hazard function, cumulative hazard function, quantile and median functions, Shannon entropy, and density of order statistics. Maximum Likelihood Estimation (MLE) approach is used to estimate parameters for the proposed distribution, and related Fisher Information Matrix (FIM) is created to evaluate parameter variability. The proposed UIW distribution demonstrates flexibility in modeling lifetime data and is determined by two parameters: scale parameter (α) and shape parameter (β). Its statistical characteristics, such as moments, reliability measures, kurtosis, skewness, and order statistics, are thoroughly studied. Using lifetime data of technology products, the UIW distribution's practical application is illustrated. The Total Time on Test (TTT) plot shows an increasing hazard rate. To evaluate its performance, the proposed distribution is compared with the Unit Rayleigh (2020), Johnson SB (1949), and Topp-Leone (1955) distributions. Based on various goodness of fit criteria, including AIC, BIC, CAIC, HQIC, log-likelihood, and the Kolmogorov–Smirnov test, the UIW distribution provided an excellent fit to the observed data, outperforming the existing models.

Keywords: *Weibull Distribution, Inverse Weibull distribution, Unit Weibull Distribution, Maximum Likelihood Estimates, Order Statistics.*

04:
APPROXIMATION OF PARABOLIC PDES USING HAAR WAVELET

Amina Iqbal, Shazia Javed and **Sidra Saleem**
Department of Mathematics, Lahore Collage for Women University, Lahore

ABSTRACT

This research focuses on adapting a simple and efficient technique for the approximation of different parabolic partial differential equations (PDEs), including first-order partial differential equation and diffusion equations. The exact solutions of the discussed equations are approximated by a multi-resolution based hybrid Haar wavelet collocation method (hHWCM), constructed on the basis of Euler's formula (finite difference method (FDM)) and Haar wavelet's collocation procedure. The construction and implementation of the algorithm of the proposed technique is carried out in MATLAB, that is helpful in obtaining approximate solutions that are compared with the corresponding exact solutions. The performance of the proposed method is measured by means of maximum absolute errors and experimental rates of convergence (illustrated in tables). Moreover, the graphical views are representing a good match between exact and approximate solutions. The results demonstrate the accuracy, efficiency and robust behavior of the hHWCM in a few collocation points.

Keywords: *Haar Wavelet, Diffusion Equation, Collocation Points.*

05:
STEIN'S METHOD FOR EXPONENTIATED EXPONENTIAL DISTRIBUTION

Maham Mahmood[1], **Naila Amjad**[1], and **Anum Fatima**[2]
[1]Department of Statistics, Lahore College for Women University, Lahore
[2]University of Oxford, UK & Department of Statistics, LCWU

ABSTRACT

The analysis of lifetime and reliability data plays a crucial role in both engineering and medical research, where flexible statistical models are required to capture complex, often skewed, and censored data. The Exponentiated Exponential (EE) distribution and its generalization, the Generalized Exponentiated Exponential (GEE) distribution, have been widely recognized for their flexibility in modelling survival and reliability phenomena. However, due to the intractable nature of the GEE distribution in many cases, suitable approximation techniques are essential. This thesis develops and applies Stein's method for the Exponentiated Exponential distribution and employs it to approximate the Generalized Exponentiated Exponential distribution. Although the GEE distribution provides greater modelling flexibility, its mathematical complexity, such as difficulties in estimation, deriving moments, and simulations, often limits practical use. To overcome these challenges, Stein's method is utilized as a powerful approximation framework, enabling the tractable analysis of GEE through the simpler EE distribution. Stein operators are constructed for both the EE and GEE distributions, and explicit error bounds are derived for the approximation of GEE by EE distribution. The theoretical findings establish that the approximation error depends linearly on the parameter deviation , with the bound vanishing when , thereby confirming that the EE distribution is a special case of GEE. Furthermore, the dependence of the error bound on scale parameters and higher-order moments is investigated, showing that larger values of these quantities improve the accuracy of the approximation.

Keywords: *Steins Method, Stein Operator, Distribution Comparison, Exponentiated Exponential (EE), Generalized Exponentiated Exponential (GEE).*

06:
ADAPTIVE DOMINANT COMPONENT ANALYSIS FOR SPEECH ENHANCEMENT IN WHITE NOISE

Rabia Sharif and **Shazia Javed**
Department of Mathematics, Lahore College for Women University, Lahore

ABSTRACT

In real-time communication systems, speech signals are often degraded or partially lost due to additive noise or transmission errors. This work presents an online speech enhancement framework named Adaptive Dominant Component Analysis (ADCA), which integrates the Affine Projection Algorithm (APA) with an incremental form of Principal Component Analysis (PCA). APA estimates residuals and weight vectors from distorted speech, which are then processed adaptively using an incremental SVD update to extract dominant components. These components help reconstruct missing or noisy parts of speech in a streaming environment. In this presentation, we focus specifically on the white noise experiment to demonstrate the efficiency of the proposed method. Results show that APA-based ADCA successfully suppresses white noise while preserving key signal attributes such as energy, RMS amplitude, covariance, and dynamic range.

Keywords: *Signal Processing, Sparsity Removal, Noise Removal, Dominant Component Analysis, Affine Projection Algorithm.*

07:
SOCIO- ECONOMIC DETERMINANT OF HOUSING OCCUPANCY STATUS IN PAKISTAN: A COMPREHENSIVE ANALYSIS USING PSLM DATA 2019-2020

Samavia Kashif, Jiya Amir and **Aqsa Atiq**
Department of Statistics, Lahore College for Women University, Lahore

ABSTRACT

The study examines how various factors affect the occupancy status of the owner of the household. The Pakistan Social & Living Standard Measurement (PSLM) survey (2019-20) was used in this regard. This study contained seven socio-economic factors that influence occupancy status. Descriptive as well as analytical analysis was done to achieve the objectives of the study. The results of descriptive statistics show that the majority of the owners are men who are paid employees and have not self-employed households. The result of the chi-square test of association indicates that employment status, salary schedule, gender, and residency status have a statistically significant impact on occupancy status. In multinomial logistic regression, the result revealed that most of the household owners prefer rent-free or rented houses rather than not self-hired, self-hired, and subsidized rent who have a monthly salary schedule. Moreover, self-hired or rented houses, as compared to rent-free houses, have female owners, considering that not-self-hired and subsidized rent houses mostly have both male and female owners.

Keywords: *Housing Occupancy, Socio-Economic Factors, Pakistan, PSLM Data, Logistic Regression.*

08:
IMPACT OF SOCIAL SUPPORT OF GERIATRIC CONDITION AND HEALTH OUTCOMES AMONG OLDER PEOPLE

Kinza Akhtar and **Hina Khan**
Department of Statistics, GCU University, Lahore

ABSTRACT

The aim of the study is to find the impact of social support of geriatric condition and health outcomes among older people. The data has been collected from local communities, household visits, religious gathering (madrasahs) and assistance (old age home) through interview based. It has been collected data from 325 older adults in different places of Lahore from 1st November 2024 to 30th March 2025. After collection of data apply different statistical techniques. The descriptive of all the variables such as percentages, frequencies and mode, indicate 42.5% male reported who participate in this research, while 57.5% female reported who participate to find these outcomes that affect their lives. The factor analysis discloses the major categories: daily self-care challenges, social engagement, post-retirement activities, health-related family dynamics, leisure engagement, sensational and cognitive limitation, mobility challenges, persistent condition, health status of vital organs, emotional challenges, social pressure on health and social exclusion. Through SEM (structural equation modeling) has been revealed that the effect of social on health is which means social interaction has a temperate positive effect on health of an older adults. By using binary logistic regression, it has been use all variables from the questionnaire. These are all variable are show significant as are less .These factors help for policymakers, families, and assistance to improve the quality of life for older peoples and reduce the health care burden in Lahore.

Keywords: *Geriatric Conditions, Social Support, Health Outcomes.*

09:
COMPARATIVE SURVIVAL MODELING OF EARLY MARRIAGE IN PAKISTAN: EVIDENCE ACROSS TWO PDHS WAVES

Sajida Nazir and **Hina Khan**
Department of Statistics, Government College University, Lahore

ABSTRACT

In Pakistan, child marriage sustains a threat to the health and empowerment of women. Economic and Sociocultural considerations continue to promote the practice despite national efforts to prevent it. The main objective of this study is to identify the determinants of child marriage among women of Pakistan by applying appropriate parametric survival analysis model on two waves of Pakistan Demographic and Health Survey (PDHS) 2012–13 and 2017–18. Data were taken from PDHS 2012-13 and 2017-18 of women who had ever married till age 49. Age at first marriage was target with sample of 11,147 women from PDHS 2017-18 and 9,965 women from 2012-13. Data was extracted using SPSS (V.27) and STATA (V.13.0). Parametric and non-parametric models were utilized. The Kaplan–Meier plots revealed notable survival patterns to featured variables, with the log-rank test indicating significance ($p < 0.05$). The contributing factors to child marriage in both waves were region, women's education level, wealth index, age of respondent at 1st birth and husband's age, number of pregnancy losses and blood relation with husband. While husband education, women's work before and after marriage, husband education and knowledge of ovulatory cycle were significant in 2017-18 data, media exposure and place of residence were significant in 2012-13. Child marriage is still common among underprivileged groups, and there was no difference in prevalence across survey waves. To end this practice, rigorous legislative execution, greater media awareness, and educational empowerment are crucial. Prior to creating and executing strategies to prevent child marriage, additional research and evaluation of the factors that have been shown to prevent child marriage in other countries are required.

Keywords: *Child Marriage, PDHS, Kaplan Meier's Survival, Log-Rank Test, Log-logistic Gamma-Frailty Model.*

10:
AWARENESS AND ATTITUDE OF MALES TOWARD PEOPLE LIVING WITH HIV (PLWH) IN PUNJAB, PAKISTAN: A STATISTICAL ANALYSIS USING MICS (2017-18)

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ABSTRACT

In Punjab, Pakistan, HIV/AIDS has remained a sensitive public health issue, with limited awareness and social acceptance among the general population. The aim of the current study is to estimate the significant factors effecting the HIV/AIDS awareness and attitude toward HIV-positive children regarding permission to attend school among males in Punjab, Pakistan. Data has been taken from the Multiple Indicator Cluster Survey (MICS) conducted in Punjab, Pakistan (2017-18). The sample comprised 5901 men aged 15-49 years. Bivariate and binary logistic regression analyses have been carried out to evaluate the significant factors. Results of the study showed that the youngest respondents between 15-19 years were less aware of HIV/AIDS as

compared to those aged 25-44 years. HIV/AIDS awareness increased with higher levels of media exposure. HIV/AIDS awareness was higher among urban males than rural males. Similarly, the percentage of awareness was lowest among the poorest men as compared to the richest. Age, frequency of reading newspapers or magazines, frequency of listening to the radio, frequency of watching television, education and wealth index had significant effects on HIV/AIDS awareness among males. HIV/AIDS awareness was highest among older, wealthier, as well as those with greater media exposure. Men with higher education were more than 12 times more likely to be aware of HIVAIDS as compared to those with no/pre-school education. More than half of the men who read newspapers almost every day showed a positive attitude toward children living with HIV regarding permission to attend school. As the educational level of males increased, their attitude toward allowing HIV-positive children to attend school became positive. Frequency of listening to the radio and education were the only factors effecting the attitude of males toward HIV-positive children regarding permission to attend school significantly. Men who were highly educated were 2.130 times more likely to show a positive attitude toward HIV-positive children regarding permission to attend school.
Keywords: *HIV/AIDS Awareness, Positive Attitude, PLWH.*

11:
SOCIOECONOMIC AND ICT IMPACT ON INCOME IN URBAN AND RURAL AREAS OF PAKISTAN

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ABSTRACT

Income inequality remains a major socioeconomic issue in Pakistan, affecting development outcomes in both urban and rural areas. This study examines the socioeconomic and technological factors influencing household income in Pakistan, with a focus on differences between rural and urban regions. Using data from the Pakistan Social and Living Standards Measurement Survey (PSLM) 2019–20, quantile regression analysis was performed at the 10th, 50th, and 90th percentiles to capture diverse effects across the income distribution. The results show that age positively and significantly impacts income in all models—overall ($\beta = 0.008$, $p < 0.001$), rural ($\beta = 0.008$, $p < 0.001$), and urban ($\beta = 0.014$, $p < 0.001$)—highlighting the importance of experience in income growth. Household size has a positive association at higher income levels, especially in rural areas ($\beta = 0.025$, $p < 0.001$). Conversely, the number of earners has a negative effect across all models—overall ($\beta = –0.181$, $p < 0.001$), rural ($\beta = –0.177$, $p < 0.001$), and urban ($\beta = –0.270$, $p < 0.001$)—indicating that larger families with multiple earners may face diminishing returns. Education is a critical factor for income. Individuals with secondary education ($\beta = 0.776$, $p = 0.004$) and professional degrees ($\beta = 1.010$, $p = 0.004$) earn significantly more, with stronger effects seen in urban areas ($\beta = 0.537$, $p = 0.005$). Employment type also influences income: government employees earn more ($\beta = 0.265$, $p = 0.024$), while self-employed individuals earn less ($\beta = –0.520$, $p < 0.001$). Access to technology significantly boosts income levels. Smartphone ownership has a positive and significant effect overall ($\beta = 0.305$, $p < 0.001$), in rural ($\beta = 0.274$, $p < 0.001$), and urban ($\beta = 0.606$, $p = 0.002$) areas, emphasizing the importance of digital inclusion. Gender disparities persist, with males earning more than females—overall ($\beta = 0.510$, $p < 0.001$), rural ($\beta = 0.517$, $p < 0.001$), and urban ($\beta = 0.219$, $p = 0.071$). Provincial differences show that households in

Punjab and Sindh earn significantly higher incomes compared to Balochistan ($p < 0.001$). Overall, the findings highlight that education, ICT adoption, and employment opportunities are key drivers of income growth, while rural underdevelopment and gender inequality remain major barriers to achieving inclusive and sustainable economic progress in Pakistan.
Keywords: *Household Income, Socio-economic Factors, ICT, Quantile Regression Analysis.*

12:
DETERMINANTS OF HOUSEHOLD WEALTH AND SOCIOECONOMIC DISPARITIES: EVIDENCE FROM THE MULTIPLE INDICATOR CLUSTER SURVEY (MICS) IN PUNJAB, PAKISTAN

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ABSTRACT

This study examines the socioeconomic and demographic determinants of household wealth in Punjab, Pakistan, using data from the Multiple Indicator Cluster Survey (MICS) 2017–18, conducted by the Punjab Bureau of Statistics in collaboration with UNICEF. The research aims to identify how factors such as education, marital status, district, area of residence, disability, health insurance, age, sex, and household language influence wealth distribution. The analysis employs both descriptive and inferential statistical methods. Frequencies and percentages were calculated to describe the demographic characteristics of respondents, while Chi-square tests and ordinal logistic regression were performed to identify significant predictors of wealth index quintiles. The model fitting information indicates that the general model significantly improves over the null model, confirming the suitability of the regression approach. Results reveal that education, marital status, district, area, functional difficulties, and health insurance are significantly associated with household wealth, while age and gender show no significant effects. Households in urban areas, with higher education levels and access to health insurance, demonstrate greater economic well-being. Conversely, those with functional difficulties and lower educational attainment are more likely to fall into poorer wealth categories. The study concludes that improving educational access, healthcare coverage, and employment inclusion—particularly for individuals with disabilities—can help reduce wealth disparities. It recommends targeted policy interventions in rural and underdeveloped districts to promote equitable economic growth and enhance overall living standards in Punjab.
Keywords: *Household Wealth, Socioeconomic Determinants, MICS, Ordinal Logistic Regression.*

13:
DETERMINANTS OF EARLY CHILDHOOD DEVELOPMENT IN PUNJAB USING MICS (2017-18)

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ABSTRACT

Early childhood development (ECD) is crucial for healthy growth of children. Globally, over 43 per cent (approx. 250 million) of children under the age of 5 years are at risk of not having their full developmental (lancet 2016). According to the Pakistan National Nutrition Survey,14% of children aged 24–59 months have at least one functional difficulty. Current study was aimed to determine

the impact of demographic factors, attention from the family factors, maternal education, family socio-economic factors and children's nutritional status on ECD in Punjab, Pakistan using data from MICS (2017-18). Bivariate and multivariate statistical techniques are used to meet the objective of the study. Results of logistic regression model revealed that children living in urban areas were 1.129 times more likely to have better early childhood development than those in rural areas. Children who were playing with someone were 1.10 times more likely to show better early childhood development. Children with normal weight and moderately underweight were better in ECD than underweight children. Children with normal height were 1.27 times more likely to develop well compared to severely stunted children. Children from the middle-income group were 13% less likely to have good early childhood development than children from the richest group. Overall, early childhood development is more likely when a child has good health, an educated mother, lives in an urban area, and receiving care and interaction at home.

