

**BIOBANKING IN SLOVAKIA: A GATEWAY TO RESEARCH
AND PUBLIC HEALTH ADVANCEMENTS**
**BIOBANKOVANIE NA SLOVENSKU: BRÁNA K VÝSKUMU A POKROKOM
V OBLASTI VEREJNÉHO ZDRAVIA**

KOTOROVÁ SLUŠNÁ Ľubica

*Centrum spoločenských a psychologických vied, Slovenská akadémia vied, Bratislava,
Slovenská republika*

ABSTRACT

Background: Biobanks are essential for biomedical research, supporting areas like genomics, cancer studies, and personalized medicine. However, assessing their socio-economic impact remains challenging due to limited data and the complexity of biobank models. Slovakia's biobanking infrastructure is underdeveloped compared to other EU countries, but recent progress has been made with the establishment of The Biobank for Cancer and Rare Diseases in Martin.

Aims: This study aims to evaluate the need for a national biobank in Slovakia and its potential benefits, focusing on sample accessibility, research collaboration, and public health.

Methods: The study employed a two-phase approach: qualitative interviews with key biobanking stakeholders followed by a quantitative survey of 24 researchers, clinicians, and laboratory personnel. Respondents provided insights into sample access challenges and the perceived benefits of a national biobank.

Results: Respondents reported difficulties in accessing adequate biological samples, with 43 % facing moderate challenges in obtaining sufficient samples and 40 % encountering quality issues. Nearly 77 % reported limiting their research due to sample shortages. However, 86 % of respondents viewed access to a national biobank as crucial for improving research efficiency, collaboration, and clinical trial participation.

Conclusion: A national biobank in Slovakia, adhering to international standards, could significantly enhance research capacity, collaboration, and public health outcomes. Success will depend on stakeholder collaboration, sustained public funding, active researcher interest, efficient management, supportive legislation, and addressing medical personnel capacity. However, a limitation of this study is its small sample size and the limited involvement of the private sector, which may affect the generalizability of the findings, highlighting the need for broader representation in future research.

Key words: Biobank. Biological samples. Public health. Benefits. Research

ABSTRAKT

Východiská: Biobanky zohrávajú kľúčovú úlohu v biomedicínskom výskume a podporujú oblasti ako genomika, onkologický výskum a personalizovaná medicína. Avšak hodnotenie ich sociálno-ekonomického dopadu zostáva výzvou, a to predovšetkým kvôli nedostatku údajov a zložitosti biobankových modelov. Biobanková infraštruktúra na Slovensku je v porovnaní s inými krajinami EÚ málo rozvinutá, k pokroku došlo iba nedávno, a to v podobe vzniku Biobanky pre nádorové a zriedkavé ochorenia v Martine.

Ciele: Cieľom tejto štúdie je posúdiť potrebu zriadenia národnej biobanky na Slovensku a identifikovať jej možné prínosy, pričom sa zameriava na dostupnosť vzoriek, výskumnú spoluprácu a zlepšenie verejného zdravia.

Metódy: V štúdiu bol aplikovaný dvojfázový prístup, ktorý zahŕňal kvalitatívne rozhovory s kľúčovými zainteresovanými stranami. Nasledoval kvantitatívny prieskum, do ktorého sa zapojilo 24 výskumníkov, lekárov a laboratórných pracovníkov. Prieskum umožnil nahliadnuť do problémov týkajúcich sa prístupu ku vzorkám a postojov respondentov voči národnej biobanke.

Výsledky: Respondenti v prieskume uvádzali problémy v oblasti prístupu k biologickým vzorkám, pričom 43 % respondentov čelilo miernym ťažkostiam pri získavaní dostatočného množstva vzoriek a 40 % pri získavaní vzoriek požadovanej kvality. Takmer 77 % respondentov uviedlo, že kvôli nedostatku vzoriek museli obmedziť svoj výskum. Prístup k národnej biobanke považovali za kľúčový pre zvýšenie efektívnosti výskumu, účasti na klinických štúdiách a podporu spolupráce 86 % respondentov.

