

## **The Impact of DNA Databases on the Investigation of Crimes**

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### **Abstract**

This study aims to establish the significance and impact of using DNA data in forensics. The study employed the anamnestic method, descriptive analysis, and forecasting. The conducted research identified the key problems of creating and using DNA databases, including insufficient logistical and laboratory support, understaffing, lack of special legislation, low level of security, slow filling of databases, disregard of the public position, and the need to establish international cooperation. It was established that DNA analysis enables identifying the identity of the deceased or a person who cannot identify himself; determining the number of persons at the crime scene; establishing whether DNA traces belong to a suspect; establishing a connection between several crimes by matching DNA samples taken from the scene; establishing those accused of crimes. It is proposed to increase the effectiveness of law enforcement activities through the development of an International Strategy for the Influence of the Use of DNA Databases and ensure international cooperation on the exchange of DNA information in forensics.

**Keywords:** DNA databases, DNA analysis, forensic method, crime investigation, human identification, forensic genetic examination.

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**Introduction**

Current realities present criminology in the field of crime investigation with new challenges that can be resolved only by introducing new sources, modern technologies, and information databases into the system of evidence and expertise. Genotyping (DNA analysis) in biological examination has become a new development and is increasingly being implemented in forensics, the effectiveness of which has not yet been fully studied (Debus-Sherrill & Field, 2019).

DNA analysis is an examination of human micro traces at the cellular level (Ram et al., 2018), which is currently considered one of the most effective forensic methods (Jakovski et al., 2017). Special scientific institutions create DNA databases for more effective application of this method, the first of which was created more than 30 years ago.

A DNA database is a collection of DNA profiles of individuals subject to legal DNA sampling and related information used to identify suspects in criminal investigations (Smith, 2018). For example, the United States of America has passed legislation at the level of each state, as well as the federal government, that stipulates which persons (arrested or convicted) must submit DNA samples. These samples shall be entered into a special database - the National DNA Index System (NDIS). The database contains more than 12 million individuals from whom DNA has been taken and is often used to compare DNA samples from crime scenes with those in the database for identification of potential criminals (Ram et al., 2018). The Central Institute of Forensic Science (CIFS) created its own DNA database in 2004, and it was used for some time to improve the effectiveness of law enforcement agencies in the field of investigating organised crime in Thailand. Later, the database was supplemented with data related to such crimes as murder, sexual violence, burglary, and drug smuggling. At the same time, the institution aims to expand the possibilities of investigations using DNA analysis. So, measures such as the collection of DNA data of all prisoners in the country to detect serial crimes, and data exchange with national and international law enforcement agencies are planned for this purpose. Furthermore, the institution sets itself such an important goal as using the DNA database to investigate crimes at the transnational level, such as illegal work, migrant smuggling, and human trafficking (Boonderm et al., 2017).

This analysis seems important and necessary for the activities of law enforcement agencies because of the effectiveness of DNA analysis in individual cases and its potential in the field of investigating serious crimes, including transnational ones. However, some researchers indicate the weaknesses of DNA analysis, particularly the issue of personal data privacy, which may be affected by

DNA analysis. It is also stated that DNA analysis can only be effective if the suspect or his relative has been arrested and a DNA sample has been collected and stored (Ram et al., 2018).

So, the significance and effectiveness of the use of DNA databases in the investigation of crimes have not been fully studied (Wickenheiser, 2022). The costs and benefits of the creation and application of universal forensic DNA databases for the investigation of crimes also require a more thorough study (Smith, 2018). This necessitates a more in-depth study of the existing opportunities and problems associated with the introduction and implementation of DNA analysis, as well as the formation of proposals to improve its effectiveness.

### **Aim**

This study aims to establish the importance and impact of using DNA databases in forensics.

### **Research Objectives**

- To determine the impact and significance of DNA database data for the investigation of crimes.
- To establish problematic aspects of the creation and use of DNA databases in forensics.
- To develop the basic principles and propositions regarding the prospects of using the forensic method of DNA analysis.

### **Literature Review**

Most studies on the importance of DNA databases in forensics and the prospects of this direction concern establishing the effectiveness of such databases, considering their purpose and content. Tièche et al. (2022) examine the effectiveness of DNA sample testing in the investigation of burglary in Switzerland, which is the country's most common crime. The researchers indicate the problem of uncertainty about whether the collected samples belong to criminals or come from the owners of the house. Given the spread of burglaries, investigators are not always able to collect a DNA sample from all residents for administrative and economic reasons. Rodrigues Carvalho et al. (2020) study the specifics of using DNA databases to preserve sexual crime evidence. The researchers note that evidence of sexual violence that has not been submitted for DNA analysis determines the low detection rates of such crimes. At the same time, the development of DNA databases contributes to obtaining important information for solving sexual crimes, which was proved by the example of the

emergence of such databases in Brazil. However, the issue of whether the demonstrated effectiveness affects the number of people convicted of crimes remains insufficiently studied. Boonderm et al. (2019) describe the use of DNA databases to monitor recidivism. For example, in Thailand, DNA samples are collected from prisoners as part of the CIFS project, which will allow comparison of these samples with those found at crime scenes after the prisoners are released.

Research on the impact and importance of DNA bases is carried out both in individual states and at the international level. Da Silva Junior et al. (2020) reveals the value of DNA databases for missing person searches by Latin American forensic specialists. The researchers emphasise the importance of monitoring the situation with the use of DNA databases for criminal investigations in Latin America because most studies relate to the experience of countries where cultural and economic characteristics significantly differ from local ones. Amankwaa and McCartney (2019) analyse the effectiveness of DNA databases in the UK. In particular, the researchers examine evidence of the effectiveness of the UK National DNA Database (NDNAD). This database is one of the oldest and largest DNA databases in the world. The researchers concluded that the database contributed to solving many “high-profile” crimes, but they did not find a direct impact on ensuring public safety.