Keywords: *ECD, Factors.*

14:
MODELING THE LENGTH OF PATIENT STAY IN HOSPITALS USING BIRNBAUM-SAUNDERS DISTRIBUTION

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ABSTRACT

THospital administration faces significant challenges in managing the length of stay for treatment, despite the importance of healthcare for human well-being. The previous studies indicated that the distribution of length of stay in hospitals is heavily tailed. The probability distribution such as Weibull and Exponential distributions were fitted for length of stay in hospital data. In this study, we fitted Birnbaum-Saunders distribution to patients stay data. We compared three distributions (Birnbaum-Saunders, Weibull, and Exponential) and found that the Birnbaum-Saunders distribution outperformed other probability distributions for two real-world data sets, with lower Akaike Information Criterion and Bayesian Information Criterion. The present study illuminates the Birnbaum-Saunders distribution as a flexible and powerful framework for modeling length of stay in health facilities as a sound statistical basis for evidence-informed healthcare administration and policy decisions.

Keywords: *Birnbaum Saunders Distribution, Healthcare, Length of Stay, Probability Distribution.*

15:
A STRUCTURED DATA PREPROCESSING FRAMEWORK FOR HORMONAL IMBALANCE ANALYSIS

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ABSTRACT

TThis research involves preprocessing and cleaning of a synthetic dataset designed to analyze hormonal imbalance symptoms and patterns. The dataset contains 10,000 records, representing individuals with varying demographic, lifestyle, and medical characteristics such as age, gender, BMI, stress level, diet quality, and hormonal symptoms. The goal of preprocessing is to prepare the data for machine learning tasks by cleaning, visualizing, normalizing, and encoding it in a

structured and standardized format. By this pipeline procedure, dataset is made consistent and suitable for various applications such as hormonal imbalance classification and health risk prediction.

Keywords: *Preprocessing, Hormonal Imbalance Data.*

16:
BMI (BODY MASS INDEX) IN PATIENT'S PREFERENCES FOR KNEE REPLACEMENT: A SYSTEMATIC REVIEW AND META-ANALYSIS

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ABSTRACT

To identify ideal BMI and review its impact, examine the relationship between BMI and pain, physical functioning or satisfaction. Improve patient's outcomes by regarding BMI and patient's preferences. A search of Google Scholar, PubMed, Sci Hub, web of science, Science direct and many other resources using keywords BMI, Meta-Analysis from 1986 to 2024. Those studies were included which published in last 38 years, and determined the outcomes of BMI in patient's preferences for knee replacement. Studies were excluded due to lack of irrelevant information. Out of 189 articles after duplicate review, 80 were excluded due to lack of irrelevant information, 109 were excluded due to lack of qualitative information and 18 were included in quantitative synthesis of Meta-Analysis of body mass index. The total of enrolled was 18, with patient's mean age is 69.0 years, 67.4% of patients were women, 32.6% of patients were men. The independent variables age, income, marital status, employment status and educational level were analyzed. Only included studies provide data on a given parameter of interest. 18 studies were included in the study. The result showed that the 95% confidence interval (CI) around the effect size, and the percentage weight of each study in the meta-analysis. The overall fixed pooled effect size is estimated to be 0.01, with 95% confidence interval of 0.01 to 0.00 ($p<0.05$), indicating a highly significant relationship between the studied factors. Overall, the findings suggest a strong and statistically significant association between the studied factors. Increased body mass index to a substantially increased risk of knee replacement surgery. The magnitude of the association varies by sex and knee replacement definition.

Keywords: *Obesity, Osteoarthritis, Meta-analysis, Knee Replacement.*

17:
FACTORS ASSOCIATED WITH KNOWLEDGE AND DETERMINANTS OF ACUTE GASTROENTERITIS USING STATISTICAL MODELING: A STUDY OF TEHSIL FEROZEWALA (PUNJAB)

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ABSTRACT

Globally, gastroenteritis is an extremely harmful condition, particularly in children under five. This symptom was first described in 1825 as gastroenteritis. This cross-sectional study, supported by primary data, was conducted at Tehsil Headquarters Hospital (THQ), Ferozewala, District Sheikhupura, Punjab, Pakistan. It focused on children under five years old to analyze the various

factors contributing to gastroenteritis in Tehsil Ferozewala. Statistical modelling was used to examine the multiple variables influencing gastroenteritis. The population included all children under five who visited the hospital during the study period, with a total sample size of 505. Data were collected using a questionnaire and analyzed through SPSS. The most significant variables associated with awareness about gastroenteritis included the patient's age, weight, mother's education, mother's occupation, number of family members, type of feeding, degree of dehydration, and symptoms. For gastroenteritis problems, key factors were patient's age, mother's education, mother's occupation, water consumption, abdominal pain, level of dehydration, and number of episodes. The study suggests that mothers should be educated about the causes, symptoms, progression, and management of pediatric diarrheal diseases. Promoting women's education is essential, as it can greatly improve children's health, especially by reducing diarrhea among infants and young children. The Integrated Management of Childhood Illness (IMCI) strategy can help prevent diarrhea through interventions such as oral rehydration therapy (ORT), appropriate antibiotic use, continued feeding during illness, prompt care for dehydration, and timely medical consultation. Policymakers should prioritize these identified factors to design effective health interventions aimed at minimizing diarrheal diseases and improving the well-being of children under five.
Keywords: *Gastroenteritis, Ferozewala, IMCI, Dehydration, Abdominal Pain, Women's Education.*

18:
SOCIO-ECONOMIC FACTORS ASSOCIATED WITH FOOD INSECURITY IN PAKISTAN: PSLM SURVEY 2019-20

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ABSTRACT

In Pakistan, like many other developing countries, political instability and poor governance have increased food insecurity. The situation has become severe as millions of people are struggling to obtain enough food. The aim of this study is to identify the factors associated with food insecurity in Pakistan. Data have been taken from the Pakistan Social and Living Standards Measurement (PSLM) Survey 2019–20, which has covered 6,500 sampled areas (enumeration blocks and villages) at the district level across the four provinces. The sample comprised of 130,686 households. A binary logistic regression model has been used to examine the significant socio-economic factors related to food insecurity in Pakistan. A considerable portion of respondents have experienced food insecurity, reflecting a serious concern. Factors such as region, province, educational background, gender, age, and marital status have been significantly related to food insecurity. Individuals from rural areas and females have found to be more affected by food insecurity. Compared to Punjab, the issue has more prevalent in all other provinces of Pakistan. Furthermore, age has shown an inverse relationship with food insecurity, indicating that as age has increased, the severity of food insecurity has decreased.
Keywords: *Food Insecurity, Socio-economic, Pakistan.*

19:
PREDICTORS OF RESILIENCE IN YOUNG ADULTS

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ABSTRACT

This study examined the predictors of resilience in young adults. Data was collected from 420 young adults by using Connor Davidson Resilience Scale, Rosenberg Self Esteem Scale, General Self Efficacy Scale, Multidimensional Scale of Perceived Social Support, Satisfaction with Life Scale, Short Grit Scale, and Meaning in Life Scale, along with some demographic information about respondents. PLS algorithm showed good psychometric properties for study constructs. Results demonstrated that every alpha coefficient, composite reliability estimate, and average variance extracted value was greater than the corresponding cutoff values. Factor loadings of tool items on their respective constructs were high, except for a very few, which were further excluded from analysis. Findings showed that convergent validity of study construct existed. Discriminant validity was evaluated through HTMT ratio, which was less than 0.8 between all constructs. So, constructs were discriminant from each other. The VIF values for study model were less than 5, so multi-collinearity assumption was fulfilled, and further evaluation was performed. Resilience's R^2 (0.519) showed that 52% of variance in resilience was explained by predictors in model. Q^2 value (0.136) indicated meaningful predictive relevance for path-model. It was concluded that resilience in young adults can be predominantly predicted by self-esteem, self-efficacy, grit, presence, and the search for meaning in life. This study adds an important perspective to debate on social support and life satisfaction as insignificant predictors of resilience. The content analysis also elucidated the major adversities faced by young adults, including psychological issues like stress and depression, health problems, and social challenges. This highlights key issues faced by young adults in their daily lives. These findings underscore the need for tailored resilience interventions to help youth cope effectively. The research findings can guide education management and community development efforts to promote resilience and well-being among youth.

Keywords: *Resilience, Self-Esteem, Self-Efficacy, Grit, Meaning in Life, Young Adults.*

20:
PREDICTING THE IMPACT OF SLEEP DISORDERS ON ACADEMIC PERFORMANCE AMONG UNIVERSITY STUDENTS, STEM VS NON-STEM MAJORS. A COMPARATIVE STUDY IN LAHORE

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ABSTRACT

Sleep plays a fundamental role in maintaining both physical and cognitive health, and disturbances in sleep patterns have been widely associated with decreased learning efficiency and academic achievement. This study investigates the relationship between sleep disorders and academic performance among university students in Lahore, with a comparative focus on STEM and non-STEM majors. A cross-sectional survey design was employed, including a sample of 767 students from Lahore College for Women University (LCWU) and Kinnaird College (KC). Data were collected using the validated SLEEP-50 questionnaire and analyzed through descriptive statistics, chi-square tests, and ordinal logistic regression to examine associations between types of sleep

disorders and academic outcomes. The results revealed that a considerable proportion of students experienced one or more sleep disorders, with insomnia, nightmares, and circadian rhythm disturbances being the most prevalent. Non-STEM students were found to be at a significantly higher risk for most sleep disorders compared to STEM students. Although STEM students achieved slightly higher cumulative grade point averages (CGPA), the overall difference in academic performance between the two groups was not statistically significant. However, ordinal logistic regression analysis indicated that certain sleep disorders had distinct effects on academic outcomes. Apnea was significantly and positively associated with higher CGPA, while sleepwalking showed a significant negative impact on academic performance. These findings emphasize the growing prevalence of sleep-related issues among university students and their complex, multifactorial relationship with academic achievement. The study underscores the importance of addressing sleep health in higher education institutions to enhance students' overall well-being and academic success.
Keywords: *Sleep Disorders, Academic Performance, STEM, Non-STEM, University Students, Ordinal Logistic Regression, Insomnia, Apnea, Sleepwalking, CGPA, Sleep Quality.*

21:
SPATIAL PATTERNS AND HETEROGENEITY IN PARITY SPECIFIC SON PREFERENCE ACROSS PAKISTAN'S DISTRICTS: A DESIGN BASED SMALL AREA ESTIMATION STUDY

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ABSTRACT

In Pakistan, son preference is deeply embedded in social and cultural norms, with sons frequently valued more than daughters due to expectations rooted in economics, social standing, and religious beliefs. This research aims to explore the spatial diversity of son preference across Pakistan's 128 districts, providing a more granular analysis of this preference's cultural and demographic impacts compared to previous studies, which focused on the provincial level. By applying Small-Area Estimation (SAE) techniques, the study seeks to create localized, district-specific projections of son preference, using data from the two rounds of Pakistan Demographic and Health Survey i.e. 2012-13 and 2017-18 PDHS and the 2023 Pakistan Census. This approach will allow for a comprehensive assessment of son preference indicators, such as women's desire for additional children based on the presence of sons and family structure (parity). The difference between "with son" and "without son" groups serves as a quantitative indicator of son preference. Direct estimates were computed using complex survey design adjustments. Model-based estimates were derived using Generalized Linear Mixed Models (GLMMs) with a logit link under a Small Area Estimation (SAE) framework, incorporating auxiliary variables such as urbanization, literacy rate, women's age, education level, employment status, and sex ratio. Findings reveal substantial spatial heterogeneity, with higher son preference in Punjab and KPK and moderate levels in other provinces. Alternative models without parity-specific variation capture aggregated son preference patterns based solely on son presence. This study delivers the first spatially detailed estimates of son preference for Pakistan, offering methodological innovations in applying SAE to DHS data and providing actionable evidence for gender-focused policy interventions.
Keywords: *SAE, KPK, PDHS, LISA.*

22:
SPATIAL ANALYSIS OF EARTHQUAKE PATTERNS AND RISK ASSESSMENT IN KHYBER PAKHTUNKHWA, PAKISTAN

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ABSTRACT

IThe study aims to identify the spatial distribution of earthquake-prone areas, patterns, and clusters in KP to reduce disaster risk and develop a model to predict earthquake events for improved resilience planning in KP. Secondary data has been collected from the Pakistan Meteorological Department (PMD), which includes official records of historical earthquake events that occurred in Khyber Pakhtunkhwa and surrounding regions, covering the area from to N and to E, from 1970 to January 2025. The study employs various spatial analysis techniques in ArcGIS to map earthquake events and uses the R language to forecast earthquake occurrences over specific time intervals. The seismicity map reveals a dense cluster of medium to high magnitude earthquakes in the Hindu Kush region (Afghanistan-Tajikistan border). The hotspot map shows that the northern part of KP exhibits a high clustering of values, indicating statistically significant hotspot areas. The cluster and outlier map demonstrates that statistically significant high clustering values are located in the Malakand, Hazara, and Bannu divisions. The earthquake zoning map identifies the Hazara division and the northern part of the Malakand division as the highest hazard zones. The study applies nine different distributions to determine the most suitable probability model for earthquake data from various zones in Khyber Pakhtunkhwa, aiming to estimate future seismic events using the best-fit model. The combination of =1 and t = 3 represents the conditional probability of earthquake occurrence between 2025 and 2028, indicating a 21% chance of an earthquake with a magnitude 4.5 in Zone I and an 18.5% chance in Zone II, based on the best-fitting log-logistic model. The study concludes that the Malakand and Hazara divisions are the most earthquake-prone areas, experiencing the highest frequency of seismic activity.

