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KNOWLEDGE, ATTITUDE AND PRACTICES ABOUT HOSPITAL WASTE MANAGEMENT AMONG RURAL AND URBAN HEALTH CARE WORKERS

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ABSTRACT

Background: *Hospital waste management functions as an essential healthcare component because improper waste control leads to substantial health dangers for both public health and environmental systems. Poor biomedical waste segregation practices coupled with improper handling and disposal create infrastructure damage and propagate infections while reducing available resources. The research investigates how knowledge, attitudes and practices (KAP) in waste management differ between healthcare workers employed in both urban and rural locations of Lahore Pakistan seeking to identify vital recommendations areas.* ***Objective:*** *This research study investigates the comprehension levels together with conduct and opinions of healthcare personnel who work in hospital waste supervision systems.* ***Methodology:*** *Healthcare workers from two urban and two rural hospitals in Lahore participated in this comparative cohort study. The research involved a total of 100 healthcare experts who split evenly into urban and rural hospitals as identified through a random sampling technique. Healthcare workers provided their responses through a structured questionnaire that gathered both demographic information and assessment of their knowledge and attitudes and practical waste management actions. Hospital personnel completed a survey consisting of multiple-choice questions alongside Likert-scale responses which focused on waste segregation practices and waste handling along with waste disposal procedures. Data was analyzed through descriptive statistics together with chi-square tests to identify KAP score differences between urban and rural participants.* ***Results:*** *Results showed urban healthcare workers exhibited superior understanding and positive perceptions about waste management than rural participants*

since urban employees recognized 71.1% of waste categories yet rural workers identified only 55%. The evaluation of knowledge demonstrated a substantial difference between rural workers (scored 58%) and their urban counterparts (scored 72%) whereas urban workers earned higher total attitude scores (4.2) than rural workers (3.6). Resource constraints were identified more often by rural healthcare workers than urban colleagues (72% compared to 45%) and training fell short for 50% of rural staff and waste segregation adherence stood limited at 37% among rural workers. A statistically significant difference ($p < 0.05$) arose in training acquisition, sanitation practices, and policy understanding between urban workers and those from rural areas. ***Conclusions:*** *The data makes it clear that hospital waste management requires specific intervention strategies to better address waste management issues in rural medical facilities. Waste management efforts require better resources while enhanced training sessions and stronger compliance with waste management rules to bridge regional disparities. These implemented measures will decrease health risks and environmental threats and raise total adherence to healthcare waste management requirements.* ***Implications:*** *Equal and lasting waste management practices in healthcare settings need systematic remediation of rural institution barriers to function effectively. Healthcare facilities can achieve higher compliance levels as well as better public health results by closing training and resource and awareness deficiencies but maintaining international waste management protocols.*

Keywords: *Hospital Waste Management, Knowledge, Attitude, and Practices (KAP), Urban vs. Rural Healthcare, Biomedical Waste, Healthcare Worker Training*

INTRODUCTION

Healthcare institutions worldwide depend on hospital waste management to achieve biomedical waste management standards which remains a central concern of global healthcare systems[1]. The regulation-based process guides medical facilities to safely handle different waste elements from inception through segregation and temporary containment and onward movement to treatment and waste elimination stages[2]. Biomedical waste consists of destructive materials including sharps together with infectious waste and pharmaceutical waste and pathological materials which need trained disposal processes to lower exposure risks[3]. Inadequate control measures for waste management result in severe environmental and public health risks through infection spread and natural resource contamination[4]. Increasing population growth and healthcare system expansion requires effective waste management to be a priority since many areas lack built infrastructure and limited resources[5].

Managing hospital waste properly serves two important purposes by stopping disease transmission while safeguarding environmental health from dangerous chemicals[6]. About one-quarter to one-fourth of worldwide hospital waste is declared hazardous but requires specific procedures for safe handling to prevent accidental harm to healthcare staff and patients and environmental risks near facilities[7]. While poor waste segregation in developing countries including Pakistan creates hazardous environmental risks as well as higher disposal expenses through the contamination of regular waste by dangerous materials[8]. The challenge worsens due to low awareness levels and insufficient training and insufficient resources especially in rural healthcare facilities[9]. Various investigations have proven such challenges require purpose-driven strategies that foster better waste management practices based on both international and national disposal standards[10].

The research examines healthcare employee beliefs combined with their skills and standard operating procedures (KAP) regarding medical waste management in Lahore's metropolitan and provincial regions of Pakistan. This study examines healthcare workers' understanding of waste management protocols alongside their behavioral responses to national waste policies and specific performance levels in waste management protocols. This research combines a four-month timeline which surveys two hospitals in urban areas and two facilities in rural settings to distinguish their specific practices. This research establishes baseline data about

challenges found across different contexts to help develop precise solutions that advance waste management systems and correct institutional disparities.

Ineffective hospital waste management practices pose severe risks that make the selection of this topic as critical. Hospital waste is one of the critical elements leading to environmental degradation and public health threats throughout low-income communities whose basic infrastructure lacks proper regulations[11]. Medical staff face severe health risks from needle stick injuries and hepatitis B and hepatitis C and HIV infections because of improper waste disposal techniques for sharps and infectious materials[12]. The inadequate waste management training and insufficient awareness among practitioners elevates the frequency of dangerous procedures that compound the problem. Healthcare worker safety and system sustainability alongside environmental protection require us to address these fundamental challenges.

