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Perceptions of Healthcare Workers Towards Biospecimen Donation and Biobank Governance in Pakistan: A Cross-Sectional Study

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Research Article

Keywords: Biobanking, Biospecimen Donation, Healthcare Workers, Biobanking Governance, Ethical Perceptions, Religious Alignment

Posted Date: September 4th, 2026

DOI: https://doi.org/10.21203/rs.3.rs-10706033/v1

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Additional Declarations: No competing interests reported.

Title:

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Running Title:

Healthcare Workers' Perceptions on Biobanking

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Acknowledgments:

None

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Authors' disclosure statement:

All the authors have read and approved the final manuscript. The authors declare that they have no conflicts of interest.

Funding statement:

This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

Data Access Statement:

The datasets generated and analyzed during the current study are not publicly available because of participant confidentiality. Nevertheless, de-identified data can be obtained from the corresponding author upon reasonable request.

Ethical Approval Statement:

This study received ethical approval from the Institutional Review Board of King Edward Medical University, Lahore, Pakistan (Reference: **197/RC/KEMU**, 08 June 2023). The study was conducted in accordance with the ethical principles outlined in the Declaration of Helsinki. All participants provided written informed consent, and consent documentation has been archived by the authors.

Abstract:

Introduction

Advancements in biomedical research require biobanks for specimen storage, aiding disease prevention and treatment. Nonetheless, biobanks face ethical, legal, and social challenges, particularly in low- and middle-income countries. Because healthcare workers (HCWs) serve as critical facilitators and advocates of biobanking, understanding their perspectives is essential. This study examines healthcare workers' (HCWs) perspectives on biobanking to facilitate the development of sustainable and culturally sensitive biobank governance.

Methods

This cross-sectional study was conducted among HCWs in Pakistan using a pre-structured questionnaire. It assessed socio-demographic factors, prior knowledge of biobanking, and perceptions and attitudes towards biobanking. Data analyses were conducted using IBM SPSS Statistics version 26.

Results

This study of 249 HCWs in Pakistan highlights limited awareness (36.9%) but positive attitudes towards biobanking, with 82.3% and 77.9% acknowledging its importance in research and diagnostics, respectively. The key findings revealed strong support for transparent sample distribution policies (69.9%) and secure data storage practices (77.9%). However, we noted uncertainties regarding religious alignment (48.9%) and willingness to donate (42.9%). Prior knowledge of biobanking was significantly associated with younger age ($p=0.045$), female sex ($p=0.034$), and physician status among healthcare workers ($p=0.007$).

Conclusion

Pakistani HCWs demonstrate favorable attitudes towards biobanking despite critical gaps in baseline awareness, religious alignment, and willingness to donate samples. Developing robust national biobank policies in Pakistan requires targeted educational strategies, explicit religious engagement, and transparent governance to build trust and ensure long-term engagement.

Keywords:

Biobanking, Biospecimen Donation, Healthcare Workers, Biobanking Governance, Ethical Perceptions, Religious Alignment

Introduction:

Advances in biomedical research have necessitated the establishment of biobanks, which are biorepositories that collect and store biological specimens (e.g., tissue, blood, urine, and sputum) for scientific investigation (Amin et al. 2018; Braun et al. 2014). These valuable research platforms enable investigators to establish clinical correlations, ultimately leading to better disease prevention and treatment through early detection and personalized therapeutic regimens (Abdelhafiz et al. 2021; Master et al. 2013).

Biorepositories exist in various forms, ranging from small early collections of specimens for specific research projects (Braun et al. 2014) to large institutional and population-based biobanks (De Souza and Greenspan 2013). Given their importance, biobanks have been established across the United States, the United Kingdom, Australia, most European countries, and China (De Souza and Greenspan 2013; He et al. 2017). Since 2019, Shaukat Khanum Memorial Cancer Hospital and Research Centre, one of the largest cancer centers in Pakistan, has also established a biobanking facility (Asghar and Loya 2022).