Záver: Národná biobanka na Slovensku, spĺňajúca medzinárodné štandardy, by mohla významne posilniť výskumné kapacity, spoluprácu a výsledky v oblasti verejného zdravia. Úspech však bude závisieť aj od spolupráce zainteresovaných strán, pokračujúceho verejného financovania, záujmu výskumníkov, efektívneho riadenia, podpornej legislatívy a riešenia kapacít zdravotníckeho personálu. Limitom tejto štúdie je však malá veľkosť vzorky a obmedzená účasť súkromného sektora, čo môže ovplyvniť zovšeobecňovanie výsledkov a poukazuje na potrebu širšieho zastúpenia v budúcim výskume.

Kľúčové slová: Biobanka. Biologické vzorky. Verejné zdravie. Prínosy. Výskum

INTRODUCTION

Biobanking refers to the systematic collection, processing, storage, and distribution of biological materials, along with associated data, for research purposes [1]. As a cornerstone of modern biomedical research, biobanks play a crucial role in facilitating "omics" studies (including proteomics, genomics, and transcriptomics), translational cancer research [2], and personalized medicine [3]. The development of robust biobanking infrastructures is thus essential for advancing these scientific fields.

Beyond their role in research, biobanks are essential for public health by enabling large-scale population studies that reveal genetic, environmental, and lifestyle factors contributing to disease risk, thereby facilitating the development of targeted prevention strategies [4]. Additionally, biobanks play a crucial role in supporting the rapid development of diagnostics and treatments for emerging health challenges, such as infectious disease outbreaks, ultimately improving global healthcare outcomes [5].

However, assessing the socio-economic impact of biobanks remains challenging, with key barriers including limited evaluation data, difficulty in attributing outcomes to specific biobanking inputs, the complexity of interdisciplinary collaborations, and the diversity of biobank organizational models [6,7]. Despite these challenges, evaluations – particularly ex-ante assessments – are necessary to justify the allocation of public funds, which are the primary source of financial support for most biobanks [8-10].

This study presents findings from a survey conducted as part of an ex-ante evaluation of the systemic public research infrastructure for biobanking in Slovakia. The study aimed to assess the need for a national biobank and its potential benefits, particularly in the context of biological sample collection for research.

While Slovakia's biobanking infrastructure remains underdeveloped compared to other EU countries, recent progress has been made with the establishment of the Biobank for Cancer and Rare Diseases in Martin. Funded by the European Structural and Investment Funds, this biobank has the potential to serve as a national facility, addressing the current gaps in biobanking capabilities in Slovakia [11].

METHODS

The study was conducted in two phases: qualitative interviews with stakeholders in biobanking, followed by a quantitative questionnaire survey.

Phase 1: Qualitative Interviews

The primary objective of the qualitative phase was to explore the perspectives, knowledge, and experiences of biobanking stakeholders, including researchers and clinicians working in universities, medical institutions, and the Slovak Academy of Sciences. A purposive sampling approach was used to capture a heterogeneous group based on geogra-

phy, institutional affiliation, and expertise. A semi-structured interview format was employed, with 12 interviews conducted between May and August 2022. Key topics discussed included current practices in sample collection, potential collaboration with national biobank, and perceived benefits of a biobank infrastructure.

Phase 2: Questionnaire Survey

The questionnaire, developed based on insights from the qualitative interviews, aimed to validate and quantify potential benefits of biobanking across a larger respondent pool. Invitations were sent to 110 researchers, clinicians, and laboratory personnel from both the public and private sectors. Data collection occurred in April 2024, and the survey included both closed and open-ended questions, addressing topics such as sample collection practices, the perceived benefits of biobanks, and attitudes towards a national biobank infrastructure.

RESULTS

1. Sample Characteristics

Of the 110 contacted individuals, 24 responded to the survey, yielding a response rate of 22 %. The majority (92 %) of respondents worked in the public sector, with representation from 10 institutions across western, central, and eastern Slovakia. Most respondents had over 10 years of professional experience, with 54 % falling within the 10 – 20-year range. In terms of roles, 14 respondents identified as researchers, six as clinicians, and two as laboratory diagnosticians.

Respondents' expertise was diverse, with the largest group specializing in oncology (n = 8), followed by medical biology and molecular biology (n = 5). Other fields included normal and pathological physiology, neurology, pathology, and clinical biochemistry (Figure 1).