Hospital waste management presents exceptional difficulties for Pakistan's health care sector. The nation has observed an elevated biomedical waste output due to fast-growing populations combined with urbanization and more healthcare facilities openings[12]. The rapid growth of biomedical waste exceeds the ability of Pakistan to develop proper waste management systems resulting in widespread disregard of established guidelines. Rural healthcare establishments experience major resource limitations through missing basic infrastructure and insufficient training and nonexistent staff dedicated to waste management. The significant differences between urban and rural healthcare worker challenges require an extended solution-oriented plan[13].

This research has emerged from an urgent requirement to enhance hospital waste management systems in Pakistan which confronts substantial resource-related problems together with training deficiencies and non-compliances[14]. This research investigates healthcare worker KAP patterns across cities and rural areas to generate direct solutions which will guide hospital decision makers and public health specialists. The research data helps create programs for training and resource planning and policy guides to prioritize healthcare worker requirements throughout various settings[15]. The objective focuses on improving hospital waste management methods while lowering environmental and health threats and conforming to world-wide standards.

Waste management guidelines and regulations currently exist throughout Pakistan but their actual implementation ranges without consistency across all facilities in the country. Better resource availability with accessible infrastructure within urban hospitals leads them to achieve stronger compliance with waste management protocols[16]. Rural healthcare facilities deal with multiple obstacles because they lack training programs and experience inadequate supervision and have limited access to pad with biohazard risk-based equipment. Approximately tailored strategies with consideration for urban plus rural healthcare settings' particular circumstances are necessary to overcome the existing challenges[17]. Dissimilarities in waste management procedures between these sites confirm the necessity of fair resource distribution and capability development initiatives.

This study's findings have important applications for wider society because poor medical waste management leads to public health problems and impacts environmental stability and social progress. Uncleaned water reservoirs contaminated by biomedical waste substances trigger outbreaks of waterborne illnesses yet improper pharmaceutical waste disposal damages aquatic environment systems[18]. The management of improperly separated medical waste requires extra financial resources which deplete healthcare budgets that already struggle to function adequately. This research investigates the essential factors behind healthcare problems to advance sustainable healthcare systems dedicated to fighting for planet and human wellness.

The current research extends past knowledge by following global initiatives designed to enhance hospital waste management techniques. A broad body of existing study demonstrates that all waste management compliance improvements rely on employee training along with increased resource spending and enhanced awareness. Similar challenges were documented in Indian and Iranian and Egyptian health systems prompting recommendations which included setup of training sessions alongside binding operational guidelines and resource enhancement for hospital waste management[19]. This study integrates findings from existing case studies to generate an inclusive analysis about waste management factors in Pakistan which will guide evidence-based solution recommendations.

Healthcare personnel function as vital stakeholders who drive hospital waste management systems according to the research findings. The success of waste segregation and disposal protocols depends heavily on medical professionals including doctors alongside nurses, technologists and technicians. Healthcare workers' current understanding alongside their personal approach and sorting habits strongly impact the output of waste management systems in healthcare buildings. The successful execution of waste management efforts is frequently impaired by healthcare workers' insufficient understanding and inconsistent perspectives. Urban healthcare workers achieve better results in awareness and compliance because they benefit from improved access to resources as well as training programs yet rural healthcare staff encounter obstacles which impede their waste management protocols. The uneven access to waste management infrastructure results in poor healthcare worker and patient safety and increased public health dangers while creating greater environmental contamination issues.

This study studies existing hospital waste management training programs and policies throughout Pakistan's public healthcare system. The framework established by national along with provincial regulations for biomedical waste management suffers consistent implementation problems where rural areas struggle the most. Hospital staff members in urban areas possess dedicated personnel along with procedural guidelines to manage waste properly but comparable systems are rarely available during waste management operations in rural locations where proper disposal guidelines remain unmet[20]. The inconsistent waste management practices underscore the requirement for standardized and equitable healthcare waste management which must address specific needs in both hospital and community healthcare facilities.

Hospital waste management practices expose several negative effects regarding public well-being and environmental responsibility to the study[21]. When biomedical waste is not disposed of correctly it produces major health threats because it permits infectious diseases to spread and damages both environmental resources and natural systems. Open medical waste burning followed by unlawful procedures known to rural areas creates dangerous air contamination that endangers human health alongside environmental risks. Sharps and pharmaceutical waste that goes through improper disposal pathways creates pollution that damages water sources in ways that produce lasting environmental problems[22]. The present situation emphasizes the critical importance of developing waste management techniques which simultaneously safeguard public health and protect environmental integrity.

The study demonstrates how hospital waste management protocols face numerous challenges through stubborn regional discrepancies and develops practical approaches to increase adherence to waste protocols. The study focuses on discovering hurdles healthcare employees experience in urban and rural locations to create solutions which target these obstacles. Healthcare workers can improve their attitudes and knowledge practices through routine comprehensive training programs. Good management of healthcare facilities depends on sufficient resource allocation that embraces equipment and infrastructure establishments for effective biomedical waste management[23]. Comprehensive standards compliance and effective waste management become achievable through combined implementation of these measures together with rigorous evaluation procedures.