Keywords: *Spatial Analysis, Risk Assessment, Resilience Planning, Earthquake-Prone Areas.*

23:
IMPROVING SPATIAL PREDICTIONS THROUGH CALIBRATED MACHINE LEARNING AND SPATIAL BLOCKING FRAMEWORK

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ABSTRACT

ISpatial prediction is often challenging due to spatial dependence and non-stationarity inherent in the data. Traditional methods, like Kriging explicitly account for spatial autocorrelation but generally rely on restrictive linearity and stationarity assumptions. Modern machine learning (ML) techniques can model complex nonlinear relationships, yet they often ignore spatial structure. This leads to biased estimates and unreliable uncertainty quantification. This study introduces a calibrated spatial machine learning framework that integrates spatial blocking and conformal calibration to improve both prediction accuracy and reliability. Firstly, the framework applies nested spatial cross-validation to prevent spatial leakage and ensure fair model evaluation. Then, calibration adjusts the prediction intervals to provide realistic uncertainty estimates.

The proposed methodology is applied to the soil quality dataset containing the zinc concentrations and related soil and topographic variables, results show that the proposed method, combining the spatial blocking with calibration, significantly improves the model performance as compared to both uncalibrated ML and Kriging. The framework offers a reliable, data-driven approach for spatial prediction and can be extended to broader environmental applications such as groundwater and climate modeling.
Keywords: *Spatial Machine Learning, Spatial Blocking, Conformal Calibration, Uncertainty Quantification, Meuse Dataset, Environmental Modeling.*

24:
DETERMINANTS OF INJURY SEVERITY IN ROAD TRAFFIC CRASHES USING BINARY LOGISTIC REGRESSION: A DATA-DRIVEN SAFETY ANALYSIS

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ABSTRACT

Road traffic injuries represent a critical public health challenge, contributing significantly to global death rate and posing considerable socioeconomic burdens, especially in developing regions. This study applies a binary logistic regression model to identify key determinants of injury severity fatal versus non-fatal using officially reported crash data from India. The analysis incorporates diverse predictors, including vehicle type, driver physical condition, roadway geometry, traffic signage, and signal control features. Comprehensive data preprocessing and diagnostic checks, including Variance Inflation Factor (VIF) assessments, confirmed model robustness with no multicollinearity concerns. The model demonstrated strong explanatory power (Nagelkerke R^2 = 0.231) and good fit (Hosmer-Lemeshow p = 0.158). Results indicate that two-wheeler users are at significantly higher risk of fatal outcomes compared to occupants of medium and heavy vehicles. Results indicate, several infrastructural features intended to enhance safety such as horizontal road markings, wider undivided roads, and all red signal phases were associated with increased fatality odds, suggesting that such elements may facilitate riskier behaviors or higher speeds. These findings underscore the vital role of statistical modeling in public health and safety policymaking. By identifying modifiable risk factors in road environments, this study provides evidence based insights to guide targeted interventions aimed at reducing traffic related mortality and mitigating associated economic costs. The research exemplifies how data driven approaches can bridge statistics and public health to foster safer mobility systems and support sustainable communities.
Keywords: *Injury Severity, Binary Logistic Regression, Public Health, Traffic Safety, Statistical Modeling, Data-Driven Policy.*

25:
THE SALIENT FEATURES OF OFFICIAL STATISTICS

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ABSTRACT

The purpose of this study is to throw light on some salient features of Official Statistics. This article is logically and systematically developed by introducing "What is Official Statistics", its fundamental principles, sources of data and their uses, followed by a discussion on the National Statistical System (NSS), its functions and types of NSS, as well as the Statistical System of Pakistan. The study also covers the activities of various Federal and Provincial Government departments, which are contributing useful data to the National Statistical System of Pakistan. Major institutions/organizations include the Pakistan Bureau of Statistics, M/O Finance, and its different organs such as the Federal Board of Revenue, State Bank of Pakistan, and Zarai Taraqiati Bank etc. M/O Economic Affairs, M/O National Food Security and Research, Pakistan Public Administration Research Center, M/O Interior, and other departments without proper statistical cells. The contribution of provincial bureaus of statistics and crop reporting services has also been highlighted in this narration. This review is focused on the task and responsibilities of the Pakistan Bureau of Statistics, which has assumed a pivotal role in data collection and coordination of statistical activities in Pakistan since its inception in 2011. The Bureau is obliged to undertake various censuses and major surveys in the country. PBS also takes care of National Accounts, Price Statistics, Trade Statistics, Social and Economic Statistics, Industrial and Business Statistics, Population and Manpower data, and miscellaneous statistics about other walks of life. Concepts of Poverty and Income Inequality are also part of this research. The Calorie-Based Approach and Basic Needs Approach of Poverty assessment have also been discussed in this study. Procedures of estimation of Income Inequality through Lorenz Curve and Gini Coefficient have also been presented in this investigation. This piece of work is a blend of both theory and practice. It is envisaged that the study would be of immense interest to academia, students, and researchers. It is beyond doubt that this pioneering work would not only inspire the young generation but also enlighten those who are interested in the promotion and development of this emerging branch of knowledge.

Keywords: *Official Statistics, National Statistical System (NSS), Major Players of NSS in Pakistan.*

26:
SPATIAL ANALYSIS OF SOCIO-ECONOMIC DETERMINANTS OF SCHOOL DROPOUTS IN PAKISTAN

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ABSTRACT

School dropouts in Pakistan are influenced by a range of socio-economic and contextual factors that vary across regions. Understanding the spatial patterns and determinants of dropout rates is essential for designing effective and evidence-based educational policies. Therefore, this study aimed to explore and analyze these factors through spatial analysis to predict school dropouts among individuals aged 5–24 years. Data were obtained from the Pakistan Demographic and Health Survey (PDHS) 2017–18, which provides comprehensive household-level information

across all provinces. Spatial analysis was conducted using ArcGIS, SaTScan, and GWR4 software to identify geographical variations, spatial clusters, and the intensity of influencing factors. The spatial distribution of school dropouts exhibited significant clustering across Pakistan, with a higher prevalence observed in Punjab and Khyber Pakhtunkhwa (KPK). Major hotspot regions included Lahore, Faisalabad, Multan, Peshawar, and Swat. Key predictors of school dropouts included poorer and middle wealth indices, households headed by individuals aged 40 years and above, lack of agricultural land ownership, and the presence of migrated household members. The geographically weighted regression (GWR) analysis further revealed that these factors exerted varying spatial impacts across hotspot areas, suggesting that economic hardship and household instability are critical determinants of educational discontinuation. The findings highlight the importance of adopting data-driven, region-specific, and inclusive interventions to address educational inequalities. Policymakers and planners can use these spatial insights to allocate resources effectively, target vulnerable communities, and promote equitable access to education for sustainable national development.
Keywords: *School Dropouts, Spatial Analysis, Socio-Economic Factors, ArcGIS, Pakistan.*

27:
SPATIO-TEMPORAL ANALYSIS OF VEGETATION DYNAMICS IN PUNJAB: EXPLORING THE ROLE OF RAINFALL

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ABSTRACT

Punjab's diverse landscapes from the fertile croplands of central districts to the semi-arid regions of southern Punjab are undergoing clear shifts in vegetation patterns driven by changing rainfall dynamics. Understanding how rainfall shapes vegetation in this agriculturally critical province is essential for ensuring sustainable crop production, ecological stability, and climate-resilient planning.This study investigates the spatio-temporal dynamics of vegetation in Punjab with a specific focus on the influence of rainfall. Vegetation and rainfall data will be collected using Google Earth Engine (GEE), which provides high-resolution satellite imagery and long-term climate datasets suitable for analyzing environmental patterns. Statistical techniques and GIS-based methods will be applied to explore spatial variation, seasonal changes, and long-term trends, while several analytical models will be compared to determine which best captures the rainfallvegetation relationship across Punjab's districts. Expected outcomes include identifying districts highly sensitive to rainfall fluctuations, mapping greening and degradation hotspots, and uncovering long-term vegetation trajectories shaped by precipitation trends. This study aims to build a data-driven understanding of Punjab's environmental future and support efforts toward climate-resilient agriculture and sustainable vegetation management. This research forms the initial phase of a broader thesis examining climate vegetation linkages in Punjab.
Keywords: *Spatio-Temporal Analysis, Vegetation Dynamics, Punjab, Rainfall, Google Earth Engine (GEE).*

28:
EARLY CHILDHOOD ANEMIA IN GHANA: PREVALENCE AND PREDICTORS USING MACHINE LEARNING TECHNIQUES

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ABSTRACT

Early childhood anemia is a severe public health concern and the most common blood disorder worldwide, especially in emerging countries. This study examines the sources of childhood anemia in Ghana through various societal, parental, and child characteristics. This research used data from the 2022 Ghana Demographic and Health Survey (GDHS-2022), which comprised 9353 children. Using STATA 13 and R 4.4.2 software, we analyzed maternal, social, and child factors using a model-building procedure, logistic regression analysis, and machine learning (ML) algorithms. The analyses comprised machine learning methods including decision trees, K-nearest neighbor (KNN), logistic regression, and random forest (RF). We used discrimination and calibration parameters to evaluate the performance of each machine learning algorithm. Key predictors of childhood anemia are the father's education, socioeconomic status, iron intake during pregnancy, the mother's education, and the baby's postnatal checkup within two months. With accuracy (94.74%), sensitivity (82.5%), specificity (50.78%), and AUC (86.62%), the random forest model was proven to be the most effective machine learning predictive model. The logistic regression model appeared second with accuracy (67.35%), sensitivity (76.16%), specificity (56.05%), and AUC (72.47%). Machine learning can accurately predict childhood anemia based on child and paternal characteristics. Focused interventions to enhance maternal health, parental education, and family economic status could reduce the prevalence of early childhood anemia and improve long-term pediatric health in Ghana. Early intervention and identifying high-risk youngsters may be made easier with the application of machine learning techniques, which will eventually lead to a healthier generation in the future.

Keywords: *Anemia, Children, Machine Learning.*

29:
HEALTHY HOUSING IN SOUTH ASIA: CHARACTERIZATION AND DETERMINANTS BASED ON MULTINOMIAL LOGISTIC REGRESSION ANALYSIS

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ABSTRACT

Substandard housing quality in South Asia poses major environmental and public health challenges. This study assesses housing conditions across six South Asian countries Pakistan, India, Nepal, Bangladesh, Sri Lanka, and Afghanistan using national Demographic and Health Survey (DHS) datasets. The main objective is to identify trends and determinants of housing quality through a composite Healthy Housing Index (HHI). A population-based design and stepwise analytical framework were employed. The HHI was constructed using factor analysis, ensuring reliability and validity, while multinomial logistic regression identified socio-demographic and environmental predictors of housing quality. Results reveal that a large proportion of South Asian households live in poor-quality housing and environments. Urban residence consistently

predicted healthier housing compared to rural areas. Pet ownership was negatively associated with healthy housing in Bangladesh, India, and Nepal, but not in Pakistan or the Maldives. Shared toilet facilities reduced the likelihood of higher HHI scores, significantly so in Pakistan, whereas private toilets correlated positively with healthier housing. Access to cooling systems, electricity, and separate kitchens were strong positive determinants of improved housing quality, particularly in Pakistan, Bangladesh, and Nepal. Overall, poor housing quality remains widespread across South Asia, reflecting low residential infrastructure standards. Enhancing household quality requires improved access to sanitation, electricity, kitchen spaces, and cooling systems, alongside addressing design and structural deficiencies. The study highlights how inadequate amenities and low socioeconomic status especially in rural areas contribute to unsafe and unhealthy living conditions. Coordinated regional policies and investments are essential to mitigate the economic, environmental, and public health impacts of substandard housing in South Asia.

Keywords: *Housing Healthy, AsianCcountries, Factor Analysis, Relative Risk Ratios, Determinants, DHS.*

30:
DOUBLE BURDEN OF MALNUTRITION PUZZLE: DECODED BY CLASSICAL LOGISTIC FRAMEWORK

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ABSTRACT

The double burden of malnutrition (DBM) poses a critical public health concern, particularly in low- and middle-income countries where under-nutrition and over-nutrition coexist within the same populations. This study investigated the double burden of malnutrition among children of and under five years of age in Lesotho using data from the Lesotho Demographic and Health Survey (LDHS 2023–2024). To capture the multidimensional nature of child malnutrition, the analysis integrates the Composite Index of Anthropometric Failure (CIAF), which measures stunting, wasting, and underweight, with the Body Mass Index (BMI), which assesses underweight, overweight, and obesity. The integration of these two indicators provided a comprehensive framework for both forms of malnutrition simultaneously. Malnutrition arises from imbalances in energy and nutrient intake, contributing substantially to morbidity and mortality among children globally. The coexistence of under-nutrition and over-nutrition reflects the complex interplay of biological, social, and economic factors. This study employed classical logistic regression to examine the socio-demographic, maternal, and child-related determinants influencing the double burden of malnutrition in Lesotho. Model accuracy and reliability had been assessed using post-estimation diagnostic tests. The study identified four key factors significantly associated with the double burden of malnutrition among children of and under five in Lesotho. These include the intake of iron during pregnancy, initiation of breastfeeding, sex of the child, and size of the child at birth. Maternal iron supplementation and early initiation of breastfeeding were associated with a lower likelihood of malnutrition, emphasizing the importance of maternal health and infant feeding practices. Additionally, the child's sex and birth size emerged as important biological determinants, indicating that both maternal and child characteristics play a crucial role in influencing nutritional outcomes.

Keywords: *Lesotho Demographic and Health Survey, Double Burden Malnutrition, Children, Logistic Regression.*

31:
DETERMINANTS OF CHILDHOOD ANEMIA IN BURKINA FASO: A MULTIVARIATE DECOMPOSITION ANALYSIS

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ABSTRACT

Childhood anemia remains a major global health concern, particularly in Sub-Saharan Africa, where Burkina Faso reports the highest prevalence and the slowest reduction rate. In Burkina Faso, about 72% of children aged 6–59 months were anemic including 29% with mild, 40% with moderate, and 2% with severe anemia. Using BFDHS 2021 data on 12,343 children aged five years and below, this study examined the socio-demographic, parental, and child-related determinants of childhood anemia through univariate and binary logistic regression analyses and quantified their contributions to urban–rural disparities using multivariate decomposition analysis. Model accuracy and reliability had been assessed using post-estimation diagnostic tests. Findings revealed a significantly higher prevalence of anemia among rural children compared to urban counterparts in Burkina Faso. Endowment effects explained 35% of the urban–rural disparity, a statistically significant contribution. The Centre Est, Nord, Plateau Central, and Sahel regions widened the gap, as urban children had better resources, whereas rural children had limited access, leading to higher anemia prevalence. In contrast, the Sud-Ouest region narrowed the gap, as urban and rural children in this region had similar facilities, reducing anemia disparities. Access to improved drinking water narrowed the gap, as rural children's access to safe water contributed to a reduction in anemia disparities. Improved toilet facilities, mothers with at least primary education, maternal age between 25 and 39 years, and children born with at least an average size widened the urban–rural gap and increased childhood anemia. In contrast, maternal age between 40 and 44 years narrowed the gap. These findings emphasize the need for targeted policy interventions focusing on sanitation, maternal education, and regional equality to effectively reduce childhood anemia and narrow the urban–rural gap in Burkina Faso.

Keywords: *Burkina Faso Demographic and Health Survey, Logistic Regression Analyses, Multivariate Decomposition Analysis.*

32:
A PURE HYPOTHESIS TEST FOR INHOMOGENEOUS RANDOM GRAPH MODELS BASED ON A KERNELISED STEIN DISCREPANCY

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ABSTRACT

Complex data are often represented as a graph, which in turn can often be viewed as a realisation of a random graph, such as an inhomogeneous random graph model (IRG). For general fast goodness-of-fit tests in high dimensions, kernelised Stein discrepancy (KSD) tests are a powerful tool. Here, we develop a KSD-type test for IRG models that can be carried out with a single observation of the network. The test applies to a network of any size, but is particularly interesting for small networks for which asymptotic tests are not warranted. We also provide theoretical guarantees.