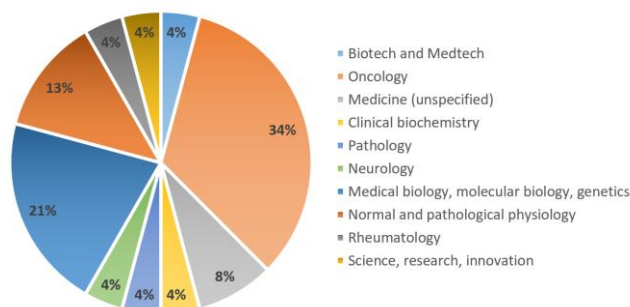


Figure 1 Structure of respondents by field of expertise

2. Access to biological samples for research

The ability to access biological samples is critical to advancing biomedical research. Respondents reported that hospitals were the primary source of biological samples, with many researchers collecting samples in collaboration with medical staff. However, access to samples was often challenging. Nearly 43 % of respondents reported moderate difficulty in obtaining enough samples, and 40% experienced similar challenges in obtaining samples of adequate quality (Figure 2). Only a small number of respondents found it very easy to acquire samples (5 %).

The lack of adequate biological samples frequently limited research. Approximately 77 % of respondents reported that they occasionally or often had to reduce the scope of their research due to insufficient samples (Figure 3).

Potential benefits of a national biobank

The questionnaire survey identified several potential benefits associated with establishing a national biobank that meets international standards. These include improved access to annotated biological samples, increased research collaboration, and greater flexibility in research due to the availability of retrospective collections of biological samples.

Up to 86 % of respondents considered access to a robust database of biological samples and associated clinical data as very or extremely important for their research. Increased work efficiency through access to well-annotated retrospective collections was deemed crucial by 73 % of participants. Furthermore, 80 % of respondents believed that collaborating with a biobank could provide opportunities for additional research funding (Figure 4).

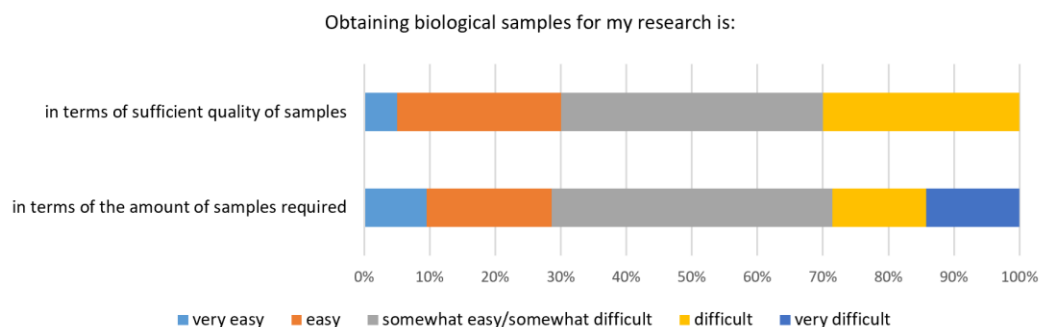


Figure 2 Difficulty in accessing the quantity and quality of biological samples required

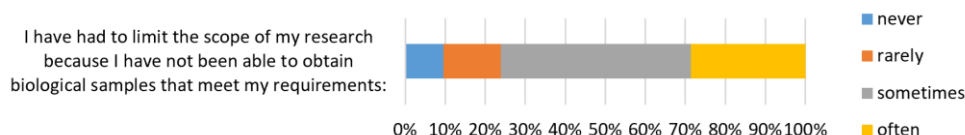


Figure 3 Effects of inability to obtain adequate biological samples

3. Potential for Scientific Collaborations and Innovation

The potential of biobanks to foster scientific collaboration was particularly notable. A total of 86 % of respondents agreed that a national biobank with international integration would enable them to participate in new research collaborations (Figure 5). Additionally, 70 % of respondents indicated that students working under their supervision could benefit from the biobank's resources, improving the quality of their academic work.

The biobank's potential to support clinical trials

was also highlighted, with 77 % of respondents stating that a well-functioning biobank would influence their decision to participate in new clinical trials.