Despite the benefits, ethical, legal, and social issues (ELSI) of biobanking are among the most controversial topics in bioethics and public health debates (Widdows and Cordell 2011). Key challenges include uncertainty related to privacy and confidentiality (due to policy-related issues of biobanks such as informed consent, access to medical records to establish correlations, and specimen ownership, control, and usage) (Turon et al. 2016), withdrawal of samples (Elger et al. n.d.), commercialization and research governance (Master et al. 2013), and incidental findings and return of research (Wolf et al. 2008). Addressing these issues requires context-specific strategies and stakeholder input (participants/donors, physicians, researchers, research organizations, funders, and ethics committees) to formulate balanced local guidelines (Abdelhafiz et al. 2021).

Prior studies have examined the opinions of different stakeholders regarding biobanking. A survey conducted on a cancer population in Canada concluded that the majority of patients preferred one-time consent, expressed willingness to have the right to withdraw their consent, desired to be informed of incidental health findings, and preferred publicly funded researchers as opposed to profit-based institutions (Master et al. 2013). A similar study conducted in China indicated that factors such as age, gender, first hospitalization, and education level influence willingness to donate biospecimens for research purposes (He et al. 2017). A study conducted in Egypt investigated the knowledge, opinions, and attitudes of physicians towards biobanking issues and revealed limited biobank awareness among physicians, along with concerns regarding consent and commercialization (Abdelhafiz et al. 2021).

However, much of the existing biobanking literature heavily emphasizes donor and patient perspectives, leaving a significant gap regarding the views of healthcare workers (HCWs). HCWs play an indispensable role in the biobanking ecosystem, serving as primary recruiters and trusted intermediaries who address patient concerns, facilitate informed consent, and collect samples, while simultaneously being potential donors themselves. Public and patient trust in biomedical research is heavily mediated by healthcare providers (Persaud and Bonham 2018); thus, HCWs' baseline knowledge, concerns, and personal willingness to donate directly influence recruitment rates, consent quality, and the overall sustainability of biorepositories (Usta et al. 2025). Despite their pivotal influence, research assessing HCW attitudes remains scarce internationally, with limited data from regions like Egypt (Abdelhafiz et al. 2021). To the best of our knowledge, this is the first study conducted in Pakistan to survey the knowledge and attitudes of various healthcare workers regarding biobanking and its challenges.

The primary objective of this research project was to explore the knowledge, ethical perceptions, consent attitudes, and willingness towards biobanking among healthcare professionals in Pakistan. Understanding these perspectives is crucial for developing local context-specific policies and guidelines to support the development of biobanking.

Materials and Methods:

Study Design and Participants:

This nationwide cross-sectional study surveyed various HCWs in Pakistan, including physicians, paramedics, histopathologists, and medical students, in both public and private settings. The participants were recruited using purposive convenience sampling. The inclusion criteria were HCWs (physicians, nurses, histopathologists, and paramedical staff) and medical students in their clinical years (third year onwards) affiliated with healthcare institutions in Pakistan and able to understand English. Non-healthcare personnel lacking direct patient interaction (e.g., administrative staff) were excluded.

Sample Size:

Sample size was determined using the single population proportion formula (95% confidence level and a 5% margin of error). Due to the lack of nationally representative estimates on perceptions of biobanking across HCWs in Pakistan, a proportion of 79.9% was adopted from a previously published study conducted among physicians (Ahsan et al. 2021). A sample size of 247 participants was calculated using the Open Epi Online Sample Size calculator. As the study achieved a complete response rate, no adjustment for non-response was applied. A total of 249 participants were included in the final analysis.

Study Tool:

A pre-structured questionnaire adapted from Abdelhafiz et al. (2021) was utilized. The questionnaire was preceded by a brief introduction to biobanks to ensure a basic level of understanding and included three major sections: sociodemographic information, participants' prior knowledge of biobanking, and perceptions and attitudes towards biobanking, which was further divided into three parts:

1. Perceptions Regarding Privacy, Sharing, and Access Issues of Samples
2. Perceptions Regarding Governance of Biobanks
3. Perceptions Regarding Consent and Participants' Rights

Items were evaluated using a 5-point Likert scale (1 = Strongly Disagree to 5 = Strongly Agree).

Data Collection:

Data were collected electronically between June and September 2024 via a self-administered questionnaire. The survey link was disseminated through multiple professional channels, including institutional mailing lists where accessible, as well as healthcare-related WhatsApp groups and professional networking platforms such as LinkedIn. These channels included healthcare workers from various tertiary care hospitals across the country. As the survey was distributed via open electronic platforms and relied on secondary sharing among professional networks, the exact sampling frame could

not be defined, and the number of contacted institutions and institution-specific response rates could not be calculated. This is acknowledged as a limitation of the study.