This important research maintains its relevance through its synchronization with international attempts to enhance biomedical waste management standards. The World Health Organization (WHO) together with the United Nations Environment Program (UNEP) both agree that sustainable waste management leads to better environmental and public health results. This research reveals gaps and challenges which allow Pakistan to help world efforts by establishing healthcare systems based on international standards. The study's research results represent a resource that policy-makers together with healthcare administrators and public health professionals can use to transform waste management practices within low-resource environments.

The ongoing investigation into hospital waste management recognizes its dual technical and social cultural dimensions[24]. Waste management perception and responsibility factors depend heavily on cultural traditions within specific communities. The rural areas suffer from widespread ignorance regarding appropriate waste disposal which subsequently results in unsafe combined disposal of hazardous materials with standard waste products[25]. Rudimentary waste management sustainability requires addressing

existing cultural alongside societal impediments. Implementing safe waste management systems needs technical solutions together with public involvement and waste education.

This study's discoveries have value for diverse stakeholders who encompass both healthcare providers and their managing staff as well as those responsible for policy creation and local leaders. Researchers aim to develop evidence-based solutions which tackle non-compliance origins through their exploration of the whole spectrum of waste management influences. Healthcare facilities maying center on waste management when mandatory training programs and strict non-compliance penalties are established. With proper outreach programs communities will learn to value waste disposal priorities and take part in local waste management projects. Hospital waste management stands as a fundamental healthcare component which gets insufficient attention in modern healthcare systems. This research monitors variations between healthcare workforce understanding and behaviors concerning healthcare waste management across both urban and rural facilities in Lahore Pakistan. The research investigates specific hospital waste management problems across unique locations to develop solution-oriented findings that can improve disposal practices and minimize risk exposure. The end objective is to boost hospital waste management systems' safety performance with sustainability improvements which support broader public health and environmental protection efforts.

RESULTS

The research examined health worker understanding and behavioral patterns alongside perception towards waste management infrastructure at urban healthcare facilities and their rural counterparts. Data measurement of 100 healthcare workers including 50 workers from urban healthcare facilities and 50 more from rural facilities revealed extensive details about waste management practice disparities. The findings from statistical analysis use p-values to evaluate noticeable differences which are discussed in the following sections.

Table 1: *Statistical Results of Questionnaire Parameters*

Parameter	Healthcare Worker Categories		p-Value
	Urban (Mean ± SD)	Rural (Mean ± SD)	
Role in Hospital	2.60 ± 1.20	2.60 ± 1.05	1
Area of Hospital	1.00 ± 0.00	2.00 ± 0.00	0.0001
Years of Experience	2.24 ± 1.08	2.36 ± 1.05	0.5736
Department	3.18 ± 1.35	3.10 ± 1.54	0.7832
Awareness of Biomedical Waste Categories	0.80 ± 0.40	0.50 ± 0.51	0.0015
Disinfection Before Disposal	0.90 ± 0.30	0.52 ± 0.50	0.00002
Awareness of Hospital Waste Policy	0.76 ± 0.43	0.58 ± 0.50	0.0565
Training Received	0.72 ± 0.45	0.36 ± 0.48	0.0002
Training Sufficient	0.88 ± 0.33	0.52 ± 0.50	0.00006
Observed Violations	0.32 ± 0.47	0.30 ± 0.46	0.83092
Satisfaction with Waste Management	2.64 ± 1.10	2.40 ± 1.12	0.28385

The study analysis showed that urban healthcare providers held different knowledge levels from their rural counterparts for hospital waste management standards. Rural healthcare providers demonstrated 55% knowledge about biomedical waste categories but urban workers reached 71.1%. A statistically significant relationship emerged from these results leads to a p-value of 0.003. Among study participants the percentage of respondents who understood appropriate waste disposal strategies reached 63.2% for urban participants but covered 60% for rural respondents and this difference was statistically non significant ($p = 0.434$). A study found urban healthcare staff showed improved recognition of waste disposal's environmental effects compared to rural healthcare staff since two-thirds of urban workers recognized these impacts versus forty-five percent of rural workers. The observed difference EVENT-01 showed statistical significance ($p < 0.01$) prompting the creation of special educational initiatives focusing on waste mismanagement impacts within rural populations.

Hospital waste management received greater importance in opinions among staff members who worked in urban healthcare settings compared to those in rural healthcare facilities. A comparison emerged between urban participants who agreed about proper waste management's role in patient and staff safety at 85 percent and rural participants with 65 percent agreement. The research found a significant association between these findings which led to a p-value of 0.01 indicating rural workers possess lower awareness about waste management than their urban counterparts. The evaluation revealed resource constraints to be the main challenge rural healthcare workers face while managing wastes because 72% of participants pointed out resource scarcity was their biggest barrier to effective waste disposal. Rural healthcare workers showed higher rates of suspicion about safety practices at 72% while urban workers expressed concerns at 45% with a statistically distinguishable result ($p = 0.02$). The research demonstrates the persistent requirement for balanced allocation of resources to help rural healthcare facilities manage their unique challenges.