Although the potential for creating spin-off companies and introducing new products and services to the market was rated as moderate, 68 % of respondents expressed optimism about the commercialization potential of biobank collaborations. The potential to file a patent application because of collaborating with a biobank that meets international quality standards was confirmed by 55 % of respondents.

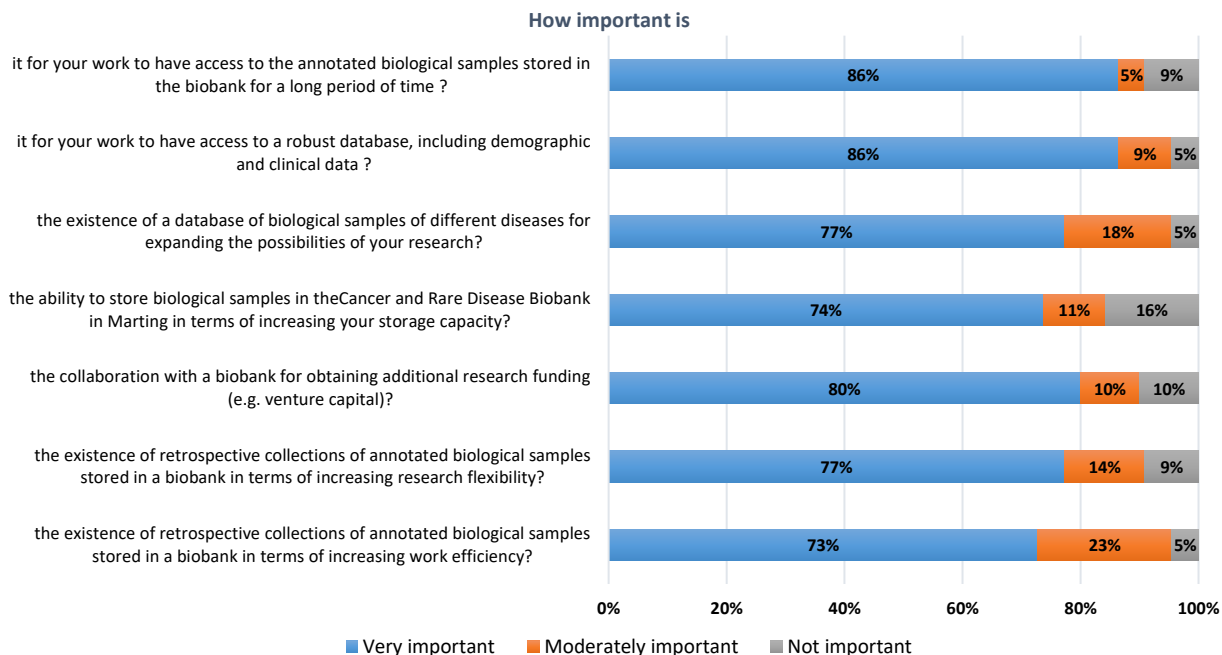


Figure 4 Assessment of the importance of various research effects



Figure 5 Assessment of the potential to achieve different benefits

4. Views and attitudes towards biobanking

The qualitative interviews revealed uniformly positive attitudes among participants regarding biobanks and the establishment of a national biobank in Slovakia. Interviewees expressed strong support for the role of biobanks in advancing scientific research and recognized their potential to enhance research capacity within the country. This optimism was further corroborated by the quantitative survey

results. All respondents agreed that the establishment of a national biobank, alongside the development of systemic biobanking infrastructure, would significantly contribute to advancing scientific knowledge in Slovakia.

However, there was slightly less consensus when it came to the biobank’s role in addressing local public health issues. Specifically, 79 % of respond-



ents agreed that the national biobank would contribute to research focused on Slovakia's specific health needs. A notable proportion of respondents (83 %) also perceived the biobank as instrumental in improving the overall quality of life for the Slovak population, emphasizing the biobank's public health relevance.

The broader implications of a national biobank on Slovakia's standing in the international research community were also positively received. In the survey, 88 % of respondents agreed that establishing a biobanking infrastructure comparable to those in developed countries would enhance Slovakia's prestige and align it with global research trends. Additionally, the same percentage (88 %) concurred that research utilizing biobank samples would better address the needs of patients, underscoring the biobank's potential to impact clinical practice and public health outcomes.