Statistical Analysis:

IBM Statistical Package for Social Sciences (SPSS v.26) was used for data analysis. Categorical variables were reported as numbers and percentages, while quantitative continuous variables were reported as means and standard deviations (SD). The chi-square test or Fisher's exact test (expected count < 5) was used to test the associations between qualitative variables. Statistical significance was set at $p < 0.05$.

Ethical Considerations:

Ethical approval was obtained from the Institutional Review Board of King Edward Medical University, Lahore, Pakistan, before data collection. The participants were informed of the purpose of this study, and their consent was obtained before completing the questionnaire. Anonymity and confidentiality were also ensured. No unnecessary information was requested or shared for any purpose outside of the study domain.

Results:

The questionnaire was completed and submitted by 249 healthcare workers. Approximately 41.8% were from medical universities, 53.8% from tertiary care hospitals, and 4.4% from laboratories. The demographic characteristics of the respondents are summarized in **Table 1.**

The responses of the healthcare workers to the ‘basic knowledge’ items are presented in **Table 2**. More than one-third (36.9%) of healthcare workers had heard the term "biobanking" before, while **30.1%** were aware of the existence of biobanks in Pakistan.

Table 3 summarizes participants’ general attitudes towards biobanking. The majority of the participants’ responses indicated a positive attitude towards biobanking. It's noteworthy that healthcare workers showed the highest level of agreement in response to the following statements: ‘I think biobanks can make a difference in biomedical research in general’ **(82.3%)**, ‘I think that the presence of biobanks is important for the development of new treatments’ **(81.5%)**, ‘I would like more information about biobanks to be more readily available’ **(81.1%)** And ‘I think that the presence of biobanks is important for the development of new methods of diagnosis’ **(77.9%)**. The following statement depicted the highest level of uncertainty among healthcare workers: ‘Donating samples for research is in line with religious beliefs.’ **(49%)**, ‘I will donate samples myself and will ask my relatives to donate samples to the biobank.’ **(43%)**, ‘In the future, I will be interested in applying to get samples for my research from the biobank.’ **(32%)** and ‘I would be willing to help create a biobank in my institute’ **(30.9%).**

Table 4 presents participants’ responses regarding privacy, sharing, and access. The highest level of agreement is shown with the following statements: ‘I believe that clinically relevant incidental findings discovered during research should be returned to the participant’s treating physician’ **(67.5%)**, ‘I believe it is acceptable for biobanks to share confidential medical information with legal authorities if requested’ **(61.0%),** and ‘I believe it is acceptable for biobanks to share samples and data with international research organizations’ **(53.0%)**. Low agreement was observed with: ‘I believe it is acceptable for biobanks to provide medical information to insurance companies’ **(35.3%)** and ‘I believe it is acceptable for biobanks to share samples and data with commercial or pharmaceutical companies’**(46.6%)**. While responses to the

statement "I am concerned that my identity could be revealed through my DNA if I donate samples to a biobank" were nearly evenly distributed: **32.9%** disagreed, **36.6%** remained neutral, and **30.5%** agreed.

Responses to the governance issues are shown in **Table 5**. Out of five statements in the survey, the healthcare workers showed the highest level of agreement with the statement 'I believe that a transparent policy for distributing samples to researchers should exist.' **(69.9%).** On the other hand, the statement asserting that 'I believe it is acceptable for biobanks to charge user fees for samples provided to researchers' received the lowest agreement among the respondents **(30.1%)**. **37%** and **39.4%** of the 294 participants also agreed with: 'I believe that individuals who donate biological samples for research should retain control over their samples' and 'I believe that biobanks own the stored samples', respectively. While **48.6%** agreed with the statement, 'I believe that biobanks act as custodians of samples, not owners.'