Keywords: *Inhomogeneous Random Graph Models, Kernelised Stein Discrepancy, Stein's Method, Pure Hypothesis Test.*

33:
A CASE STUDY BASED ON POST-COVID HEALTH COMPLICATIONS IN PATIENTS OF FATIMA MEMORIAL HOSPITAL LAHORE

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ABSTRACT

It is not an easy task to deal with pandemics or natural disasters without really understanding their nature. History shows us that dealing with natural pandemics without knowing enough usually makes things worse. Here is a perfect example, COVID-19, caused by the SARS-CoV-2 virus, widely known as Corona Virus. This study looks closely at patients from Fatima Memorial Hospital in Lahore who dealt with these long-lasting health problems after COVID-19. At Fatima Memorial Hospital, lots of patients said they still felt bad months later. Things like age, other health problems, or how sick they were with COVID-19 might make long COVID more likely.

This study focuses on 400 people dealing with post-COVID health issues and related factors. The group is almost evenly split between females (50.5%) and males (49.5%), showing no big gender gap. Only a small fraction, 6.5%, were hospitalized, meaning most (93.5%) managed their symptoms without a hospital stay. About 30% have hypertension, 20.3% have diabetes, and 14% have lung disease, so these conditions are present but not super common. Vaccination status shows a close split: 40.3% are unvaccinated, 39% are fully vaccinated, and 20.8% are partially vaccinated, indicating a mix of vaccine uptake. Symptoms are widespread, 71.3% reported fever, 76.5% felt fatigue, and a hefty 80.3% had lethargy, making these the most common complaints. Body aches (52.8%), loss of smell and taste (56.5%), and hair loss (72%) also hit a lot of people, while cough (47.5%), shortness of breath (36%), chest pain (27.5%), dizziness (20.5%), anxiety (34.3%), and depression (25%) were less frequent but still notable. For symptom duration, most people (31.5%) had symptoms for 2-4 weeks, followed by 26.8% for 1-2 weeks, only 24.5% of patients were observed with symptoms for over 4 weeks, and 17.3% for less than a week.

Keywords: *Long COVID; Post-COVID Complications; PASC (Post-Acute Sequelae of COVID-19); COVID-19 Sequelae; Post-COVID Syndrome.*

34:
STORYTELLING TECHNIQUE IN INFLUENCER MARKETING AND ITS EFFECT ON DIGITAL CONSUMER

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ABSTRACT

Stories are significant and often used in marketing. The current study is an effort to examine this Storytelling technique in digital influencers on the behaviour and decisionmaking of digital consumers. With the shift from traditional advertising to digital platforms such as Instagram, YouTube, and TikTok, influencers have become key figures in shaping consumer attitudes through engaging and emotionally driven narratives. Grounded in the Elaboration Likelihood Model, Narrative Transportation Theory, and Source Credibility Theory, the study examines how storytelling influences consumer trust, emotional connection, and purchase intention through both central and peripheral processing routes. A quantitative survey was conducted with 270 active social media users in Pakistan. The findings reveal that storytelling significantly increases purchase intention by enhancing perceived expertise and emotional engagement. While the central route

(deep message processing) showed a strong mediation effect through expertise, the peripheral route (surface-level cues) mediated by attractiveness was less significant. The research highlights storytelling as a powerful strategic tool in influencer marketing, offering valuable insights for brands and marketers seeking to foster stronger digital consumer relationships in a saturated online environment.

Keywords: *Influencer Marketing, Advertising , Story Telling , Purchase.*

35:
SIN-DUS CLASS OF DISTRIBUTIONS: THEORY AND APPLICATIONS FOR INFECTION TIMES OF CKD DIALYSIS PATIENTS

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ABSTRACT

This study introduces a novel transformation-based class of probability distributions through the Sin-DUS framework, which integrates the sin trigonometric function with the DUS transformation to construct flexible models. The proposed class is generated by applying the DUS transformation into the Sin-G family and developed a novel class of distributions named Sin-DUS class of distributions which is used to various baseline distributions, including the exponential, exponentiated exponential, Weibull, inverse Weibull and Burr-XII distributions, among others. Within this framework, we develop and investigate a range of distributional properties for the Sin-DUS family, with particular emphasis on the selected models (sub-models), which are explored in detail for their theoretical properties and applications. Several properties of the proposed sub-models are derived and illustrated with visualizations. The resulting models exhibit diverse distributional shapes, accommodating skewness, heavy tails, and varying hazard rate structures. Key theoretical results are established, including explicit forms for the probability density function, cumulative distribution function, quantile function, moments, reliability measures, inequality measures, and entropies of the sub-models. Parameter estimation is carried out using multiple estimation techniques, and a simulation study is conducted to assess and compare the performance of these estimators. Finally, real-life data applications are presented to demonstrate the practical utility and superior goodness-of-fit of the proposed models in comparison to existing distributions.

Keywords: *Sin-G family, DUS Transformation, Probability Distributions, Weibull, Exponential, Reliability, Maximum Likelihood, Estimation, CKD.*

36:
THE KUMARASWAMY EXPONENTIATED INVERSE WEIBULL DISTRIBUTION

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ABSTRACT

This paper introduces a novel and very elastic five-parameter continuous probability model, which is called Kumaraswamy Exponentiated Inverse Weibull (KEIW) distribution. The innovation of the proposed KEIW distribution is that it can capture a broad spectrum of data behaviors and shape of hazard rates such as upside-down bathtub, decreasing, and constant shape that are typical with medical and reliability data. The KEIW model is a generalization of a number of popular

distributions, including the Kumaraswamy Inverse Weibull, Exponentiated Inverse Weibull, and the classical Inverse Weibull distributions, which can be obtained as a special case of the suggested model. This unifying feature increases the flexibility of the model and gives it more flexibility to model the practical data. The KEIW distribution is mathematically studied in detail which includes the derivation of all the basic properties of the distribution which include the survival and hazard rate functions, quantile function, characteristic function, moments, moment generating function, mean deviation, and the Rényi entropy. Estimates of the model parameters are done using the maximum likelihood estimation (MLE) technique, which guarantees statistical efficiency and asymptotic consistency. A Monte Carlo simulation experiment is also carried out to test the performance and the stability of the estimators in different parameter settings and sample sizes. The actual power of the KEIW model is illustrated by the fact that it is applied to two real life data sets, which are survival and lifetime data sets which have complicated hazards rate behavior. According to the empirical findings, the suggested KEIW distribution fits much better than the current competing models, which makes it robust and flexible. This leads to the KEIW distribution as a strong and new statistical instrument to model medical survival data, biological processes and reliability systems in which the traditional models prove to be inadequate to model data complexity.
Keywords: *Kumaraswamy Exponentiated Inverse Weibull (KEIW) Distribution, Mixture Form, Maximum.*

37:
AN EFFICIENT PARTIAL AND OPTIONAL RANDOMIZED RESPONSE MODEL FOR ESTIMATING THE SENSITIVE ATTRIBUTE USING NEGATIVE BINOMIAL DISTRIBUTION

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ABSTRACT

In research, the problem where some people have a rare sensitive attribute is really small, and a large sample size is required to estimate this number. For example, the number of AIDS patients continues to increase their relationship with strangers; the number of people who witnessed the murder. Nowadays the communication system is increasing rapidly, so it is possible to conduct such large randomized response surveys on the Internet or by telephone. Some developments to estimate the mean of persons possessing a rare sensitive attribute using Poisson distribution were given by (Narjis and Shabbir, 2021) and some with negative binomial distribution which were (Narjis and Shabbir, 2021). It was also shown that theproposed model of Partial RRT and optional RRT was more efficient. We will propose a partial and optional randomized response (RRT) method to estimatesensitive attribute using Negative Binomial Distribution. The properties of the proposed partial RRT and optional RRT components would be proposed on the Negative Binomial distribution. The use of both models will also be consideredunder stratification. Efficiency comparison between proposed partial RRT models and optional RRT will be done theoretically and numerically under SRS and Stratified random sampling.
Keywords: *Sampling, RRT, Optional RRT, Partial RRT, Negative Binomial.*

38:
QUANTIFYING AND CORRECTING TRUST DEFICIENCIES AND MEASUREMENT ERRORS IN MIXTURE BINARY RRT MODELS

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ABSTRACT

This study examines the effect of measurement error on binary Randomized Response Technique models. We discuss a method for estimating and accounting for measurement error and untruthfulness in two basic models and one comprehensive model. Both theoretical and empirical results show that not accounting for measurement error leads to inaccurate estimates. We introduce estimators that account for the effect of measurement error. Furthermore, we introduce a new measure of model privacy using odds ratio statistic, which offers better interpretability than traditional methods.

Keywords: *Measurement Error, Untruthfulness, Privacy.*

39:
FAIR CURVE CONSTRUCTION USING RATIONAL CUBIC BÉZIER CURVES WITH MINIMUM STRAIN ENERGY

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ABSTRACT

This research presents an efficient and mathematically robust framework for the construction of fair curves using rational cubic Bézier curves with minimum strain energy. The concept of fairness in curve design refers to achieving smoothness and visual balance while maintaining the geometric accuracy of the modeled shape. In this study, geometric continuity constraints are imposed at the endpoints, while the remaining degrees of freedom are optimized through the minimization of the strain energy functional. This approach ensures that the resulting curve exhibits minimal bending energy, producing aesthetically pleasing and computationally stable shapes. The proposed method offers a simple yet powerful tool for computer-aided geometric design (CAGD), data interpolation, and surface modeling. By integrating principles of energy minimization with rational Bézier formulation, the developed framework provides enhanced control over curve shape and smoothness without increasing computational complexity. Comparative examples demonstrate that the energy-minimized rational cubic Bézier curves outperform conventional polynomial curves in achieving smooth transitions, reducing oscillations, and preserving geometric integrity. The results highlight the potential of this approach in various applications such as CAD/CAM design, computer graphics, and scientific visualization. This study contributes to the advancement of computational geometric design by providing a mathematically grounded and practically efficient technique for fair curve construction.

Keywords: *Fair Curve Design, Rational Cubic Bézier Curves, Strain Energy Minimization, Geometric Continuity, Computational Geometry, CAD/CA.*

40:
IMPACT OF PLASMA ON THE SHADOW OF A CHARGED SPHERICALLY SYMMETRIC BLACK HOLE

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ABSTRACT

The purpose of this paper is to study the effect of plasma on the shadow of a charged, static, and spherically symmetric black hole in f(R) gravity. In this modified theory of gravity, curvature corrections influence the spacetime geometry, which in turn affects photon motion around the black hole. When plasma surrounds the black hole, its refractive index alters light propagation, leading to observable changes in the shadow's size and structure. We derive analytical expressions for the photon sphere radius, angular radius of the shadow, and shadow radius in the presence of a low-density, non-magnetized plasma. Our results show that plasma causes a reduction in the shadow radius compared to the vacuum case, and this effect becomes more pronounced with increasing plasma density. The alteration in shadow characteristics depends not only on plasma parameters but also on the charge of the black hole. Furthermore, we investigate the rate of energy emission in the presence of plasma and find that plasma decreases the overall emission rate while shifting the peak of the emission spectrum from higher to lower frequencies. This shift reflects the dispersive interaction between photons and plasma, influencing the radiative behaviour near the horizon. The angular radius of the shadow for a distant observer also exhibits a decreasing trend with increasing plasma concentration. These findings highlight the significant impact of plasma on both the geometrical and observational properties of black hole shadows in f(R) gravity.

Keywords: *Black Hole, Shadows, Accretion.*

41:
PREDICTING UNDER-FIVE MORTALITY IN PAKISTAN USING SUPERVISED MACHINE LEARNING MODELS: EVIDENCE FROM PAKISTAN DEMOGRAPHIC AND HEALTH SURVEY 2017-18

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ABSTRACT

Under-five mortality (U5M) serves as a vital indicator of a nation's socioeconomic development and health status. In Pakistan, the Pakistan Demographic and Health Survey (PDHS) 2017–18 reported 69 deaths per 1,000 live births, highlighting the country's ongoing struggle to meet child survival goals after missing the Millennium Development Goals (MDGs) target. This study aims to identify major risk factors influencing U5M and to determine the most effective predictive model for estimating child mortality in Pakistan. Using PDHS 2017–18 data, the survival status of children (alive or dead) was taken as the dependent variable. Potential predictors were identified through literature review, and univariate logistic regression was performed to select statistically significant variables. After removing missing values, the Synthetic Minority Oversampling Technique (SMOTE) was applied to balance the dataset at a 60:40 ratio. The data were split into 80% training and 20% testing sets. Four supervised machine learning algorithms—Random Forest (RF), Support Vector Machine (SVM) with linear and radial basis function (RBF) kernels, Artificial Neural Network (ANN), and AdaBoost—were used, with hyperparameter tuning

conducted via 3-, 5-, and 10-fold cross-validation. Significant predictors included residence, region, education, occupation, wealth index, birth characteristics, breastfeeding status, mother's age, family size, antenatal care, iron use during pregnancy, and birth intervals. Among all models, SVM with the RBF kernel demonstrated the highest accuracy, making it the most reliable model for predicting child survival outcomes. These findings offer valuable insights for data-driven health policies aimed at reducing under-five mortality in Pakistan.
Keywords: *Under-five Mortality, PDHS, Machine Learning, SMOTE, Support Vector Machine, Random Forest, Artificial Neural Network, Adaptive Boosting.*

42:
IMPACT OF RAPID URBANIZATION ON AGRICULTURAL FARMLAND IN MAJOR CITIES OF PAKISTAN: A COMPARATIVE GIS-BASED ANALYSIS

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ABSTRACT

Rapid urbanization has significantly transformed the spatial and agricultural landscape of Pakistan during the past two decades. This study investigates the impact of urban expansion on cultivated farmland across 19 major districts between 1998 and 2023 using data from the Pakistan Bureau of Statistics, FAO, and satellite sources such as Landsat and Sentinel. Employing GIS-based spatial analysis and Power BI dashboards, the study quantifies changes in urban and cultivated areas and visualizes patterns of land-use transformation. Results reveal a substantial increase in urban areas, most notably in Lahore (247 to 959 km^2), Karachi (1,147 to 3,109 km^2), and Faisalabad (165 to 639 km^2), corresponding with a consistent decline in cultivated land. The findings highlight regional disparities, where Punjab and Sindh have experienced the sharpest farmland conversion, while certain districts in southern and northern regions exhibit agricultural stability. The study underscores the urgent need for integrated land-use policies, better enforcement of zoning regulations, and the adoption of sustainable urban planning practices to mitigate the negative consequences of rapid urban expansion on Pakistan's agricultural productivity and food security.
Keywords: *Rapid Urbanization, Agricultural Land Conversion, GIS Spatial Analysis, Power BI Visualization, Sustainable Urban Planning.*

43:
PREDICTING THE HEALTH BURDEN DUE TO AIR POLLUTION IN SOUTH ASIAN COUNTRIES

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ABSTRACT

Air pollution in South Asian regions acts as a major public health risk by elevating death rates while damaging life expectancy through DALYs. Classical time-series models, machine learning algorithms, and deep learning methods are utilized to predict death rates and DALYs due to APM and HAP. Utilizing data from the GBD database (1990–2019), ARIMA, ETS, ANN, DT, GAM, SVR, GBR, GRU, and LSTM networks were employed to develop predictive models. Comparative model evaluation, based on MAE, RMSE, and MAPE, reveals that deep learning models, LSTM and GRU, consistently outperform traditional statistical models, with LSTM achieving the highest

and GRU, consistently outperform traditional statistical models, with LSTM achieving the highest predictive accuracy. The research demonstrates a critical need for pollution-intervention-powered policy changes that must be developed based on data to reduce South Asia's growing health problems from air pollution.