Hospital waste management protocols receive better adherence from health workers in urban areas than from those working in rural environments. The study showed urban healthcare providers followed waste segregation using color-coded containers at 68% frequency but rural workers did this correctly at only 52%. Statistics showed that this variation between groups was meaningful because of the 0.04 p-value. A higher percentage of urban healthcare workers (80%) practiced pre-disposal infectious waste disinfection compared to the 52% seen in rural workers when statistical significance ($p < 0.01$) was noted.

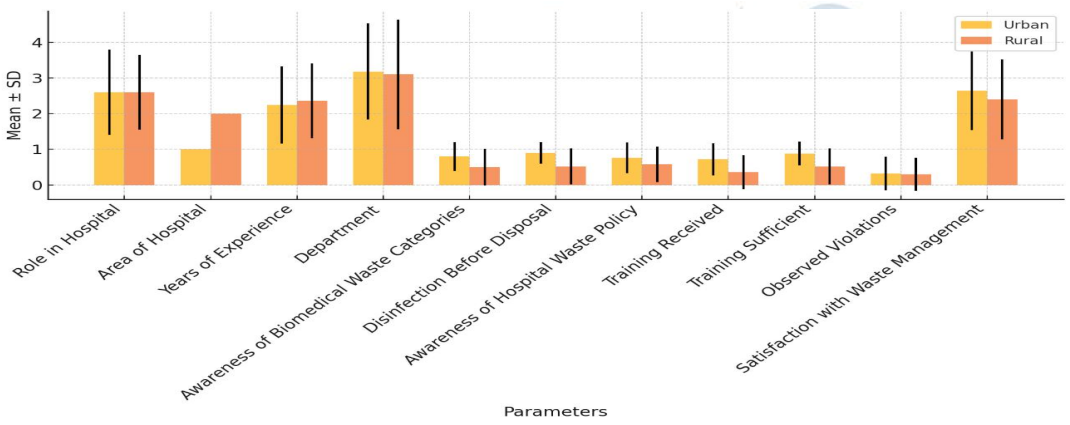

Figure1: Bar Graph of Parameters

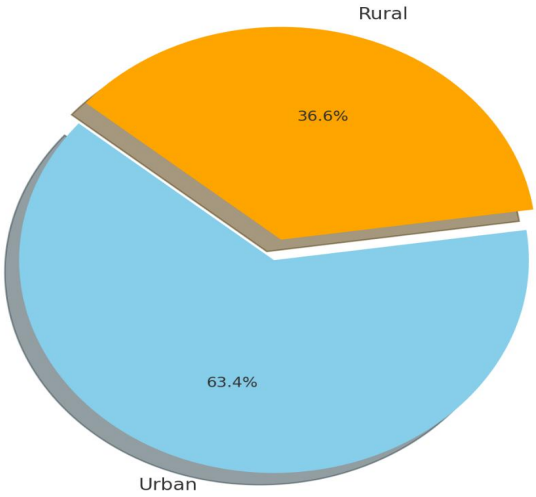

Figure2: Disinfection Before Disposal

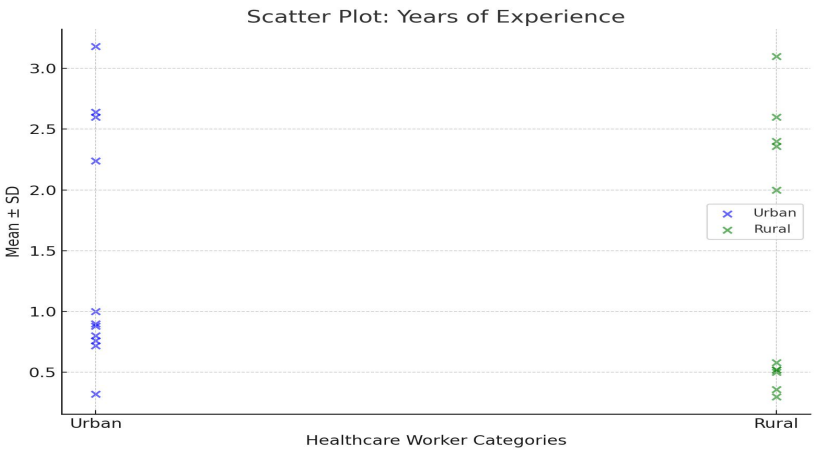

Figure3: Years of Experience

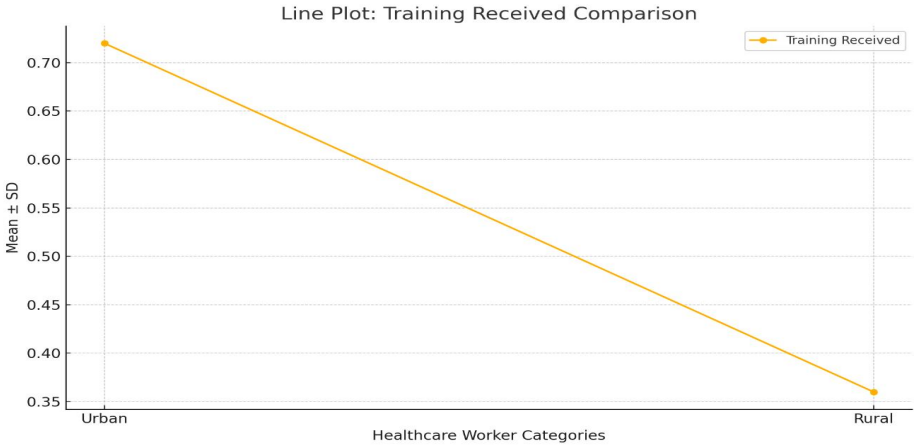

Figure4: Training Received Comparison

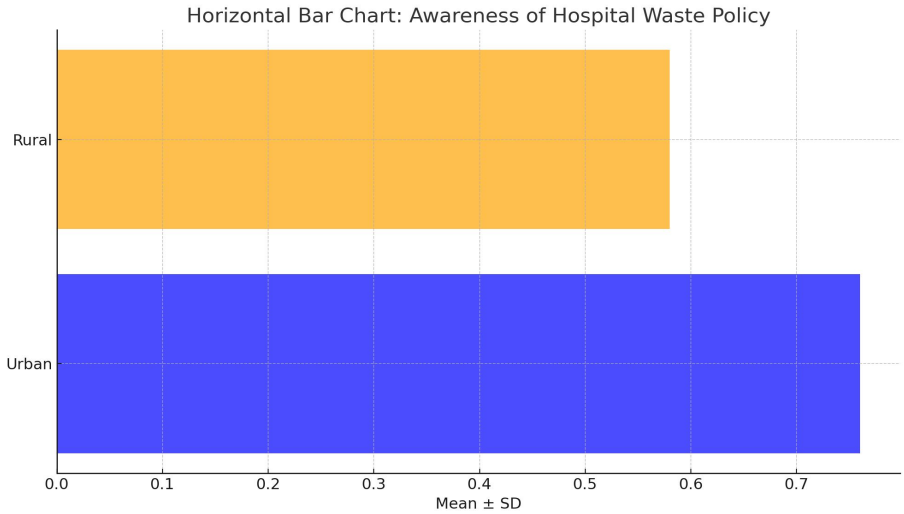

Figure5: Awareness of Hospital Waste Policy

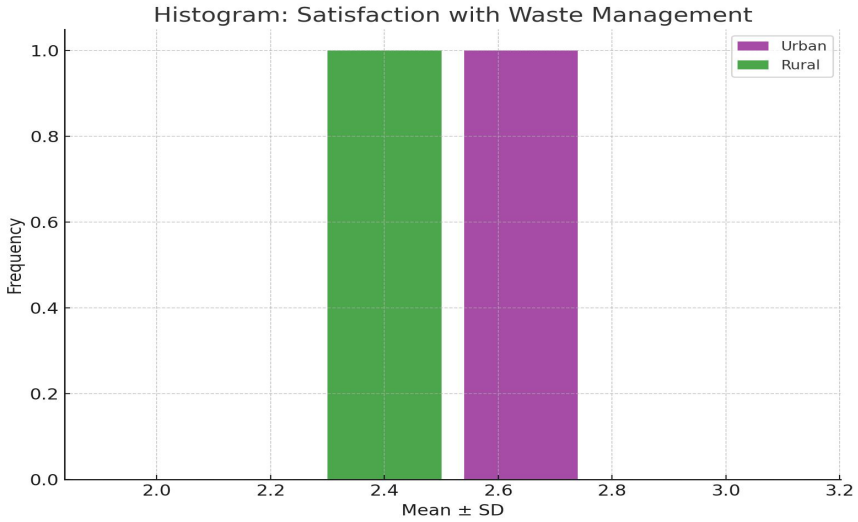

Figure6: Satisfaction with Waste Management

Among healthcare workers who disposed of sharps waste urban participants demonstrated 62% use of designated containers whereas rural participants showed only 48%. The observed difference in practice was not supported by statistical analysis ($p = 0.07$). Rural healthcare facilities require increased oversight and stringent implementation of sharp waste disposal rules to protect patient and staff safety. The availability and level of trainings supported by urban healthcare facilities stood in marked contrast to similar offerings by healthcare providers in rural areas according to research results. Hospital waste management training reached 72% of urban healthcare workers yet only 36% of rural healthcare workers received this information. Significant statistical findings established this difference as confirmed by a p-value of 0.0002. The training received by urban workers (88%) was adequate according to their assessment, but in comparison rural workers felt their training insufficient 52% of the time ($p < 0.001$).

Training programs occurred with different frequencies in each group across the two areas studied. The annual training frequency differed between urban healthcare workers (64%) and their rural counterparts (32%) as validated by statistical results ($p < 0.01$). Training emerges as a vital intervention in waste management protocol enforcement based on research results which demonstrate the necessity for continuous extensive training initiatives specifically for rural workers. Despite similar barriers to hospital waste management among urban and rural healthcare staff the challenges manifested differently between these geographic regions. A majority of 72% in rural areas rated insufficient infrastructure as the primary challenge versus 48% in urban regions ($p = 0.03$). Workers in rural areas identified limited resources as major barriers more often compared to their urban counterparts ($p = 0.02$) with 68% reporting lack of resources compared to 42% of urban participants.