Regarding consent and participants' rights, most responses showed a general level of agreement among the participants, as shown in **Table 6**. The following survey items showed the highest level of agreement: 'I believe that sample donors should be informed in detail how their samples will be used' **(79.5%)**, 'I believe that participant information and samples stored in the biobank should be protected and securely stored.' **(77.9%)**, 'I believe that sample donors should be informed if their samples will be transferred abroad**'**, 'I believe that sample donors should be compensated by some means for their samples' **(60.6%).** Lowest agreement was observed with: 'I believe that a broad consent that does not include every future research is more suitable for biobank work' **(47.0%).**

Prior Knowledge of the term 'biobank' was strongly associated with age (p=0.045), gender (p=0.034), and healthcare worker status (p=0.007), with those aged 20-29, females, and physicians among the healthcare workers showing greater alignment. 'There is a biobank in my institute' is associated with gender (p=0.048), with significant concurrence in females, and type of healthcare worker (p=0.048), with a greater proportion of physicians agreeing to it. 'There are several biobanks in Pakistan' (p=0.005), 'I think biobanks can make a difference in aspects related to the quality of samples and data provided for research' (p=0.003), 'There is a law that governs biobanks in Pakistan'(p=0.00), 'In the future, I will be interested in applying to get samples for my research from the biobank'(p=0.016), 'If there is a biobank in my institution, I will inform my patients about it'(p=0.022) and 'I believe that participant information and samples stored in the biobank should be protected and securely stored' (p=0.001) is associated with gender, where females show greater alignment with the statements mentioned above. 'I think that the presence of biobanks is important for the development of new methods of diagnosis' is strongly associated with age (p=0.026), with great concurrence amongst individuals aged 20-29 years, and gender (p=0.029), with females showing greater alignment. 'If there is a course/lecture/conference about bio-banking, I will be interested in attending' is associated with age (p=0.016), shown by greater alignment of individuals aged 20-29 years, and type of health care worker (p=0.006), with greater concurrence in physicians. 'I believe that it is acceptable for biobanks to share samples and data with international research organizations' (p=0.001), 'I believe that sample donors should be informed in detail about how their samples will be used' (p=0.00), and 'I believe that clinically relevant incidental findings discovered during research should be returned to the participant's treating physician' (p=0.048) have shown greater alignment amongst the physicians. 'Donating samples for research is in line with religious beliefs' and 'I believe that biobanks own the stored samples' have shown more agreement among females (p=0.008) (p=0.035) and type of healthcare worker (p=0.003) (p=0.007), with greater alignment shown in physicians. The details of these associations are provided in the Supplementary Data.

Discussion:

This study sought to investigate Healthcare Professionals' (HCPs) knowledge, perceptions, and concerns regarding biospecimen donation and biobank governance in Pakistan. A prominent finding was the general lack of awareness about biobanking among HCPs. A comparison with a study exploring the public's perspective in Pakistan and India showed similar results, with a limited understanding of the concepts of biobanking (Jafarey et al. 2017). In contrast, a two-tier study conducted on a similar demographic in Egypt reported significantly greater awareness among physicians than among patients (Abdelhafiz et al. 2021). This can be attributed to the limited emphasis on biobanking research in Pakistan during medical education and training, as well as the lack of institutional support and research funding (Mahmood et al. 2025; Farooq et al. 2024; Shabbir et al. 2025).

Additionally, approximately two-thirds of participants were unaware of the existence of biobanks in Pakistan. This highlights the absence of well-known biobanks in the country and, consequently, less exposure among the primary stakeholders of biospecimen donation (Ahsan et al. 2021; Farooq et al. 2024). Knowledge of biobanking was significantly associated with younger age (20-29 years), female gender, and physician respondents. Similar associations were also reported in a study conducted in Eastern Morocco (Lhousni et al. 2019). The significant association with the female gender can be explained by the greater proportion of females in our sample (58% vs 42% males). Physicians are generally more engaged in clinical research than nurses and allied health professionals, which might explain their familiarity with biobanking (Vergara-Mejía et al. 2022; Lee et al. 2020). Greater awareness of biobanking among physicians in Pakistan was also noted in a survey conducted among 473 Pakistani physicians, which reported that over 70% had heard of "biobanking," indicating moderate baseline awareness (Ahsan et al. 2021). Comparison with our results highlights a potential knowledge gap among other healthcare professionals (medical students, nurses, allied health professionals), addressing which is essential for biobanking promotion in this region.