DISCUSSION

The distribution of biological samples and related data is a core function of biobanks, yet it often poses challenges regarding sample type, quantity, and quality. In our Slovak survey, respondents reported mixed experiences in obtaining sufficient, high-quality samples. The majority found it either "somewhat easy" or "somewhat difficult", which aligns with findings from U.S. study [12]. In Slovakia, an equal proportion found sample access either easy or difficult, contrasting with the U.S., where a larger gap (23 percentage points for quantity and 35 points for quality) existed between these groups. Factors like research field, the proximity of hospitals, and healthcare staff collaboration may influence these divergent views on sample accessibility.

The need for high-quality, well-characterized samples is critical to advancing research, especially in public health. Our findings stress the importance of ensuring that biobanks can meet the diverse and evolving needs of researchers. Properly maintained collections of biological specimens can play a crucial role in scientific advancement.

A notable issue revealed in our survey is that only 10 % of Slovak respondents reported never needing to limit their research due to lack of samples, while 77 % indicated that they occasionally or frequently faced such restrictions. This points to a significant barrier to research progress. Similarly, in

the U.S., only 2.8 % of researchers never faced limitations due to sample access, with 66.6 % reporting occasional or frequent restrictions [12]. In Australia, 64 % of respondents had to curtail their research due to insufficient sample availability, with higher rates among basic (69 %) and translational researchers (73 %) [13]. These findings suggest that sample shortages remain a global issue, even in countries with advanced biobanking systems.

More detailed data is needed to understand the underlying causes of these accessibility issues, such as logistical challenges, biobank capacity, and the financial resources required to sustain sample collection and distribution efforts.

Our study has several limitations. The small sample size and limited representation from the private sector may restrict the generalizability of the findings. Additionally, the lack of stratification by research type – such as basic, clinical, or translational – precludes a deeper analysis of specific needs. The use of self-reported data also introduces potential biases, where respondents may provide more favorable responses than what might be seen in a larger, representative cohort. The low response rate observed in our survey may be attributed to the specialized nature of the targeted sample. Among the studies discussed in this article, none reported a response rate except for Massett et al. (2011), whose rate was even lower than ours (14 %). These limitations highlight the need for further research to accurately assess the needs of researchers regarding biological samples.

Biobanks must focus on creating and maintaining collections that align with researchers' needs to maximize their impact on public health research. A global study by Batheja et al. (2023) emphasized that sample quality, characterization, and access to endemic samples are top priorities for researchers [14]. Cost also plays a key role in determining biobank utility. In the UK, sample diversity, quality, and availability of associated data were highlighted as essential features [15]. Our survey results confirm the need for biobanks to maintain robust, well-organized databases with diverse samples and relevant data to support retrospective studies.

This study highlights the significant potential of biobanks in fostering collaboration and innovation. Over 86 % of respondents agreed that biobanks meeting international standards and integrated into global networks could enhance their participation in

scientific collaborations, which are essential for advancing public health research. Additionally, 72 % of respondents indicated that biobanks with adequate capacity to store diverse samples would influence their decision to engage in clinical trials. Clinical trials are critical to public health by providing access to innovative treatments, and expanding biobank capacity could help address Slovakia's relatively low number of recruiting trials compared to similarly sized countries [16].

Though a smaller percentage of respondents viewed biobanks as drivers of business growth or patent generation, this is likely due to the predominance of public-sector respondents in the survey. Future studies involving private-sector participants may reveal more about the commercial potential of biobanks.

CONCLUSIONS

This study highlights the pressing need for a national biobank infrastructure in Slovakia, particularly one that meets international quality standards. The survey results suggest that such an infrastructure has the potential to significantly enhance research outcomes, foster new collaborations, and promote participation in clinical trials. A well-functioning biobank infrastructure could serve as a catalyst for improving public health outcomes and advancing biomedical research in Slovakia.

However, it is crucial to understand that establishing a modern biobanking infrastructure does not automatically ensure the aforementioned benefits. Several factors are essential for success, including collaboration among all relevant stakeholders, a willingness from donors to contribute to the biobank, sustained public funding, researchers' interest in utilizing biobank samples, efficient and transparent management practices, legislation that supports research on biobank samples, and the creation of a conducive environment for biobank development. Additionally, medical personnel play a vital role in this process, which presents another challenge, as their capacities are frequently stretched thin due to the demands of healthcare delivery.