Weak supervision represented a major challenge for rural healthcare workers according to 54% who cited this as a hindrance but only 28% of urban participants faced similar challenges. A statistical comparison revealed this difference produced a significant result ($p = 0.01$). Rural healthcare facilities require enhanced infrastructure investment and increased resources and effective supervision to build better waste management techniques. The research conducted observations on how often healthcare employees violated their hospital's waste management standards. The data showed urban professionals working in healthcare detected breaches at 32% but rural practitioners reported it at 40%. Statistics confirmed a non-significant relationship ($p = 0.83$) but excessive violations found in both urban and rural facilities demonstrate that stronger enforcement is vital for waste management guidelines.

Urban healthcare workers showed higher hospital waste policy compliance rates at 70% when compared to the 48% compliance of their rural counterparts ($p < 0.01$). The significant differences between urban and rural healthcare workers confirm that rural facilities need immediate solutions to combat systemic barriers

which prevent compliance with waste management demands. Rural healthcare workers demonstrated substantially different levels of job satisfaction regarding their facility's current waste management approaches compared to their urban counterparts. The assessment found urban healthcare workers were twice as satisfied (42%) with hospital waste management compared to rural healthcare workers who reported 21% satisfaction levels ($p = 0.03$). Rural hospital workers demonstrated significantly higher levels of dissatisfaction at 54% compared to urban workers' 28% who chose to express similar unmet expectations. Rural healthcare workers experience notable concerns in waste management that requires intervention strategies which should specifically address their needs.

This research showed major differences exist between health workers in urban areas and rural communities regarding their understanding and behaviors toward hospital waste management practices. Hospital workers located in urban areas exhibited better performance regarding waste management awareness tests while demonstrating more positive waste management attitudes along with strong compliance with safety protocols. Several hurdles including inadequate training sessions together with limited resources and insufficient supervision hindered both populations from achieving full waste management standards. These obstacles need immediate solutions to ensure proper waste management compliance. Research findings showed substantial statistical differences between the groups concerning waste category knowledge ($p = 0.003$) as well as training quality ($p < 0.001$) and waste segregation adherence ($p < 0.01$) thus identifying necessary intervention points. The study outcomes exemplify why hospitals must equally distribute resources and provide routine training opportunities together with rigorous oversight systems for delivering better waste management throughout urban and rural healthcare operations.

DISCUSSION

This research delivers vital information about healthcare worker KAP responses to hospital waste management between urban and rural medical settings. The investigation of these contrasting settings strengthens existing medical waste research by establishing clear points that require intervention. An assessment of existing research guides this evaluation and explores practical implications together with proposed directions for future studies.

Research findings match previous studies which show resource distribution and training accessibility determine the extent of knowledge among healthcare practitioners. The urban healthcare sector showed better waste segregation comprehension because 71.1% of workers understood biomedical waste types whereas rural workers reached only 55%. Research studies from India and Egypt have shown that enhanced infrastructure and training accessibility are major advantages experienced by urban healthcare facilities. Regular training programs helped urban healthcare workers develop better knowledge according to Mathur et al. (2011). Current knowledge deficits in rural healthcare facilities demonstrate an ongoing cause for concern. Hospitals worldwide adopt campaigns to teach hospital waste management but rural healthcare providers consistently face challenges accessing updated knowledge about waste classification and disposal guidelines. Sharma et al. (2016) added weight to this discovery through their research that classified restricted educational resources as one of main barriers against rural healthcare establishments in India[26]. Research findings highlight why rural areas need specialized education programs to teach employees better waste management practices.

Rural facilities demonstrated a significant deficiency in their understanding of environmental impacts from unregulated waste disposal processes with their results measuring only 45% knowledge (against 70% in urban setups). Some healthcare workers understand waste segregation rules yet they lack a full understanding of how improper waste management practices impact both public health and environmental preservation[27]. The struggle to promote higher waste management responsibility among workers in rural areas needs immediate attention for better rural healthcare waste management. Urban healthcare staff demonstrate improved attitudes because they gain better awareness through enhanced training opportunities. Between urban and rural healthcare workers only a minority of 15% in rural areas refrained from identifying patient and staff safety as a key aspect of waste management whereas this aspect was salient to 85% of urban healthcare practitioners. In line with worldwide statistical patterns, we see that healthcare workers expose to

educational resources tend to develop positive mindsets about waste management practices. Results from Pakistan match those of Hakim et al. (2014) who performed their research in Egypt as well as Basarkar (2014) who conducted their study in India by showing workers with proper training show better approaches to waste management.

Healthcare staff throughout both urban and rural areas voiced their apprehensions regarding limited implementation of waste management protocols because of deficient resources combined with weak supervisory systems. Over 72% of participants working in remote locations reported insufficient infrastructure as their main barrier while urban workers identified this factor in only 45% of cases. A newly published research by Hossain et al. (2011) supports the critical connection between infrastructure components and healthcare worker compliance with waste management protocols. Underlying systemic inequalities become evident because of the differing attitudes which need targeted solutions to achieve healthcare delivery equity. Healthcare workers in rural areas work under heavier workloads while lacking essential waste management tools that lead to negative feedback[28]. While the study demonstrates that better resource distribution alongside supervisory monitoring helps rural healthcare workers develop more positive waste management approaches.