Despite their limited awareness, the participants showed a positive perception of biobanking, acknowledging its importance in research and diagnostics. Broadly favorable attitudes toward biobanking, irrespective of baseline knowledge, have also been reported across HCPs in Eastern Morocco, Saudi Arabia, Egypt, Canada, and Australia, ranging from willingness to recruit patients into biobanks to incorporating biobanking into their clinical workflow (Abdelhafiz et al. 2021; Lhousni et al. 2019; Buhmeida et al. 2022; Usta et al. 2025; Caixeiro et al. 2016). Despite their positive attitudes, we noted uncertainty in their willingness to donate samples (only 43% were willing). This hesitation is consistent with studies conducted on HCPs in Saudi Arabia and Egypt and can be attributed to inadequate awareness or concerns about misuse and confidentiality (Abdelhafiz et al. 2021; Buhmeida et al. 2022).

One of the key factors in willingness, religious concerns, was assessed, with 49% of participants being unsure whether sample donation aligned with their religious beliefs. Similar concerns have been reported in studies from other Muslim-majority settings (Amin et al. 2018; Buhmeida et al. 2022), although findings remain inconsistent, with a difference of opinion seen in Egypt, Qatar, and Nigeria, where participants regarded sample donation as a charitable act according to Islamic principles (Abdelhafiz et al. 2021; Caixeiro et al. 2016; Igbe and Adebamowo 2012). However, religious uncertainties among Pakistani doctors have previously been reported as a barrier to biobanking (Ahsan et al. 2021). In our study, religious concerns were significantly associated with female gender and physician respondents. This association is likely due to their dominance in sample size, as no other report of such associations could be seen in the literature. Overall, these concerns indicate uncertainty among participants regarding whether sample donation for research is in line with Islamic principles. In countries where religious

considerations strongly influence health behaviors (Anwar et al. 2012; Zimmer et al. 2019), explicit engagement with religious scholars and integration of a religiously sensitive consent language may contribute to building trust. Studies in the Middle Eastern and other Muslim-majority settings support this and indicate that perceived religious approval positively influences willingness to donate biospecimens (Makhlouf et al. 2019).

Trust is foundational to biobanks' participation (Thompson et al. 2025). Trust in this initiative can be fostered by addressing the privacy and confidentiality issues. In our demographic, the majority of HCPs favored returning incidental findings to the treating physician. This is protective against many harms of research return (directly to donating patients), such as the usefulness of the findings, psychological distress, and the added financial burden on the healthcare system and patients, as reported in Husedzinovic et al. 2015, Downing et al. 2013, and Vaz et al. 2018. Although healthcare professionals favor research returns, the practicality of reporting incidental findings needs to be explored in future studies, especially considering resource constraints, financial requirements, and the need to define the criteria for disclosure (Husedzinovic et al. 2015).

Another ethical dilemma is the international transfer of biospecimens or data, raising concerns about confidentiality breaches, misuse of samples, and authorship claims on the generated research (Widdows and Cordell 2011). However, the majority of respondents (53%) favored sharing, suggesting that the benefits of data transfer outweighed the risks in the views of our participants. Opinions regarding genetic privacy were highly fragmented; only 32.9% of HCPs felt confident that re-identification was not a major concern, while the vast majority were either uncertain (36.6%) or explicitly concerned (30.5%). This hesitation highlights their inadequate awareness regarding biobank security measures, likely driven by the limited public discourse on genetic privacy in Pakistan and the absence of comprehensive data protection frameworks such as the General Data Protection Regulation GDPR (Europe) or the Health Insurance Portability and Accountability Act HIPAA (USA) (Khan 2024; Asad and Irfan 2025).

Nonetheless, the participants demonstrated low agreement with commercialization or data sharing with pharmaceutical or insurance companies; however, the reasons underlying this perception were not explored in this study. While commercialization ensures the biobank's financial sustainability (Walshe et al. 2024), the participants could consider it an opposition to the altruistic nature of sample donation (Huang et al. 2025). Such views are supported by other studies where similar distrust in for-profit organizations has been reported (Domaradzki et al. 2024). However, such concerns need to be addressed by promoting awareness of the benefits of commercialization, such as using profits to support future research or equitably distributing profits to donors and research organizations. Moreover, transparent governance frameworks that articulate clear benefit-sharing mechanisms are crucial for mitigating ethical concerns surrounding the commercial exploitation of biosamples, particularly in low- and middle-income country contexts where asymmetric power dynamics in international collaborations are prevalent (Abdelhafiz et al. 2021; Singh and Moodley 2021). Overall, balancing financial constraints with research needs is essential to successful biobanking initiatives.