Future studies should aim to capture a more diverse respondent pool, including greater representation from the private sector, and explore the long-term impacts of biobanking on research and health outcomes in Slovakia.

Acknowledgements

This publication has been produced with the support of the Operational Program Slovakia for the project: Systemic Public Research Infrastructure - Biobank for Cancer and Rare Diseases, phase II., co-financed by the European Union.

REFERENCES

- [1] NATIONAL INSTITUTE OF HEALTH. *Biobanking*, 2019. <https://www.nih.gov/institutes-nih/nih-office-director/office-research-services/office-research-infrastructure-programs/biobanking>, accessed 10 July 2024.
- [2] GKIOKA V., BALAOURA O., GOULIELMAKI M. et al. The Organization of Contemporary Biobanks for Translational Cancer Research. *Onco*. 2023; 3 (4): 205-216.
- [3] POLICIUC L., NUTU A., ZANOAGA O. et al. Current aspects in biobanking for personalized oncology investigations and treatments. *Med Pharm*. 2023; 96 (3): 235-245.
- [4] VÉGVÁRI A., WELINDER C., LINDGERG H. et al. Biobank resources for future patient care: developments, principles and concepts. *J Clin Bioinforma*. 2011; 16 (1): 24.
- [5] MEDINA P., LEIOLANI GARCIA D., HONG CHEONG I. et al. Construction and Application of Biobanks for Infectious Diseases: Focus on SARS-CoV-2. *Innovations in Digital Health, Diagnostics and Biomarkers*. 2022; 2: 40-47.
- [6] LINDGREEN A., DI BENEDETTO C.A., CLARKE A.H. et al. Editorial. How to define, identify, and measure societal value. *Ind. Mark. Manag.* 2021; 97: A1-A13.
- [7] ZINÖCKER K. *Austrian Genome Research Programme GEN-AU: Mid Term Programme Management Evaluation*. Technical Report, 2005. <https://www.ffg.at/en/gen-au>, accessed 10 May 2024.
- [8] DOUCET M., YUILLE M., GEORGHIOU L. et al. Biobank sustainability: current status and future prospects. *Journal of Biorepository Science for Applied Medicine*. 2017; 5: 1-7.
- [9] HENDERSON G.E., CADIGAN R.J., EDWARDS T.P. et al. Characterizing biobank organizations in the U.S.: results from a national survey. *Genome Med*. 2023; 5 (1): 3.
- [10] RAO A., VAUGHT J., TULSKIE B. et al. Critical Financial Challenges for Biobanking: Report of a National Cancer Institute Study. *Biopreserv Biobank*. 2019; 17 (2): 129-138.

- [11] DANKOVÁ Z., CHOVANEC M., KVIETIKOVÁ I. et al. Etablovanie systémovej biobankovej infraštruktúry na Slovensku. *Onkológia*. 2023; 18 (1): 63-66.
- [12] MASSETT H.A., ATKINSON N.L., WEBER D. et al. Assessing the Need for a Standardized Cancer Human Biobank (caHUB): Findings From a National Survey With Cancer Researchers. *JNCI Monographs*. 2011; (42): 8-15.
- [13] RUSH A., CATCHPOOLE D.R., REAICHE-MILLER G. et al. What Do Biomedical Researchers Want from Biobanks? Results of an Online Survey. *Biopreserv Biobank*. 2022; 271-282.
- [14] BATHEJA D., GOEL S., FRANSMAN W. et al. Understanding the value of biobank attributes to researchers using a conjoint experiment. *Sci Rep*. 2023; 13: 22728.
- [15] LAWRENCE E., SIMS J., GANDER A. et al. The Barriers and Motivators to Using Human Tissues for Research: The Views of UK-Based Biomedical Researchers. *Biopreserv Biobank*. 2020; 18 (4): 266-273.
- [16] WORLD HEALTH ORGANIZATION. Global Observatory on Health R&D, 2023. <https://www.who.int/observatories/global-observatory-on-health-research-and-development/monitoring/number-of-clinical-trials-by-year-country-who-region-and-income-group>