Keywords: *South Asia, Deaths, DALYs, HAP, APM, Time Series, Machine Learning.*

44:
INDUSTRIAL PROCESS MONITORING USING ADAPTIVE VARIABLE SAMPLE SIZE EWMA CONTROL CHARTS WITH SIGMOID FUNCTIONS

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ABSTRACT

Control charts have been used to monitor industrial processes for many years. This study provided the EWMA control chart with a variable sample size, also known as the SEWMA control chart. In the proposed control chart, the EWMA statistic in the sigmoid function is employed to adopt the sample size value. To compare the performance of the proposed technique, a Monte Carlo simulation technique is applied for generating numerical results for average run length, median run length, and standard deviation of run length. The recommended technique is compared to an existing EWMA chart created with an integer linear function known as an adaptive VEWMA control chart. The results revealed that the suggested strategy outperforms existing methods to identify changes in processes. Real-life data from the automobile sector is utilized to demonstrate how the proposed strategy can be applied. These findings demonstrated that, when statistically analyzed, the SEWMA control chart is certainly useful in monitoring processes.

Keywords: *Average Run Length, Control Chart, Statistical Process Control.*

45:
ARTIFICIAL NEURAL NETWORK-BASED ADAPTIVE CUMULATIVE SUM CONTROL CHARTS FOR ENHANCED PROCESS MONITORING

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ABSTRACT

The ability to quickly and precisely identify changes, specifically those occurring as outliers, is a primary imperative in the field of industrial process monitoring, where maintaining high-quality levels and operational effectiveness is of the utmost importance. Control Charts provide a methodical and statistically sound basis for detecting and controlling such deviations, which are generally caused by assignable causes, specific, recognizable sources of variation, and not by inherent process randomness. Here, the current research proposes an innovative adaptive Cumulative Sum (CUSUM) chart enriched with Artificial Neural Network (ANN) methodology, specifically designed to enhance sensitivity for monitoring small and medium-scale process behavior shifts. Leveraging the ability to recognize patterns and adapt through learning, this scheme dynamically adjusts the reference parameter of the traditional CUSUM chart based on real-time data features. This adaptive process enables more responsive and accurate monitoring, which is vital when process dynamics undergo gradual or unexpected changes. To demonstrate the real-world applicability, the proposed adaptive CUSUM chart is applied to a real engineering data set involving measurements of piston diameters, where even small discrepancies in dimensional

set involving measurements of piston diameters, where even small discrepancies in dimensional accuracy can significantly impair engine performance. Monte Carlo simulations confirm the superior ability of this control chart to detect anomalies early, offering a robust and intelligent method for modern quality control in production systems.

Keywords: *Adaptive Cumulative Sum, Artificial Neural Network, Machine Learning, Monte Carlo Simulation.*

46:
A COMPARATIVE APPROACH TO MODELING STOMACH CANCER BURDEN ACROSS SAARC NATIONS

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ABSTRACT

Stomach cancer stands among the principal reasons for cancer deaths throughout SAARC nations because patients receive delayed diagnoses as well as inadequate medical infrastructure, which directly leads to elevated mortality rates. This research employs the GBD database to anticipate stomach cancer mortality statistics and DALYs using both time series analysis and machine learning and deep learning models. This research implements Auto-ARIMA together with ETS and SVR algorithms in addition to LSTM and GBR and GAM and GRU, Decision Trees, Random Forest, TCN, and Cat Boost. Finally, all the models were evaluated through MAE, RMSE, and MAPE. Deep learning versions of LSTM and GRU surpass regular time series models and machine learning approaches in terms of modeling stomach cancer, while LSTM yields 2.72% MAPE as the best performance across SAARC nations. The performance of GBR and CatBoost machine learning models matches well with other approaches yet shows minor cases of model overfitting at times. The study demonstrates AI predictive analysis capabilities for improving cancer burden forecasting, which supports policymakers in developing strategic early intervention programs and healthcare resource distribution initiatives. The further development of epidemiological studies requires combined AI modeling techniques alongside real-time data improvement and AI systems that offer explainable decision-making processes to boost accuracy and field implementation.

Keywords: *Stomach Cancer, DALYs, Time Series Analysis, Machine Learning, Deep Learning, SAARC, Forecasting.*

47:
FACTORS AFFECTING WOMEN ENTREPRENEURSHIP IN PUNJAB USING WOMEN'S ECONOMIC AND SOCIAL WELL BEING SURVEY, PUNJAB (2017-18)

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ABSTRACT

Entrepreneurship plays a vital role in eliminating unemployment, destitution, and weak economy. Successful entrepreneurship enhances the women's financial autonomy in the society. In Pakistan, participation of women in labor force is very limited and women particularly face numerous challenges in setting up their businesses. Women comprise 52% of population of Pakistan, therefore it is necessary to engage them in economic development of the country and explore

factors that determine their success in business and industry. In this study, it was aimed to identify factors affecting women entrepreneurship in Punjab using binary logistic regression and also predict women's entrepreneurial success using machine learning algorithms. The data was taken from Women's Economic and Social Well Being (WESWB) Survey, Punjab (2017-18). The success in business was used as the outcome variable. SPSS version 27 and Python 3.13 were the softwares used in this study. Major cities residence, excellent self-reported health, and personal savings were found as the key determinants of women's business success in Punjab. Among the different machine learning algorithms, Extra Tree Classifier was the best predictive model, with accuracy (0.87), precision (0.91), recall (0.83), F1 score (0.87), and AUC (0.93). The feature importance analysis revealed that personal savings, women's health, wealth index, and personal bank account were found as the top predictors of women's entrepreneurial success, aligning with the SPSS findings. The findings of this study have clear implications for policy makers to facilitate business women with financial support on easy terms and conditions for their startups and also to provide business women with health care insurance.
Keywords: *Entrepreneurship, Women's Entrepreneurial Success, WESWB, Binary Logistic Regression, Machine Learning.*

48:
ADVANCING SUSTAINABLE EDUCATION OF STATISTICS IN PAKISTAN: INNOVATIONS, CHALLENGES, AND OPPORTUNITIES

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ABSTRACT

Statistics education is essential for developing countries like Pakistan to achieve sustainable development through data-driven policies. To create such policies, Pakistan requires professionals with strong statistical knowledge and skills. It requires advancement in sustainable statistics education in the country. There are various challenges associated with it. Currently, in Pakistan, a declining trend is observed in the student's enrolment in statistics degree programs due to the growing hype for data science, computer sciences, robotics, etc. There is a need to transform the existing system of teaching statistics in the country to attract good students to the various degree programs of statistics. As a step toward producing future generations of skilled statisticians who can play their role in effective policy formulation, we conducted an investigation into the perceptions of three key stakeholders. We surveyed students of statistics, faculty members, and statistical officers from the National Office of Statistics in Pakistan regarding innovations and challenges for sustainable statistics education in Pakistan. Additionally, it sought to gather opinions on potential strategies to address these challenges and foster sustainable statistics education by implementing locally effective possible strategies. Key challenges identified in advancing sustainable education of statistics in Pakistan were rote memorization of formulae, lack of problem-solving skills, curriculum not aligned with needs of today's fast-growing complexities of the world, inadequate teachers training to impart complex topics of statistics and less career prospects due to emergence of data science. Major opportunities identified were access to online resources helpful in the learning of complex topics of statistics, different degree tracks for statistics graduates for higher education, and new free-lancing market of data analysis. It was recommended

to work on training of teachers, use of online resources and curriculum reforms.

Keywords: *Sustainable Education, Statistics, Data Science, Stat Labs, LISA.*

49:
UNRAVELING THE IMPACT OF MARRIAGE AND CHILDREN ON WOMEN'S OCCUPATIONAL GROWTH USING MULTINOMIAL REGRESSION AND MACHINE LEARNING APPROACH: INSIGHTS FROM THE WOMEN'S ECONOMIC AND SOCIAL WELLBEING SURVEY, PUNJAB 2017-18

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ABSTRACT

Significant structural changes in developing countries have altered labor force dynamism and raised longstanding social problems of women's roles as caregivers and participants in the labor force. This study examines how marriage and children shape women's occupational growth in Punjab, Pakistan, using data from the Women's Economic and Social Wellbeing Survey (2017-18). The effect of marriage and children on occupational growth is observed as a nominal variable having a positive effect, a negative effect, and no effect on 15–64-year-old married females sampled from Punjab. The independent variables such as number of dependents, wealth index, number of children aged ≤ 3 years, number of children aged 5–16 years, husband's education, husband's age, female's age, female's education, district, and health status are considered. This study used a multinomial logistic regression model to discover the most important determinants for occupational growth. The independent variables number of children ≤ 3 years, number of children 5–16 years, district, wealth index, overall health, ever worked for cash or in-kind payment, and joining the workforce significantly affect occupational growth in females. Machine learning classification algorithms were applied to choose the best algorithm to predict the outcome based on accuracy, precision, recall, and F1 score. The Random Forest model performed well, producing an accuracy of 0.68, a precision of 0.78, a recall of 0.83, and an F1 score of 0.79, so it can be the actionable model to predict occupational growth. A 'positive effect' has been the most accurately predicted category. Feature importance is calculated using the Random Forest algorithm. The results show that district, number of household members, number of children aged 5–16 years, husband's education, and female's education are the most influential features. These findings provide insights to inform policymakers in designing evidence-based policies to empower women and promote inclusive growth.

Keywords: *Women's Occupational Growth, Socioeconomic Factors, Work-life Balance, Labor Force Participation, Multinomial Logistic Regression, Machine Learning, Feature Importance.*

50:
ASSESSING THE IMPACT OF HOUSEHOLD FUEL CHOICES ON HOUSEHOLD ENERGY EXPENDITURES USING MACHINE LEARNING AND CLASSICAL APPROACH: EVIDENCE FROM HOUSEHOLD INTEGRATED ECONOMIC SURVEY (HIES) 2018-2019, PAKISTAN

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ABSTRACT

Controlling and sustaining energy expenditure is a major concern based on a consensus of common sense among all stakeholders in the sector, including households. This study assessed the determinants of household energy expenditures including electricity, and gas monthly usage based on fuel choices (electricity, natural gas, firewood, and solar energy) for heating/cooling, lighting, and cooking demands in Pakistan's diverse socio-economic and urban/rural areas. The study used a linear regression model and Machine Learning (ML) algorithms including Random Forest (RF), Decision Tree (DT), Linear Regression (LR), Gradient Boosting (GB), and Support Vector Machines (SVM) to analyze data from the Household Integrated Economic Survey (HIES) 2018-2019. Fuel choices for lighting, cooking, and heating/cooling have a considerable impact on energy expenditures in Pakistani cities, but not in rural areas. Household energy expenditures were strongly influenced by socioeconomic and demographic factors, including household head education, employment, and marital status, as well as household features, province, and region. The study compared the performance of ML algorithms using evaluation metrics like R Square (R^2), Mean Squared Error (MSE), Mean Absolute Error (MAE), and Root Mean Squared Error (RMSEA). Random forest and gradient boosting are the best ML algorithms identified, whereas linear regression is consistent but somewhat more effective, and decision tree performs better in rural than urban areas. Furthermore, the study's findings give important information to policymakers and have implications for reducing the risks connected with energy imports and expenditures.

Keywords: *Household Energy Expenditure, Socio-economic Factors, Energy, Household Characteristics, Machine Learning, Regression Analysis.*

51:
HYBRID DEEP LEARNING AND SIGNAL DECOMPOSITION MODELS FOR PREDICTIVE ANALYTICS IN RENEWABLE ENERGY AND FINANCIAL MARKETS OF PAKISTAN

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ABSTRACT

The current research is a thorough analysis of predictive programming of wind speed and stock market in Pakistan involving two separate fields' renewable energy and financial markets. The data on the wind speed were taken in four locations within Punjab and the stock market data was taken in Karachi Stock Index (KSI). The study's primary objective is to evaluate how well more complex machine learning models and decomposition algorithms perform in terms of identifying underlying patterns, temporal relationships, and nonlinear dynamics in these data sets. Three deep learning models Recurrent Neural Network (RNN), Long Short-Term Memory (LSTM), and Gated Recurrent Unit (GRU) were used separately as well as with two modes of decomposition

Variational Mode Decomposition (VMD) and Empirical Mode Decomposition (EMD). When the two data domains are compared, the results of the integration of decomposition techniques indicate that there is a huge difference in the performance of models used to forecast the outcome of the data. To predict wind speed, VMD-based hybrid models (RNN+VMD, LSTM+VMD, GRU+VMD) are more successful in reflecting variations of the multi-scale changes and non-linear patterns in the forecasting in this case, which proves to be highly effective in renewable energy forecasts. On the other hand, in the context of stock market prediction, decomposition-based model, EMD and VMD, showed a comparatively low level of improvement with traditional deep learning models like RNN and LSTM showing competitive predictability even without decomposition. The studies made a significant contribution to the understanding of the effect of decomposition-based deep learning models on predictive analytics. The results indicate the value of domain-specific modeling approaches, as it is shown that machine learning and signal decomposition integration is capable of greatly increasing the accuracy of forecasting in renewable energy systems and the moderate contribution to financial market prediction.
Keywords: *Predictive Modeling, Deep Learning, EMD-VMD Decomposition, Wind Speed and Stock Market Forecasting, Diverse Datasets.*

52:
STRUCTURAL EQUATION MODELS FOR THE ESTIMATION OF PSYCHOLOGICAL WELL-BEING OF COVID-19 CAREGIVERS IN PAKISTAN

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ABSTRACT

The responsibilities of caregiving can have a serious negative influence on the well-being of caregivers, who play a crucial role in giving support and care to COVID-19 patients. It's necessary to know the psychological impact of caregiving so that can support and assist them in the best possible ways. The goal of this study was to comprehend the mental burden that COVID-19 patients' caregivers in Lahore, Pakistan, bear as well as the factors that contribute to their emotional instability. In order to acquire data for this study, questioned those who were caring for COVID-19 patients. Caregivers from various socioeconomic backgrounds were evaluated by the researchers. This indicates that they gave consideration to caregivers of all ages, genders, monthly income, locations, marital status, occupations, and educational backgrounds. Caregiver participants were selected for this research project in a systematic approach that reflected their qualities. A wide range of places in Punjab-Lahore Pakistan, including markets, hospitals, and educational institutions, were used to select caregivers. A questionnaire with 40 questions was subjected to factor analysis using principal component analysis. The reliability of the questionnaire is evident from the Cronbach's alpha values of 0.828, which indicate a good level of internal consistency throughout the items. The elements discovered by factor analysis include emotional impact, resentment and emotional load, empathy in caregiving, insecurity, and obsession. The study finds that emotional impact is the most reliable component and that perceptions and knowledge may be changed by emphasizing it. After components were identified, the study used structural equation modeling (SEM) of look at the COVID-19 factor. By evaluating numerous relationships, such as those between genders (male or female) or employment status (employed or

unemployed), it better to understand the component associated with COVID-19.