The HCPs' opinions also highlight potential misconceptions regarding biobanking governance. Approximately 40% believed that biobanks should own the stored samples, but the majority expressed that custodianship would best describe the role of biobanks. Studies carried out on the general public and professionals have similar views (Verlinden et al. 2016; Langhof et al. 2018), which have led to the implementation of stewardship-based models in US biobanks (where the biobank operators act as stewards, not owners, of biological samples, ensuring their ethical use while safeguarding the rights of donors) (Henderson et al. 2013). However, a deeper understanding of these perceptions is needed to evaluate whether they impact the willingness to donate.

Additionally, we found that 37% of the participants believed that patients should retain control over their samples, reflecting their limited understanding of the biobanking process, where contributors or donors have almost no control over biobanking practices, as this would hinder the practice of research and possibly give rise to ethical issues regarding the commodification of the human body (Widdows and Cordell 2011).

Consent remains a central ethical dilemma in biobanking (Widdows and Cordell 2011). Due to the unpredictability of future research, broad consent (allowing unspecified future use) is often preferred by biobanks (Mikkelsen et al. 2019). However, our participants were more inclined towards an informed consent model (where participants choose the types of research they agree to). Different countries have adopted various approaches to biobanking consent, with a broad consent model and ongoing ethical oversight by Institutional Review Boards (IRBs) dominating in the USA, the European Union, and the UK (Kaye et al. 2016).

In Pakistan, the ethical framework for biobanking consent has been evolving. The guidelines developed by the National Bioethics Committee (NBC) in 2020 emphasize the process of informed consent, ensuring that participants understand how their biological materials might be utilized in research (Jafarey et al. 2023). A pilot study conducted in Karachi on medical and non-medical students also reported that the majority were against broad consent, with concerns about misuse and exploitation (Jafarey et al. 2017). However, this raises the important issue that participants' lack of literacy may hinder their complete understanding of the concept (Luthuli et al. 2022), making the process of informed consent merely procedural and potentially ineffective. Thus, there is a need to enhance the public understanding of biobanking and its implications to ensure truly informed consent (Kasperbauer et al. 2021).

Another perspective of HCPs came to light in this survey regarding financial compensation for the donors, with 60.6% being in favor. This has the benefit of encouraging participation (Acharya et al. 2017), and it becomes a significant ethical concern if the samples are used for profit-generating research (Allen et al. 2018). However, the sustainability risks faced by biobanks already mandate dedicated funding streams (Campos et al. 2015), making financial compensation an unnecessary and impractical burden. Overall, this belief underscores the need to educate HCPs in this demographic on biobanking governance issues.

In general, the HCPs in this study supported biobanking and recognized its importance in advancing medical research. However, their limited awareness of biobanking, concerns about participation, and insufficient understanding of the ethical/governance concerns can slow down its adaptation and progress. Targeted educational initiatives could address this knowledge gap. We recommend using structured courses, workshops, and e-learning platforms to promote awareness among HCPs, and counselling sessions or discussions to address their concerns, similar to the “biobank clinic initiative,” which was successful at Shaukat Khanum Memorial Cancer Hospital and Research Centre, Pakistan, in enhancing patient participation in biobanking (Asghar and Loya 2022). Furthermore, integrating biobanking into undergraduate and postgraduate medical education, through blended learning (online + on-site visits to biobanks) to expose students to different biobank types and international practice, technical learning of all activities and duties of biobanks, sample types, pre-analytical handling, storage, cryobiology, multi-omics research, data management and data sharing protocols, with an emphasis on the role of biobanks in diagnostics, therapeutics, precision medicine, and research design, can improve future healthcare professionals' (HCPs') understanding of biobanking (Kinkorová 2021; Seidler et al. 2022). Another aspect of successful biobanking integration into clinical practice is training healthcare providers to act as liaisons between biobanks and participants, clarifying patient misconceptions and providing effective communication and counselling.