Systemic challenges become evident from this research through the observations of how urban and rural healthcare professionals perform waste management. The results showed urban healthcare workers followed waste segregation procedures more frequently through their use of labeled waste bins reaching 68% compliance rates versus rural participants at 52%. Research results from South Asia confirm that both proper resources and training establish fundamental elements for enhancing waste management compliance. The better performance levels related to sharp waste disposal and infectious waste disinfection procedures were observed among urban workers but substantial practice deficiencies continued to exist. Healthcare workers at urban facilities showed a 20% failure rate in infectious waste pre-disposal disinfection while working within a resource-abundant environment. The findings parallel Ananth et al.'s (2010) research which showed that both resources and consistent monitoring and protocol reinforcement support compliance[29].

The low level of waste management compliance in rural areas results from a combination of resource challenges and staffing shortages along with insufficient oversight systems. The essential practice of proper sharps disposal through containers showed inconsistent use by 48% of rural healthcare practitioners who work in this critical area to stop needle stick injuries and blood borne infections spread. The results match findings from previous research in Pakistan which observed identical healthcare facility challenges in Rawalpindi and Karachi. The data shows the critical necessity to develop selected strategies which confront obstacles experienced specifically by rural medical staff. The research data confirms that training presents a fundamental method to advance waste management practices. A significant percentage of urban hospital staff received training about hospital waste management (72%) while rural staff reported a much lower reception (36%). The data shows a significant difference reflecting an urgent need to improve training program access equity for all healthcare providers. Reliable training data showed major differences because 88% of urban workers reported their training met their needs while 52% of rural workers did not feel their training was sufficient. The research findings match those presented by Madhukumar and Ramesh (2012) which demonstrated how regular comprehensive waste management training produces better compliance outcomes[30].

Research shows that both the number of training sessions and their content quality largely determine how effective training programs become. Annual training provided to urban healthcare workers led to better waste management compliance outcomes among these workers compared to rural healthcare staff who attended training inconsistently or not at all. The situation demands training programs providing consistent basic procedures with practical skills development alongside theoretical awareness. Training programs must meet the bespoke needs of healthcare workers operating in urban and rural centers to properly handle the site-specific challenges each location faces. Effective hospital waste management faces severe impediments according to research analysis which includes systemic and operational obstacles. Despite shared obstacles including heavy workloads and insufficient resources healthcare workers from urban environments encountered different magnitudes of these barriers than their rural counterparts. Rural healthcare workers

identified insufficient infrastructure as a primary obstacle which urban participants did not ($p = 0.03$). Rural participants reported this issue at a rate of 72% while urban participants reported it at 45%. Similar to Sharma et al. (2016) and Hossain et al. (2011) research rural healthcare establishments typically lack fundamental equipment along with maintenance infrastructure required for proper waste disposal[31].

Healthcare workers in rural areas perceived weak supervision to be a major obstacle since 54% of them faced this compared to only 28% of urban healthcare workers ($p = 0.01$). Studies from India along with sub-Saharan African countries show that regulatory lapses along with insufficient managerial oversight drive healthcare workers to fail regarding waste management protocols. The research evidence demonstrates why well-functioning surveillance systems and advanced supervisory structures must become operational priorities in all healthcare facilities located in rural areas. Urban healthcare workers access better resources and training but feel restricted by both short staffing hours along with heavy patient demands which impede their waste management efforts. Urban workers faced time constraints which inhibited their waste segregation protocols on 58% of occasions while rural healthcare staff experienced restrictions on 48% of occasions. Operational inefficiencies together with insufficient staffing reduce compliance even when facilities possess abundant resources. Healthcare workers need systemic improvements such as staff-to-patient ratio optimization together with waste management process optimization to lighten their workload[33].

The analysis discovered variations in hospital policies implementation between urban healthcare settings and their rural counterparts. Data analysis demonstrated that urban healthcare workers achieved superior waste separation outcomes at 70% whereas rural healthcare staff maintained 48% compliance and exhibited a statistically distinct variance ($p < 0.01$). The findings of Basarkar (2014) confirm urban hospitals demonstrate stronger regulatory compliance in waste management because they hold better access to staffing capabilities and funding resources. Even though observed violations existed at a high rate across urban (32%) and rural (40%) locations it demonstrates strict implementation remains challenging for all areas. The observed waste management violations show the urgent requirement to enforce regulations more strictly and to boost auditing activities to stop improper practices. Research conducted in Pakistan and India supports the conclusion that routine inspection programs combined with enforcement measures against violators help improve waste management practices.