Keywords: *Structural Equation Modeling, COVID-19, Factor Analysis, Principal Component Analysis, Emotional Instability.*

53:
DATA MINING OF NON-COMMUNICABLE DISEASES INDICATORS OF PAKISTAN AND ASSOCIATED COUNTRIES

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ABSTRACT

Non-communicable diseases (NCDs) have arisen as a global health challenge, representing the leading cause of death worldwide. However, their associated risk factors are not uniformly distributed across genders. This study focuses to analyze gender-based differences for major NCD indicators across nine countries, namely Pakistan, India, Sri Lanka, Bangladesh, Nepal, Afghanistan, Indonesia, Kenya, and Nigeria, using panel data from WHO NCD database. The main indicators are blood pressure, diabetes, cholesterol, hypertension, and body mass index (BMI). A comparative and quantitative approach was employed, using descriptive statistics such as mean, standard deviation, minimum and maximum for males and females in each country. Independent samples t-tests were conducted to assess whether gender-based differences in NCD indicators were significant. Additionally, t-tests were utilized to compare Pakistan's averages with the combined averages of the other eight countries. Trend analysis using line graphs was performed to visualize temporal changes across genders and countries. Furthermore, a data mining approach was applied using machine learning techniques, through a decision tree classification model with gender as the target variable. This technique provides the identification of key patterns among NCD indicators and provides interpretable insights into gender-specific health disparities. The findings revealed substantial gender-based variations. Blood pressure was higher among males in Pakistan and Kenya, while a sharp increase in diabetes prevalence was observed in Pakistan. Hypertension was more common among males in Pakistan and Nepal, and among females in Afghanistan and Pakistan. Cholesterol levels increased in Indonesia but declined in India and Afghanistan. The BMI trend indicated a decrease in underweight prevalence in Bangladesh and India and a rise in obesity in Afghanistan and Pakistan. These results highlight the importance of implementing targeted and gender-sensitive health interventions.

Keywords: *Health Statistics, Non-communicable diseases, Data mining, Gender disparities, Comparative analysis.*

54:
A STATISTICAL STUDY ON BRANDED SHOES AND CUSTOMER SATISFACTION

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ABSTRACT

This study explores customer satisfaction with branded footwear by evaluating the interrelatedness among key determinants: brand image, product quality, pricing, and accessibility. The elementary

objective is to assess how these factors collectively shape consumer experiences and behaviour toward branded shoes. Data was obtained from 400 defendants through a structured, self-administered questionnaire based on convenience sampling, which allowed competent access to a large and separate group of participants. The instrument involved 32 items divided into two sections: demographic information (10 items) and construct-specific measures (22 items). Data analysis was performed using the Statistical Package for the Social Sciences (SPSS). Given the ordinal nature and non-normal distribution of the responses, non-parametric techniques namely the Mann-Whitney U Test and the Kruskal-Wallis H Test were applied to explore significant differences throughout demographic categories. These methods ensured robust and reliable inference under relaxed normality assumptions. Findings show that consumers generally recognize their preferred footwear brands as high in quality, associating brand loyalty with promising product performance and durability. Loyal customers also exhibited lower price sensitivity, demonstrating a commitment to pay quality prices and promote their preferred brands within social circles. Accessibility emerged as another positive factor, with respondents noting convenient retail locations and association between online and physical store offerings. Furthermore, brand image was identified as a multidimensional construct incorporating reliability, credibility, and aesthetic demand. Overall, the study concludes that brands maintaining strong images, superior quality, fair pricing, and accessible distribution channels achieve higher customer satisfaction and loyalty. Future research should employ probabilistic sampling and longitudinal approaches to acquire evolving consumer preferences more comprehensively.
Keywords: *Brand Image, Product Quality, Pricing, Accessibility, Customer Satisfaction, Brand Loyalty, Consumer Behaviour, Branded Footwear, Non-parametric Analysis, SPSS.*

55:
QUANTUM COMPUTING IN HEALTHCARE: CURRENT STATUS AND FUTURE PROSPECTS – A COMPREHENSIVE REVIEW

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ABSTRACT

The area of quantum computing has made immense progress, and its computational expertise has enabled it to achieve levels of performance that were previously unimaginable. The scope and impact of quantum computing in healthcare are not explored greatly. This study examines the state-of-the-art of quantum computing and its future role in medicine, focusing on its potential to revolutionize tasks like precision medicine, radiotherapy, medical imaging, genomics, drug discovery, and effective treatments for contagious diseases. It provides not only a systematic review of the literature but a plethora of benefits associated with quantum computing in healthcare and highlights potential benefits and challenges in the industry. This study concludes that although quantum computing is in its early stages, its potential to bring a significant revolution is promising, provides quick and precise solutions to complex problems for various medical sectors including hospital, medicine, organizations of health insurance where extensive speed and accuracy is required. However, further research is needed to comprehend its implications in healthcare.
Keywords: *Healthcare, Medical Imaging, Qubits, Quantum Algorithms Quantum Computing, Quantum Machine Learning.*

56:
MODELING LONGITUDINAL TRAJECTORIES OF CLINICAL MARKERS TO ESTIMATE THE RISK OF STAGE SHIFT AMONG CKD PATIENTS

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ABSTRACT

Chronic Kidney Disease (CKD) is a progressive condition of the gradual reduction of kidney function and causes serious systemic complications. The gradual loss of renal excretory function leads to the disturbance of the homeostasis of the body and is well correlated with cardiovascular diseases, acute infections and increased mortality. CKD is often affected by comorbid conditions: anemia, diabetes mellitus, chronic heart disease, hypertension, and hepatitis. CKD is a significant global burden of disease in terms of morbidity and mortality. In Pakistan, it has been previously studied both in terms of its prevalence among the community and its outcome in the advanced stages. For example, Elahi et al. (2025) determined some of the most important predictors of survival in hemodialysis patients and highlighted the effect of uncontrolled comorbidity. Building on this evidence, the current study examines the effects of biomarkers that have specially uncontrolled BP, diabetes and heart failure on the progression of CKD stages. The purpose of this study is to look at the stage progression of CKD, to determine if it is affected by certain clinical biomarkers, including uncontrolled blood pressure, the presence of diabetes mellitus, and a previous diagnosis of heart failure. Specifically, this research is focused on the evaluation of the impact of elevated or poorly controlled BP on the rate of CKD stage progression and the role of diabetes in accelerated renal function decline.

Keywords: *CKD, Progression, Biomarkers, Stage Shift, Renal Function.*

57:
CONNECTED BUT STRAINED: DATA-DRIVEN PERSPECTIVES ON TECHNOLOGY, LIFESTYLE AND MENTAL HEALTH

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ABSTRACT

The widespread adoption of digital technology has heightened concerns about its impact on psychological well-being, particularly in digitally active populations such as Pakistan's. This study explores the relationship between technology use, lifestyle behaviors and mental health, examining how variables like screen time, stress or physical activity influence psychological well-being. Using the Tech Use and Stress Wellness dataset from Kaggle (N = 5,000), eight key variables were analyzed, including age, gender, daily screen time, sleep duration, physical activity, stress level, wellness app usage, and overall mental health score. Analyses conducted in R included exploratory data analysis, regression modeling, and imputation testing. Descriptive results indicated that participants generally exceeded recommended screen time limits, with higher exposure linked to increased stress and poorer mental health. Correlational and regression analyses revealed that stress level was the strongest negative predictor of mental health ($p < 0.001$), while greater physical activity and adequate sleep were associated with improved well-being. Younger individuals reported higher stress and lower mental health scores, compared to older adults who demonstrated better coping patterns whereas gender differences were statistically insignificant when checking for stress in different age groups. The findings emphasize the need for balanced technology use and

stress management. At the personal level, reducing daily screen exposure and maintaining regular physical activity are recommended, while policymakers should consider promoting digital wellness programs in schools and workplaces. Future longitudinal studies and localized data collection are recommended to establish causality and evaluate intervention efficacy. This work contributes to understanding modifiable pathways linking digital behavior to mental health in contemporary contexts.
Keywords: *Screen Time, Mental Health, Stress, Digital Wellness, Sleep Duration.*

58:
DEEP LEARNING APPROACHES FOR CLIMATE DRIVEN CROP YIELD FORECASTING IN PAKISTAN

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ABSTRACT

Climate change has become a growing threat to the agriculture sector of Pakistan where variations in the temperature, precipitation and carbon emissions have a direct effect on crop productivity. This paper examines the dynamic nature of climatic variables and yields of the two most important Pakistani staple crops, which are wheat and rice based on the sophisticated deep learning methods. Several architectures such as Convolutional neural network (CNN), Recurrent neural network (RNN), Long short-term memory (LSTM), Bi-Directional Long short-term memory (BiLSTM), gated recurrent unit (GRU) and Vector autoregression (VAR) were used to learn linear and nonlinear time-dependent relationships in multivariate time-series data. Statistical performance measures like RMSE, MAE, MAPE, and R^2 were used to evaluate the models to ensure the holistic evaluation of the forecasting accuracy of the models and the error measures of the models. Results indicated that recurrent architectures, especially BiLSTM and LSTM, had better predictive accuracy and less error measures than the other deep learning and statistical architecture showing that they can capture nonlinear interactions between climate variables and crop yields. VAR also exhibited good performance and confirmed its further applicability in forecasting multivariate time series. These effectively modeled the complicated time-dependent relationships between climatic signs and crop harvest provided very precise predictions for the future decade. The results show that changes in temperature and carbon emissions have the most important impact on yield results whereas precipitation has a relatively minor effect. In general, this research highlights the possibilities of deep learning models as solid predictive models of climate agriculture interactions in Pakistan and in the context of contributing to adaptive policies that facilitate sustainable agricultural growth in the presence of climate uncertainty.
Keywords: *Deep Learning Model, Climate Dynamics, Forecasting, Crop Yields, Time Series.*

59:
THE IMPACT OF PERSONALITY ON SOCIAL ENGAGEMENT – A DATA DRIVEN APPROACH

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ABSTRACT

Personality can be classified into the extrovert and introvert categories, with their own specific patterns of behavior. This study aims to determine whether specific behaviors can predict

personality and how correlated these behaviors are to extrovert and introvert traits. A public dataset (N=2900) helped carry out a logistic regression and correlation analysis, with imputation used to analyze the predictors. Time alone strongly predicted introversion (β=0.121, $p<0.001$), while social engagement variables predicted extroversion, although their correlation was weaker compared to introverts. This provides an insight into personality and behavior, as extroverts are more flexible with social engagement. This study can provide a quantitative basis for the link between social behaviors and personality type and provide context for further research into the lack of consistency among extroverts.
Keywords: *Introversion, Extroversion, Social Engagement, Correlation, Logistic Regression.*

60:
DEVELOPMENT AND STATISTICAL ANALYSIS OF MODIFIED KIES PERKS DISTRIBUTION

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ABSTRACT

This paper introduces a novel development of the Perks Distribution called the Modified Kies Perks distribution (MKPD), a highly adaptable probabilistic model characterized by its versatile probability density function, distribution function (DF) and hazard rate function. The MKPD can take various shapes, such as a single peak (unimodal), leaning to the right (right-skewed), leaning to the left (left-skewed), a curve resembling a bathtub, and more, demonstrating its flexibility in statistical modelling and it is one of the most important and well-established ideas in reliability analysis. Several fundamental characteristics of the proposed model have been derived, including its PDF, CDF, quantile function, Hazard rate, survival function, cumulative hazard function, Odds Ratio and Average Failure Rate. Furthermore, a Monte Carlo simulation study is performed to assess the efficiency of different estimation methods across varying sample sizes confirming the MKPD's flexibility and strong fit for lifetime, epidemiological and actuarial data. To validate its practicality, the proposed distribution is applied to real datasets. The results demonstrate that the MKPD is a valuable contribution to both statistical theory and applied statistical work.
Keywords: *Perk Distribution, Modified Kies Distribution, Estimation, Reliability Measures, Simulation.*

61:
WHITE COAT PREFERENCES FOR PHYSICIANS' ATTIRE: FIXED EFFECT META-ANALYSIS

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ABSTRACT

The white coat is a symbol of the medical profession, representing cleanliness, professionalism, and trust. Its use has significant implications for patient perceptions and physician behavior, influencing clinical outcomes and the professional identity of healthcare providers. This meta-analysis aims to evaluate the preferences for white coats among physicians and their patients, assess the impact on patient trust and satisfaction and aim to enhance the patient-physician relationship, inform hospital policies, and improve overall healthcare experiences, ultimately contributing to better patient outcomes and a more patient-centered approach in medical practice. Search data

bases like Google Scholar, PubMed, Medline, ScienceDirect, SciHub are used for searching articles. The STATA (14.1 version) commands "metaprop" is used to find out the pooled estimates. The results obtained by Meta-Analysis shows the individual's study proportion of the outcome variable along with 95% Confidence Interval and the forest plot is the graphical representation of the Meta-Analysis for proportions. The meta-analysis revealed that 50% of patients prefer physicians who wear white coats, associating them with higher levels of professionalism, competence, and trustworthiness. Physicians reported increased confidence and a stronger sense of professional identity when wearing white coats. The analysis also highlighted concerns about hygiene and cultural sensitivity related to white coat use. In addition, an overall pooled estimate for the study variable is also presented, obtained by using fixed effect model because all the studies included in the analysis have the same effect size and there is no heterogeneity. One-size-fits-all clothing policy is unlikely to reflect the patient's wishes and expectations; a tailored approach should be adopted that attempts to adapt clothing to the clinical context. With patients' clear preference for white coats, its reintroduction should be given consideration and education regarding the cleanliness of scrubs may increase patient confidence. Further research and updated guidelines are necessary to optimize the use of white coats in clinical practice.

Keywords: *Meta-Analysis, PRISMA, White Coat, Patient Preference, Physicians' attire.*

62:

ANALYZING SPATIAL PATTERNS AND FACTORS INFLUENCING POOR TETANUS TOXOID IMMUNIZATION AMONG PREGNANT WOMEN IN PAKISTAN: A SPATIAL AND MULTILEVEL ANALYSIS

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ABSTRACT

Tetanus affects individuals of all ages, but newborns and pregnant women remain the most vulnerable. In many developing nations, maternal and neonatal tetanus (MNT) continues to be a significant cause of maternal and infant mortality. As of December 2024, Pakistan is among the ten countries yet to eliminate MNT. Vaccinating pregnant women with the tetanus toxoid (TT) vaccine is one of the most effective preventive measures. This study aimed to examine the geographical distribution and determinants of poor TT immunization among pregnant women in Pakistan. Data were obtained from the Pakistan Demographic and Health Survey (PDHS) 2017–18. A multilevel binary logistic regression model was applied using STATA version 15 to identify factors associated with poor immunization. Spatial distribution and hotspot analysis were conducted through ArcGIS 10.7.1, while Kulldorff's SaTScan software, employing the Bernoulli model, was used to identify significant spatial clusters. Furthermore, Geographically Weighted Regression (GWR) analysis using GWR4 software was employed to determine predictors of spatial variations in immunization coverage. The results showed that inadequate TT immunization was significantly associated with husband's education, wealth index, media exposure, wanted last-child status, place of delivery, antenatal care (ANC) visits, community-level media exposure, and region. Spatial analysis revealed a clustered pattern (Global Moran's $I = 0.389$, $p < 0.0000$), with hotspots primarily located in South-West KPK, Balochistan, Sindh, and FATA. The GWR results indicated that fewer than four ANC visits, lack of media exposure, low education, and higher birth order contributed to regional disparities. Strengthened policies and long-term health initiatives are essential to improve vaccination coverage, particularly in identified hotspot regions.