A notable contribution of our study is the identification of religious alignment and donation willingness as areas of uncertainty. To address this, biobank outreach programs in Pakistan should consider consultations with religious scholars to clarify permissibility and address donors' concerns. The addition of a clause on religious permissibility to consent forms can mitigate this concern for HCPs and donors. From an operational perspective, uncertainties regarding the commercialization and ownership of biospecimens require urgent policy clarification. Developing national guidelines that address these issues is essential as it will help standardize practice across institutions in Pakistan, avoiding fragmentation and ensuring international compatibility. This study also highlights the need to reach a consensus on the issue of informed consent to allow the development of a national ethical framework for the regulation of biobanks in Pakistan. Drawing on experiences from Sub-Saharan Africa and the Arab region (Ibrahim et al. 2024; Mohammadzadeh et al. 2025), where researchers have emphasized that stronger regulatory protection and ethical guidance are essential to building stakeholder confidence, Pakistan also needs to strengthen its oversight and data protection practices.

A significant limitation of our study is its cross-sectional design, which restricts us from evaluating the impact of HCPs' perspectives on their participation in biobanking. Furthermore, the use of a physician-derived proportion for sample size estimation may limit the representativeness of the calculated sample for other healthcare professional groups, given potential variability in awareness and perceptions across disciplines. The findings of this study cannot be generalized to healthcare professionals in the rural areas of Pakistan, where differences in infrastructure and professional exposure could also mould perspectives. Future studies should adopt a structured sampling framework with defined institutional participation and response tracking to improve representativeness and methodological rigor.

To our knowledge, this is one of the first studies in Pakistan to systematically assess healthcare professionals' perceptions of biobanking across multiple professional groups. Unlike prior studies that have focused on single groups, our study captures a broader range of perspectives within the healthcare system. Additionally, beyond demonstrating general attitudes, our findings identify specific areas of uncertainty, including religious alignment, willingness to donate, and opinions on governance and consent frameworks. These insights provide more nuanced and actionable information for the development of appropriate biobank policies and educational interventions. These findings are particularly relevant for informing emerging national biobanking initiatives in Pakistan. It provides foundational data that can be used to bridge the gap between developing research institutions and HCPs in this region. Finally, it can directly act as a framework for future research on biobanking carried out in this demographic.

Conclusion:

This study emphasizes Pakistani healthcare workers' lack of knowledge and favorable attitudes towards biobanking. However, uncertainties surrounding religious alignment, commercialization, and willingness to donate samples need to be addressed. This requires a multi-step strategy of education, religious engagement, and transparent governance frameworks through national policy development. Future longitudinal and intervention-based research is needed to assess patient perspectives and to determine whether integrating biobanking content into medical curricula and engaging with religious scholars leads to measurable improvements in awareness, willingness to donate, and trust over time.

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Tables:

Table 1: Basic Demographic characteristics of the respondents.

Basic Demographic Characteristics	Frequency
Age	
<20 years	**26 (10.44)**
20-29 years	**141 (56.62)**
>30 years	**82 (32.93)**
Total	**249 (100.0)**
Gender	
Male	**104 (41.8)**
Female	**145 (58.2)**
Total	**249 (100.0)**
Type of healthcare worker	
Medical student	**104 (41.8)**
Physician	**106 (42.6)**
Histopathologist	**11 (4.4)**
Paramedical staff	**28 (11.2)**
Total	**249 (100.0)**
Name of Institution	
Medical School	**104 (41.8)**
Hospital	**134 (53.8)**

Lab	**11 (4.4)**
Total	**249 (100.0)**

Table 2. Basic knowledge about biobanking among the respondents (n=249)

Knowledge item	Level of Agreement		
	Disagree	Unsure	Agree
	N (%)	**N (%)**	**N (%)**
I have heard the term "Biobanking" before.	122 (49)	35 (14.1)	**92 (36.9)**
There is a biobank in my institute.	77 (30.9)	119 (47.8)	53 (21.3)
There are several biobanks in Pakistan.	48 (19.3)	126 (50.6)	**75 (30.1)**
There is a law that governs biobank work in Pakistan.	47 (18.9)	149 (59.8)	53 (21.3)

Table 3. Level of agreement of the respondents with the survey items regarding general attitudes towards bio-banking (n =249).