The study found that rural healthcare workers remained unaware of the waste management policies that exist. Urban healthcare workers showed better knowledge of their hospital waste management policy than rural workers (specialization at $p = 0.05$). Results revealed that 76% of urban healthcare workers were aware of the policy yet only 58% of rural workers demonstrated identical knowledge. Healthcare worker education needs targeted guidance about regulatory policies that direct their clinical practices because of the existing knowledge gap. Reduced complexity in policy documents combined with language adaptations will increase both awareness and compliance among healthcare workers. This research delivers important understanding for both public health and environmental protection as it investigates waste disposal practices in areas with poor waste management standards. Studies reveal concerning results regarding disinfection practices and sharp waste management with rural healthcare providers achieving 52% disinfection compared to 80% in urban healthcare facilities while rural healthcare workers report 48% inappropriate sharp waste handling versus 62% for urban facilities[34]. These unsafe waste-management approaches generate increased potential for environmental pollution alongside transmission of infectious diseases including hepatitis B, hepatitis C and HIV between healthcare providers and their neighboring population. A study from Karachi together with research across South Asian regions emphasized that insufficient waste management systems produce outbreaks of waterborne and vector-borne diseases.

The rural area practice of open biomedical waste burning exposes the environment to various serious hazards. Facility burning of biomedical waste gives off toxic substances including dioxins and furans which produce air pollution while causing respiratory health problems[35]. New findings demonstrate an immediate requirement for responsible waste disposal approaches including controlled incineration protocols and autoclaving procedures to reduce these dangerous risks. Modern cost-effective waste management technologies together with ecological features present an opportunity to create substantial reductions in

healthcare facilities' environmental consequences particularly in relatively impoverished locations[36]. This research demonstrates the vital necessity for healthcare worker education about full-scale consequences resulting from inadequate waste disposal methods. Research findings show that urban healthcare workers had better environmental awareness yet rural staff revealed weak knowledge about risks that calls for specialized educational approaches. Educational programs should teach healthcare providers about the public health along with environmental damage that accrues from bad waste management practices while instilling enthusiasm for sustainable practice methods.

This research supports many other hospital waste management studies yet reveals new details regarding Pakistan's specific management hurdles. Similar findings exist between Pakistan's KAP result data and comparable research from India and Egypt which documented how population discrepancies between rural and urban healthcare professionals impede waste management in remote locations[37]. This investigation demonstrates how weak supervision and specific Pakistani cultural attitudes represent distinctive obstacles facing healthcare workers while previous studies devoted less attention to these challenges. Urban hospital workers surprisingly frequently described time limitations as an operational barrier while participating in this study. This study diverges from conventional research by showing that operational dysfunction causes waste management failures regardless of resource availabilities in urban centers. Future studies need to examine workforce levels and volumetric demands on staff performance with waste disposal protocols throughout urban hospitals.

The research adds value by evaluating how well training programs fulfill their objectives. This study brings fresh information about healthcare workers' evaluations of training adequacy alongside examinations of training frequencies in other research works. Research findings show the critical need to improve both training frequency and content quality for healthcare staff since only 52% of rural hospital personnel find their education sufficient. This research contributes essential insights about waste management standards between hospitals in cities and countryside areas yet reveals new research opportunities for exploration. Research needs to examine how training programs affect workers' ongoing compliance with waste management procedures over extensive periods of time. Longitudinal research would help explain the progression of knowledge and practices with time while creating mechanisms for supporting ongoing beneficial developments.

The investigation of cultural and social factors which affect attitudes toward waste management presents a direction for upcoming research. Diverse cultural norms together with collective social perceptions which affect compliance should guide the creation of culturally appropriative strategies that prove more effective. Data-driven studies of waste management solution costs will help healthcare facilities select high-impact methods which maximize resource utilization. The role of technology in waste management should be investigated to develop better waste management practices of the future. Mobile applications aimed at waste monitoring can improve both accountability and compliance levels especially in rural environments the study suggests. Research into the practical applications and effects of technological solutions will generate novel answers for overcoming study-defined difficulties.

CONCLUSIONS

This investigation sought to measure healthcare staff understanding along with behaviors and opinions about hospital waste management within both metropolitan and remote facilities as it assessed the discrepancies and practical solutions moving forward. This data emphasis the broad knowledge shortages alongside noncompliance problems and shortages of methods among rural healthcare facilities. Healthcare staff operating in urban areas demonstrated increased understanding and positive disposal mindset with superior waste management procedures due to their better training opportunities and facility resources. The rural healthcare workforce faced multiple structural obstacles from inadequate facilities and insufficient teaching and insufficient monitoring procedures resulting in diminished capacity to implement approved protocols.

They studied what their main goals were to identify crucial inequities alongside execution hurdles between urban facilities' enhanced waste management training together with their bigger budgeting freedom. The research exposed problems within urban waste management programs because operational systems need

improvement along with sufficient timeliness requirements. Research findings demonstrate clear evidence that effective interventions must be developed to address distinct obstacles across both rural and urban territories. The study contains restrictions due to its small participant numbers and based its information collection from respondents who could introduce misunderstanding to the results. These methodological boundaries permit researchers to obtain useful knowledge about hospital waste management operations in Pakistan for additional scientific investigations and policymaking initiatives. The validity of these findings could strengthen through ongoing longitudinal research combined with extensive geographical sample collection. The study presents evidence showing why balanced funding distribution combined with consistent staff education programs and rigorous monitoring frameworks are essential for hospital waste management performance enhancement. Healthcare facilities can reach higher compliance rates while protecting public health together with environmental standards by fixing previously identified disparities and systemic barriers. This investigation makes an essential contribution toward achieving sustainable healthcare systems with effective performance.

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