Keywords: *Tetanus Toxoid, Pregnancy, PDHS, Spatial Analysis, GWR.*

63:
DETERMINANTS OF HOUSEHOLD POVERTY IN PUNJAB: A LOGISTIC REGRESSION ANALYSIS USING MICS (2017-2018)

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ABSTRACT

Poverty continues to be a major socioeconomic challenge in Punjab, Pakistan especially among rural and low-income households. The aim of this study is to identify key determinants of household poverty in Punjab, Pakistan. Data has been taken from the Multiple Indicator Cluster Survey (MICS) 2017-2018 conducted in Punjab, Pakistan. Multinomial logistic regression model is used to analyze the impact of demographic, economic and geographical characteristics on household poverty using SPSS version 26.0. The results indicated that poverty is more common among households headed by young males, with larger family size, with lower education level and those living in rural areas. Households without access to agricultural land and those that own animals also showed higher poverty rates. On the other hand, households receiving remittances from abroad or with members working abroad had lower poverty rates while those relying on cash donations from within the country were more likely to be poor. All independent variables such as area of residence, sex, age and education level of household head, number of children under age 5, number of children age 5-17, household size, households that own agricultural land, households that own animals, any members working outside the country, households that receive remittances from outside the country, households that receive any cash donation from within the country and region are significantly associated with the dependent variable 'wealth index quintile'.

Keywords: *Determinants, Punjab, MICS, Poverty, Logistic Regression, Wealth Index.*

64:
ANALYZING THE RELATIONSHIP BETWEEN WORKFORCE DEMOGRAPHICS AND LABOR MARKET CHALLENGES IN PAKISTAN

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ABSTRACT

Pakistan's economic growth is closely intertwined with the structure, composition, and productivity of its workforce. This study examines the relationship between workforce demographics and the challenges faced by different labor segments in Pakistan, aiming to understand how these factors collectively influence national economic performance. Using data from the Pakistan Bureau of Statistics (PBS), Labor Force Surveys (LFS), and the World Bank's World Development Indicators (WDI), this research employs both descriptive and inferential statistical analyses. Regression and correlation techniques are applied to evaluate the relationship between demographic variables, such as age distribution, gender, education level, and employment status with labor productivity, and sectoral employment trends. The findings suggest that higher educational and experience level significantly enhance productivity and income while gender disparities and the prevalence of informal employment remain major impediments to inclusive growth. Moreover, regional disparities in employment opportunities indicate that urban centers capture most of the skilled labor benefits, deepening rural-urban inequality. The study further explores major challenges confronting Pakistan's workforce, including skill mismatches, informal employment, gender

disparities, and technological workforce, including skill mismatches, informal employment, gender disparities, and technological adaptation gaps. Findings reveal that average income of employees in many sectors is not according to the suggested pay scales by Government that highlights the importance of policy formulation for strict check on pay scales and problems faced by Pakistan's workforce. These structural constraints can empower the workforce to act as a sustainable driver of Pakistan's economic transformation.

Keywords: *Labor Force Surveys, Pakistan's Workforce, World Bank's World Development Indicators (WDI).*

65:
MODELING THE RELATIONSHIP BETWEEN ARABIAN SEA SURFACE TEMPERATURE AND PRECIPITATION IN PAKISTAN USING MULTIVARIATE TIME SERIES TECHNIQUES

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ABSTRACT

Multivariate time series models play a pivotal role in understanding the relationship among various interdependent time-dependent variables. These techniques consider not only the temporal dynamics within individual series but also the interactions and correlations between different variables over time. This study aimed at identifying the best multivariate time series model among ARIMAX (Autoregressive Integrated Moving Average with exogenous inputs), Gaussian process, Vector Auto-Regression (VAR), and multivariate exponential smoothing to model the relationship between SST of Arabian Sea with precipitation patterns in Punjab, Pakistan. The spatial Sea Surface Temperature (SST) data from 2000 to 2024, encompassing 99 locations in the Arabian Sea with a spatial resolution of 0.5° grid intervals, was sourced from the National Oceanic and Atmospheric Administration (NOAA) whereas the precipitation data for the period 2000 to 2022 was acquired from the Pakistan Meteorological Department (PMD). The regions within the Arabian Sea were further categorized into coastal and deep-sea zones. Areas near the shoreline were classified as coastal, while those farther from the shore were designated as deep-sea zones. Various multivariate techniques were employed, with precipitation serving as the dependent variable and the temperatures of the coastal and deep-sea zones in the Arabian Sea considered as exogenous predictors. The study revealed that the ARIMAX model appeared to be the best-fit model in terms of forecast accuracy with the highest value of adjusted R-Square and lowest residual standard error, BIC, and AIC values. The results will help policymakers to use the best model in identifying the rainfall patterns in Pakistan which will ultimately help in the formulation of effective strategies to deal with flooding in heavy rains.

Keywords: *Sea Surface Temperature, Multivariate Time Series Techniques, Precipitation, Coastal and deep-sea zones in the Arabian Sea.*

66:
CRITICAL REVIEW OF THE EVOLUTION OF ECONOMIC SURVEY OF PAKISTAN

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ABSTRACT

Almost everything that has capability to impact change, either on its own or by making other to cause it, evolves gradually. To gauge and realize its evolution, a step by step appraisal helps a lot. The Economic Survey of Pakistan, one of the most important source of Official Statistics in Pakistan, is being regularly published by Ministry of Finance, Government of Pakistan annually, a day before the annual budget is presented. Over the last seventy years it evolved to the most recent shape. The study is aimed at assessment of the evolution. The Economic Survey of Pakistan holds a remarkable value as it encompasses the facts and figures regarding all the economic, social and socio-economic indicators measured in the preceding twelve months. Although it started getting published right after Pakistan came into being, we chosed a period from 1971-72 to 2017-18 as 1971 signifies inception of a 'New Pakistan' after Dacca Fall. The study is manifold in the sense that it covers study of the contents, type of contents, inclusion and exclusion criteria, its relation to political and social stimuli, and chronological milestones. Being an innovative study, several new exploratory and graphical methods have to be developed to substantiate the rationale of growth and establishing the trends. Indices were developed to gauge various impacts. Hence it was the study of the progression of Economic Survey of Pakistan in a variety of ways that could be covered in the given time frame.

Keywords: *Economic Survey of Pakistan, Evolution, Stimuli of Change, Indices, Profile Analysis, Cluster Pattern Recognition.*

67:
PREDICTING THE IMPACT OF ANTIRETROVIRAL THERAPY ON VIRAL LOAD AMONG HIV/AIDS PATIENTS IN LAHORE: A MACHINE LEARNING APPROACH

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ABSTRACT

Human Immunodeficiency Virus (HIV) remains a major public health challenge, with viral load serving as a key indicator of disease progression and treatment efficacy. While antiretroviral therapy (ART) effectively suppresses viral replication, individual responses vary due to adherence, demographics, and co-existing conditions. Machine learning has yet to be applied to predict ART's impact on viral load among HIV patients in Lahore. This study enrolled 350 HIV-positive patients from Services Hospital, Lahore, to examine the influence of socio-demographic factors, ART adherence, lifestyle, and comorbidities on viral load. Ordinal logistic regression identified significant associations ($p < 0.05$): gender (Male: OR=2.914, Female: OR=1.707), age 18–24 (OR=1.268), marital status (Single: OR=1.459; Separated: OR=1.581), and education level (Secondary: OR=1.540). Skipping ART doses (OR=2.074), forgetfulness (OR=2.379), quitting treatment (OR=1.449), and symptoms such as fever/fatigue (OR=12.901), weight loss (OR=2.733), and TB (OR=15.833) were strongly linked to higher viral load. Testing frequency and healthcare relationships also influenced outcomes.

Machine learning models, including Decision Tree, Random Forest, Gradient Boosting, K-Nearest Neighbor, and Support Vector Machine (SVM), were applied to predict viral load. The SVM model performed best, achieving accuracy, precision, recall, and F1 scores of 0.73, 0.75, 0.73, and 0.74, respectively, outperforming KNN. These findings highlight the importance of medication adherence, lifestyle management, and comorbidity control in maintaining optimal viral load. For patients, consistent ART use and healthy behaviors are essential, while healthcare providers should offer targeted support and interventions to improve treatment outcomes and overall patient health.

Keywords: *EHIV, Antiretroviral Therapy (ART), Viral Load, Adherence, Comorbidities, Adverse Drug Reaction.*

68:
EFFECT OF BAY OF BENGAL SEA SURFACE TEMPERATURE ON PRECIPITATION IN BANGLADESH, INDIA AND PAKISTAN

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ABSTRACT

Global warming is a pressing concern worldwide, with significant regional climatic implications. It is well-established that elevated sea surface temperatures (SST) can intensify hydrological cycles, leading to more extreme precipitation events. This study investigates the effect of SST in the Bay of Bengal on precipitation patterns across Bangladesh, India, and Pakistan from 2010 to 2024. SARIMA models were developed to identify the underlying patterns in both SST and precipitation data over the 15-year period. Subsequently, the SARIMAX technique was employed to quantify the impact of SST in specific sectors of the Bay of Bengal on precipitation in various climatic regions of the three countries. The analysis revealed statistically significant associations between Bay of Bengal SST and precipitation in several key region-pairs, particularly affecting the coastal and northeastern zones of India and Bangladesh. Based on the established SARIMAX models, forecasts for the 2024-2025 period were generated, which largely project a continuation of the observed historical patterns, underscoring the persistent influence of the Bay of Bengal on the regional monsoon and precipitation variability.

Keywords: *SARIMAX, Sea Surface Temperature, Precipitation.*

69:
RURAL–URBAN GAPS IN EARLY CHILDHOOD EDUCATION AND DEVELOPMENT IN PAKISTAN: EVIDENCE FROM THE MULTIPLE INDICATOR CLUSTER SURVEY (MICS) IN PAKISTAN

Khadija Ashraf, Jiya Amir and **Maira Asif**
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ABSTRACT

Early Childhood Education (ECE) and Early Childhood Development (ECD) are vital for fostering children's cognitive, emotional, and social growth. This study examines rural and urban inequalities in ECE participation and child development outcomes in Pakistan using data from the Multiple Indicator Cluster Survey (MICS) 2017–18, conducted by the Punjab Bureau of Statistics in collaboration with UNICEF. The analysis includes 8,708 children aged 36–59 months. The Early Childhood Development Index (ECDI), covering physical, literacy numeracy, social emotional,

and learning domains, was used as the dependent variable. Independent variables included ECE attendance, gender, age, mother's education, marital status, wealth index, disability status, and place of residence. Descriptive statistics and Poisson regression analysis were performed in STATA 13 to identify key predictors of child development. Results indicate significant disparities between rural and urban areas in both ECE participation and developmental outcomes. Children enrolled in ECE programs had higher ECDI scores across both settings. Male children and those without functional disabilities showed better development levels. Regional variations were evident, with Gujranwala division performing better than other regions. Mother's education and household wealth also played important roles in enhancing ECD outcomes. The study highlights the need to expand quality early education in rural areas, promote maternal education, and enhance parental involvement. Strengthening these factors can help reduce inequalities and ensure more equitable early childhood development across Pakistan.
Keywords: *Early Childhood Education, Early Childhood Development, MICS, Poisson Regression, Child Development Index.*

70:
FACTORS ASSOCIATED WITH CHILD MALTREATMENT IN PUNJAB, PAKISTAN USING MICS (2017-2018)

Kiran Fatima, Sameena Irfan and **Asifa Kamal**
Department of Statistics, Lahore Collage for Women University, Lahore

ABSTRACT

In Punjab, Pakistan, child maltreatment is a whispered issue that is continuously affecting the child's well-being. The aim of current study is to estimate the prevalence of child maltreatment in Punjab and to examine factors that have significant effect on different forms of child maltreatment (moderate physical abuse, severe physical abuse, emotional abuse, domestic work and economic activities). Data has been taken from Multiple Indicator Cluster Survey (MICS) conducted in Punjab, Pakistan (2017-18). The analysis has been carried out on children aged 5-17 years. The sample comprised of 27,368 respondents. Descriptive analysis showed the higher prevalence of children's emotional abuse in Punjab, Pakistan. Binary logistic regression model is fitted to explore the significant factors affecting different forms of child maltreatment. Results of the study showed that area of residence, gender of child, wealth index, household's head education, maternal education, parental attitudes towards punishment and household size were found to be significant factors. Chances of all forms of abuse were higher for children whose parents were in favor of child's punishment. Gender biasedness also increased the chance of child maltreatment. Children of educated parents or belongs to rich families were less likely to experience any form of maltreatment. The chances of child maltreatment have been increased for each additional member in a household.
Keywords: *Child Maltreatment, Punjab, Emotional Abuse, Parental Attitudes.*

71:
STATISTICAL ANALYSIS OF CEREAL PRODUCTION AND CULTIVATED AREA IN PAKISTAN: A PROVINCIAL AND NATIONAL PERSPECTIVE

Maryam Waheed and **Sehar Saleem**
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ABSTRACT

Data for this study were collected from reliable secondary sources, organized year-wise and province-wise to examine Pakistan's agricultural trends. The research analyzes the production and cultivated area of major cereals—wheat, rice, maize, bajra, jowar, and barley—over an eighteen-year period (2004–2005 to 2021–2022). It explores both provincial and national variations to identify key trends and relationships between cultivated area and cereal production. Statistical techniques such as graphical analysis, simple linear regression, and One-Way ANOVA were applied to study how cultivated area affects cereal production and to test for significant differences among provinces and cereals. The results revealed a positive linear relationship between cultivated area and production, showing that increases in land area generally lead to higher output. Tests of normality confirmed that the data followed a normal distribution, while diagnostic evaluations indicated no problems of autocorrelation or heteroscedasticity. High coefficients of determination (R-squared values) for Punjab and Sindh demonstrated a strong model fit, while Khyber Pakhtunkhwa (KPK) showed weaker variability. The ANOVA results confirmed that cultivated area significantly influences production in all regions except KPK. Post-hoc analysis further indicated significant mean differences among provinces and cereal types, with Punjab having the highest production and Balochistan the lowest Overall, the study concludes that cereal production in Pakistan has remained relatively consistent with cultivated area over time, but regional disparities persist. The findings emphasize the need for efficient land use and region-specific strategies to improve agricultural productivity across the country.

Keywords: *Cereal Production, Cultivated Area, Regression Analysis, One-Way ANOVA, Pakistan Agriculture.*

72:
FACTORS AFFECTING WOMEN'S PERCEPTION OF SAFETY (INSIDE OR OUTSIDE HOME) IN PUNJAB USING WOMEN'S ECONOMIC AND SOCIAL WELL BEING SURVEY, PUNJAB (2017-2018)

Aiza Farooq, Asifa Kamal and **Maria Khalid**
Department of Statistics, Lahore College for Women University, Lahore

ABSTRACT

Data for this study were collected from reliable secondary sources, organized year-wise and province-wise to examine Pakistan's agricultural trends. The research analyzes the production and cultivated area of major cereals—wheat, rice, maize, bajra, jowar, and barley—over an eighteen-year period (2004–2005 to 2021–2022). It explores both provincial and national variations to identify key trends and relationships between cultivated area and cereal production Statistical techniques such as graphical analysis, simple linear regression, and One-Way ANOVA were applied to study how cultivated area affects cereal production and to test for significant differences among provinces and cereals. The results revealed a positive linear relationship between cultivated area and production, showing that increases in land area generally lead to higher output.