Survey items	Level of Agreement		
	Disagree	**Unsure**	**Agree**
	N (%)	N (%)	N (%)
I think that the presence of biobanks is important for the development of **new treatments.**	16 (6.43)	30 (12.05)	**203 (81.52)**
I think that the presence of biobanks is important for the development of new methods of diagnosis.	15 (6.0)	40 (16.1)	**194 (77.9)**
I think biobanks can make a difference in **biomedical research** in general.	9 (3.6)	35 (14.1)	**205 (82.3)**

I think biobanks can make a difference in aspects related to the quality of samples and data provided for research.	15 (6.0)	46 (18.5)	188 (75.5)
In the future, I will be interested in applying to get samples for my research from the biobank.	23 (9)	**80 (32)**	146 (59)
I would like to help create a biobank in my institute.	18 (7.23)	**77 (30.92)**	154 (61.85)
I will **donate samples** myself and ask my relatives to do the same to the biobank.	31 (12.4)	**107 (43)**	111 (44.6)
If there is a biobank in my institution, I will inform my patients about it.	19 (7.6)	39 (15.7)	191 (76.7)
I would like more information about biobanks to be more readily available.	12 (4.8)	35 (14.1)	**202 (81.1)**
If there is a course/ lecture/conference about Biobanking, I will be interested in attending.	21 (8.4)	46 (18.5)	182 (73.1)
Donating samples for research is in line with **religious beliefs.**	29 (11.6)	**122 (49)**	98 (39.4)

Table 4. Level of agreement of the respondents to the survey items regarding privacy, sharing, and access issues (n=249)

Survey items	**Level of Agreement**		
	Disagree	Unsure	Agree
	N (*%*)	N(**%**)	N (**%**)
I believe it is acceptable for biobanks to share samples and data with international research organizations.	49 (19.7)	68 (27.3)	**132 (53.0)**
I believe it is acceptable for biobanks to share samples and data with commercial or pharmaceutical companies.	54 (21.7)	79 (31.7)	**116 (46.6)**
I believe it is acceptable for biobanks to provide medical information to insurance companies.	62 (24.9)	99 (39.8)	**88 (35.3)**
I believe that clinically relevant incidental findings discovered during research should be returned to the participant's treating physician.	24 (9.6)	57 (22.9)	**168 (67.5)**
I believe it is acceptable for biobanks to share medical information with government agencies.	42 (16.9)	74 (29.7)	133 (53.4)
I believe it is acceptable for biobanks to share confidential medical information with legal authorities if requested.	33 (13.3)	64 (25.7)	**152 (61.0)**
I am concerned that my identity could be revealed through my DNA if I donate samples to a biobank.	**82 (32.9)**	91 (36.6)	76 (30.5)

Table 5. Level of agreement of the respondents with the survey items regarding governance (n = 249).

Survey items	Level of Agreement		
	Disagree	Unsure	Agree
	N (%)	N **(%)**	N **(%)**
I believe that individuals who donate biological samples for research should retain control over their samples.	60 (24.1)	97 (38.9)	**92 (37)**
I believe that biobanks own the stored samples.	63 (25.3)	88 (35.3)	**98 (39.4)**
I believe that biobanks act as custodians of samples, not owners.	34 (13.6)	94 (37.8)	**121 (48.6)**
I believe it is acceptable for biobanks to charge user fees for samples provided to researchers.	61 (24.5)	113 (45.4)	**75 (30.1)**
I believe that a transparent policy for distributing samples to researchers should exist.	18 (7.2)	57 (22.9)	**174 (69.9)**

Table 6. Level of agreement of the respondents with the survey items regarding consent and participants' rights (n = 249).

Survey items	Level of Agreement		
	Disagree	**Unsure**	**Agree**
	N (%)	N (%)	N (%)
1. I believe that a broad consent that does not include every future research is more suitable for biobank work.	55 (22.1)	77 (30.9)	**117 (47.0)**
2. I believe that participant information and samples stored in the biobank should be protected and securely stored.	15 (6.0)	40 (16.1)	**194 (77.9)**
3. I believe that sample donors should be compensated by some means for their samples.	37 (14.9)	61 (24.5)	**151 (60.6)**
4. I believe that sample donors should be informed in detail about how their samples will be used.	19 (7.6)	32 (12.9)	**198 (79.5)**
5. I believe that sample donors should be informed if their samples will be transferred abroad.	16 (6.4)	38 (15.3)	**195 (78.3)**

Supplementary Files

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