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Keywords: *Cereal Production, Cultivated Area, Regression Analysis, One-Way ANOVA, Pakistan Agriculture.*

73:
A COMPREHENSIVE ANALYSIS ON VITAMIN D SUPPLEMENTS AND INTAKE ON BODY MASS INDEX

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ABSTRACT

Vitamin D deficiency (VDD) means lack of enough vitamin D in the body. Vitamin D deficiency is a growing public health concern that can significantly impact bone development and nutritional status. VDD is a common global issue, about one billion people worldwide suffering from it, while 50% of the population has Vitamin D insufficiency. It maintains a balance between calcium and bones of your body. The objectives of this study are to determine the prevalence of Vitamin D deficiency among the selected population, to assess the intake and supplementation practices related to Vitamin D among individuals with this deficiency, and to evaluate the effects of Vitamin D supplementation on body mass index (BMI). A cross-sectional study is carried out at outdoor patient department (OPD), Sheikh Zayed Medical Complex, Lahore during the month of August 2025 to September 2025. The study population was the patient visit for orthopaedics. The sample size was calculated using WHO sample size calculator.

- The mean value of Vitamin D deficiency 25(OH) is 29.22.
- The prevalence of Vitamin D deficiency was found to be 64.4% in our sample.
- Among the sample, 31.1%are those who are taking Vitamin D supplements.
- There exist insignificant correlation between BMI and Vitamin D deficiency.

This study emphasizes the importance of identifying the prevalence of Vitamin D deficiency to guide effective health planning and intervention strategies. It aids in creating awareness of adequate Vitamin D intake through diet and supplementation to prevent and manage deficiency. Furthermore, it supports evaluating the impact of Vitamin D supplementation on body mass index (BMI) and overall metabolic health to inform evidence-based nutritional guidelines and improve population health outcomes.
Keywords: *Vitamin D Supplements, Body Mass, Supplements, Health, Nutritional Status.*

74:
ASSESSING THE RELATIONSHIP BETWEEN SOCIAL MEDIA USAGE AND DEPRESSION AMONG FEMALE UNIVERSITY STUDENTS

Aqsa Atiq and **Ayisha Shafiq**
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ABSTRACT

The purpose of this study was to examine the relationship between depression and social media use among female university students. The goal was to identify which aspects of social media activity (i.e., intensity and duration) might be associated with different depression levels in this group. A cross-sectional design was used, and primary data were collected through a structured questionnaire. The sample consisted of 306 female students from Lahore College for Women University (LCWU), selected via simple random sampling. The questionnaire included demographic questions, items on social media usage patterns, and the Patient Health Questionnaire-9 (PHQ-9) to assess depression levels. Descriptive statistics summarized the data, while bivariate analysis (Chi-square tests) and multinomial logistic regression examined relationships between variables. Results showed that most students (76.5%) spend more than 3 hours daily on social media, mainly for entertainment. Worryingly, many participants already experience depression, with over half reporting mild to moderate symptoms and approximately 22% experiencing moderate to severe symptoms. Bivariate analysis revealed that both the frequency and duration of social media use, as well as the intensity, were significantly associated with higher depression levels ($p < 0.05$). However, social media use extent was not related to age or its perceived impact on studies. Multinomial logistic regression indicated that higher social media engagement was linked to an increased risk of depression. Conversely, those with low to moderate social media use were more likely to report mild to moderate depressive symptoms. Age was not a predictor of depression severity. The study concluded that excessive social media use is positively associated with higher depression severity among female university students. These findings underscore the importance of mental health awareness programs and promoting healthier digital habits within academic institutions to reduce the psychological risks linked to social media overuse.

Keywords: *Social Media Usage, Depression, Female University Students, PHQ-9, Multinomial Logistic Regression.*

75:
RELATIONSHIP BETWEEN MATERNAL KNOWLEDGE AND DEMOGRAPHIC FACTORS IN THE HOME MANAGEMENT OF CHILDHOOD DIARRHEA: A STATISTICAL ANALYSIS FROM SHAIKH ZAYED HOSPITAL, LAHORE

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ABSTRACT

The main objective is to determine Knowledge of Mother's regarding Diarrhea Management of Child under 10 years of age at home and to identify the relation of the knowledge with demographic variables. The data of this study has been collected from NHRC department of Shaikh Zayed Hospital, Lahore. A Chi-square test used to check the association between dependent variable and independent variables. For each category, baseline demographic characteristics were presented using both absolute numbers and percentages. To investigate the

likelihood that a case would be studied regrading knowledge of mother, diarrhea among all risk factors, a binary logistic model was utilized. Chi-square test shows that Age of Mother, Danger Sign, Sourceof know about diarrhea, Used to mix ORS, Wash hand, Stop ORS during vomiting, Feed, Doing diarrhea, Diet, Preventive measurement, Preventive measurement taken, Treatment all these are significantly associated with Spread of Diarrhea. Each category's demographic data were provided using both absolute numbers and percentages. The Binary Logistic Results with Significant (OR) are interpret significant risk factor associated with spread of diarrhea at a 5% level of significance. And the BinaryLogistic Results with In-Significant (OR) also interpret the odd ratio which is greaterthan 1. The risk factorswith OR>1 is more likely to affectwith spread of diarrhea. Study was conducted that maternal knowledge about diarrhea, ORS, feeding and hygienic practice, care seeks behavior while spread of diarrhea had significant effect.
Keywords: *Diarrhea, Cause, Spread,Feed, ORS, Preventive Measurement.*

76:
RISK FACTORS OF MULTIDRUG-RESISTANT TUBERCULOSIS IN THE SOUTH ASIA: A META-ANALYSIS

Faiza Faisal, Asifa Kamal and **Hamda Batool**
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ABSTRACT

Multidrug-resistant tuberculosis (MDR-TB) poses a significant challenge to both infection control and treatment with higher proportion of pathology and mortality. It represents a huge public health problem in South Asia. The World Health Organization (WHO) South-East Asia Region, which includes several South Asian nations, is responsible for nearly 30% of all MDR-TB cases globally. A meta-analysis was carried out to assess the risk factors for MDR-TB from the studies conducted in the Southeast Asian using a random-effects model. The pooled log odds ratios (ORs) with 95% confidence interval (CI) were computed for the risk factors. The test was applied to examine the heterogeneity of the studies. Total 73 studies were retrieved related to MDR-TB in the Southeast Asian region. Among these 13 studies were found eligible and 8 risk factors were observed in those studies. The pooled log ORs with 95% CI 1.42 (95% CI, 0.71–2.12) for diabetes, 0.55 (95% CI, 0.09–1.01) for smoking, 2.20 (95% CI, 0.91–3.48) for history of TB treatment, 0.62 (95% CI, 0.18–1.06) for and close contact to TB patient were found significant. Diabetes, anti-TB treatment history, close contact to TB patients and smoking were observed as significant risk factors of MDR-TB. The risk of MDR-TB was found higher for these four factors regardless of clinical setting or regional or environmental context. It is recommended to consider these factors for effective local policy formulation to control MDR-TB in the South Asian region.
Keywords: *Multidrug-resistant Tuberculosis (MDR-TB), Risk Factors, South Asia, World Health Organization (WHO), Meta-analysis.*

77:
EFFECT OF SOCIAL MEDIA ADVERTISEMENT ON PURCHASING BEHAVIOR: A RESPONSE FROM FEMALE UNIVERSITY STUDENTS AND FEMALE FACULTY MEMBERS

Sehar Imran and **Sehar Saleem**
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ABSTRACT

Social media has introduced online marketplaces where companies can offer their products and services. The present study is focused on evaluating the effect of social media advertising on the purchasing behavior of female university students and faculty members. The effect of the advertisement is measured on a four-point Likert scale from high effect to no effect according to the participants' opinions. To find the relationship between the effect of social media and study variables, primary data have been collected using questionnaires from 396 female students and faculty members from three public sector universities in Lahore, Pakistan. The extent of social media advertisements' effect has been explored by applying an ordinal logistic regression model. The independent variables of daily hours, attention, better decisions, improved standard of living, and kinds of advertisements significantly impact the effect of advertisement and move the log odds to the higher category of the effect of advertisement. The variables family income, education, university, status, daily hours, motivate you to shift, kinds of advertisement, source of advertisement, and age of respondents are more likely to move in the higher category of the effect of advertisement on purchasing behavior with an odds ratio >1. The findings reveal that social media advertising influenced the purchasing behavior of female social media users. It is proposed from the study results that companies should focus on publicity elevation activities using social networks, as this is a less costly, more effective method and addresses a large target audience.

Keywords: *Social Media Advertisement, Influence, Consumer Purchasing Behavior, Adverts Exposure, Ordinal Logistic Regression.*

78:
GLOBAL PATTERNS OF ANTIMICROBIAL RESISTANCE THROUGH STATISTICAL AND MACHINE LEARNING INSIGHTS

Rabia Akbar and **Noor Shahid**
Department of Statistics, Lahore College for Women University, Lahore

ABSTRACT

Antimicrobial Resistance (AMR) is when microorganism (such as viruses, fungi and bacteria) develop so that they are no longer affected by the medicines. Antimicrobial resistance is microbes becoming resistant to antimicrobial. The Worlds Health Organization (WHO) launched the Global Antimicrobial Resistance Surveillance System (GLASS) in 2015. GLASS provides a standardized platform for countries to collect, analyze and share data on AMR and antimicrobial consumption. This study use GLASS–AMR data to access the participation of CTA's (Countries, Territories and Areas) that are enrolled and actively reporting data, as well as global map of testing coverage by pathogens and infection type across regions. Data were handled by compiling reported datasets from GLASS, remove repeated isolates and discard missing values from the data. Descriptive analysis were performed to summarize resistance rates by pathogen, antibiotic and years. Furthermore, visualization techniques including heat maps,

time series graphs and spatial map were utilized to illustrate temporal trends and geographical variations in antimicrobial resistance Multivariate analytical techniques and clustering were employed to identify relationships and similarities in resistance profiles among different countries and pathogens. Furthermore, machine learning models are applied to estimate resistance and identify key risk factors associated with antimicrobial resistance. Overall, this study demonstrates that systematic analysis of GLASS-AMR data can effectively transform complex surveillance information into actionable insights. This findings reinforce global efforts to monitor stewardship and public health policy development.
Keywords: *Antimicrobial Resistance, GLASS Data, Machine Learning, Spatial Analysis, Public Health.*

79:
STATISTICAL AND MACHINE LEARNING APPROACHES TO CHILDHOOD DIARRHEA AND WASH-RELATED RISK FACTORS IN PUNJAB, PAKISTAN

Rameen Asif and **Naila Amjad**
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ABSTRACT

Childhood diarrhea remains a leading public health concern in developing countries, closely linked to water, sanitation, and hygiene (WASH) conditions. This study investigates the association between household WASH indicators and the prevalence of childhood diarrhea in Punjab, Pakistan, using the Pakistan Social and Living Standards Measurement (PSLM) 2022 survey. Key variables include drinking water sources, type of toilet facility, handwashing practices, and water treatment behaviors. The analysis employed both conventional statistical methods and advanced machine learning models. Descriptive statistics and Chi-Square tests were first applied to explore distributions and assess associations. Findings revealed that water treatment practices, type of toilet facility, and handwashing behavior were significantly associated with childhood diarrhea ($p < 0.05$), highlighting their role as critical household-level risk factors. To extend the analysis, classification models including Neural Network, Random Forest, and Support Vector Machine (SVM) were implemented in R. Neural Network and SVM models exhibited limitations in sensitivity and specificity, emphasizing challenges in predictive generalization. Despite these limitations, the findings underscore the vital role of clean water access and improved sanitation in reducing childhood diarrhea. They further demonstrate the complementary value of combining statistical association techniques with machine learning to inform public health planning. The study contributes to evidence-based policymaking by identifying actionable WASH-related determinants and emphasizes the need for improved data collection methods to enhance predictive modeling.
Keywords: *Childhood Diarrhea, WASH, PSLM, Machine Learning, Public Health, Pakistan.*

80:
MACHINE LEARNING MODELS AND BOOTSTRAP METHODS FOR PREDICTING SCHOOL ENROLLMENT WITH MISSING DATA

Syeda Fatima Naqvi, Naila Amjad and **Sawera Farooq**
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ABSTRACT

Missing data poses a major challenge in statistical analysis, as it can introduce bias and compromise the validity of conclusions. In this study, school enrollment of children in Punjab is examined using the Multiple Indicator Cluster Survey (MICS) 2018 data, which revealed missing values in key explanatory variables. To address this, median imputation was applied, followed by bootstrap variance estimation to obtain consistent and robust variance estimators under the complex survey design. The relationship between children's school attendance and socio-economic determinants was modeled using survey-weighted logistic regression, given the binary nature of the response variable. To further evaluate predictive performance, machine learning classification methods, including Support Vector Machines (SVM), Random Forests, and Neural Networks, were compared with the traditional logistic regression model. Findings highlight that machine learning approaches outperform conventional methods in predictive accuracy, while bootstrap resampling provides reliable measures of statistical uncertainty. This study underscores the importance of robust variance estimation techniques in survey-based research and demonstrates how machine learning can complement traditional statistical approaches in educational policy analysis. The results contribute to methodological advancement in handling missing data and offer practical insights for improving school enrollment outcomes.

Keywords: *Missing Data, Median Imputation, Bootstrap Variance, Logistic Regression, Machine Learning, Classification, Survey Data, School Enrollment.*

81:
IMPACT OF WATER, SANITATION, AND HYGIENE (WASH) FACTORS ON CHILDHOOD DIARRHEA IN PAKISTAN: A STATISTICAL ANALYSIS USING PSLM DATA

Attiqa Urooj, Mariyam Hafeez and **Afza Rasool**
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ABSTRACT

This study investigates the influence of environmental factors of Water, Sanitation, and Hygiene (WASH) on the prevalence of childhood diarrhea among children under five years of age in Pakistan. Using data from the Pakistan Social and Living Standards Measurement (PSLM) Survey, the research applies descriptive statistics, Chi-square tests, and binary logistic regression to examine the relationship between key WASH indicators and the occurrence of diarrheal diseases. The dependent variable, nature of death due to diarrhea, is analyzed in association with multiple independent variables, including source of drinking water, water treatment practices, handwashing with soap, sewerage system connectivity, and water source used for cooking and handwashing. The statistical analysis identifies significant predictors of childhood diarrhea, emphasizing that households with access to treated and safe drinking water, proper sanitation, and consistent hand hygiene practices experience notably lower disease incidence. The findings highlight the critical role of WASH interventions in improving child health outcomes and reducing mortality risks in developing regions. Moreover, the results provide evidence-based insights for policymakers to strengthen national sanitation programs and promote sustainable hygiene awareness. The study contributes to the broader discourse on public health and development, underscoring that investment in basic hygiene infrastructure is essential to achieving the Sustainable Development Goals related to child health and well-being.

Keywords: *WASH, Childhood Diarrhea, Pakistan, PSLM, Logistic Regression, Public Health.*

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We look forward to continued collaboration in the years ahead.

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