Munir et al. (2020) examine the challenges of using DNA databases in Pakistani justice. The researchers aptly note that there are no crime scenes that are completely free of evidence. In other words, the absence of evidence at first glance does not indicate the “perfect” crime, rather, the evidence was not properly discovered. The collection of DNA samples enabled by the development of technologies in the field of forensic genetics is used in those situations. However, the use of DNA as evidence in judicial investigations in Pakistan raises several significant challenges and barriers related to sampling, analysis, profiling, inclusion/exclusion criteria, oversight, and due diligence mechanisms.

Moreover, there are obstacles related to the inviolability of personal life, constitutional guarantees of rights, etc., which cause contradictions while determining the admissibility of evidence for the court. A central DNA database was not created in the country because of these problems. Accordingly, the observed obstacles significantly slow down the investigation and reduce the possibility of solving several crimes.

Amankwaa (2020) studies the influence and importance of DNA databases at the international level from the perspective of the possibility and effectiveness of creating international DNA databases for the transnational exchange of such data. The researcher notes that the transnational data exchange of DNA databases is an important direction in the fight against terrorism, cross-

border crime, and illegal migration. It also enables connecting separate crime scenes, which makes it possible to identify serial criminals or uncover criminal schemes. The researcher offers a division of approaches to transnational data exchange into several categories: creation of an international DNA database, formation of a network of national databases, exchange of information by sending requests, as well as combining data. The author's work reveals approaches to the transnational exchange of DNA data, describes legal and operational boundaries, identifies several political problems arising in the process of exchange, etc. The study also emphasised that data sharing played a significant role in solving serious crimes, in particular, gang or serial rapes and armed robberies. At the same time, the overall effectiveness of data sharing, including related legal and ethical issues, is understudied.

Several studies deal with the possibility of identifying suspects through family searches in DNA databases (García et al., 2017) and the use of DNA databases of individual genealogy in forensic analysis to find criminals (Katsanis, 2020). But along with the fact that almost all studies prove the necessity of creating DNA databases, the high efficiency of their use during the investigation of various types of crimes, and the prospects for the development of this forensic method, many shortcomings in the use of these databases are also indicated (ethical use of such data, low-security level, etc.). A considerable number of studies support the importance and impact of DNA databases for crime investigation; however, some issues remain poorly studied. In particular, the problems of establishing the value of using DNA data in the investigation of crimes and the prospects for further application of the method of genotypic analysis using national and international DNA databases are poorly studied.

## **Methods**

Three main stages are determined under the research objectives. The first stage involved determining the impact and significance of DNA database data for crime investigation. The second stage provided for identifying problematic aspects of the creation and use of DNA databases in forensics. The third stage involved providing key proposals regarding the prospects of using the forensic method of DNA analysis.

This study used data on national and international (Interpol) DNA databases, in particular, the year of creation of such databases and the number of individual profiles contained in these databases (data for 20 countries). The problems and debatable issues of the creation and use of DNA databases in the investigation of crimes, as well as the essence of the main tasks that rely on the analysis of DNA data in criminology, law enforcement, and justice, were studied.

The legal framework of the research was made up of the provisions of international legal acts, in particular, the Prüm Convention of May 27, 2005, Recommendation of the Committee of Ministers of the Council of Europe No. R (87) 15 of September 17, 1987, the Council of Europe Convention on Protection of Children against Sexual Exploitation and Sexual Abuse of October 25, 2007.

The study employed the following methods:

- *the anamnestic method* was used to gather information on international and national cooperation during the investigation of criminal offences using the genotypic method.
- *descriptive analysis* was applied to study the literature on the creation and use of DNA databases in forensics;
- *forecasting* was used to formulate proposals for legislative regulation, improve the mechanism of creation and use of DNA data in the investigation of crimes, and establish a system of international data exchange of DNA databases.

## **Results**

Human DNA data is personal sensitive information that must be protected at all levels. This provides for the existence of special international and national regulatory legal acts designed to regulate both the creation of such DNA databases and their use, in forensics. Thus, the human genetic code (DNA) is mentioned in Art. 37(1) of the Council of Europe Convention on Protection of Children against Sexual Exploitation and Sexual Abuse. Subsequently, the Prüm Treaty (Prüm Convention, Schengen III) of May 27, 2005, provided for the data exchange between the member states of this Treaty. This regulation of data exchange provides for the possibility between member states of this Treaty to provide each other with legal access to databases with genetic (DNA), dactyloscopy, and other personal information. The basic principles and principles of the use of personal data, including DNA data, are enshrined in the Convention of the Council of Europe Convention for the Protection of Individuals about Automatic Processing of Personal Data of January 28, 1981, Recommendation No. R (87) 15 of the Committee of Ministers of the Council of Europe of September 17, 1987, as well as Directive 95/46/EU of the European Parliament and the Council On the Protection of Individuals about the Processing of Personal Data and on the Free Movement of such Data of October 24, 1995.

Since the beginning of the 21<sup>st</sup> century, countries have begun to create DNA databases, which are constantly replenished with new samples and profiles (see Table 1). A DNA database was separately created by the international

organisation — Interpol, which unites national DNA databases for their use in criminal investigations.

**Table 1**

National DNA databases (by country and city)

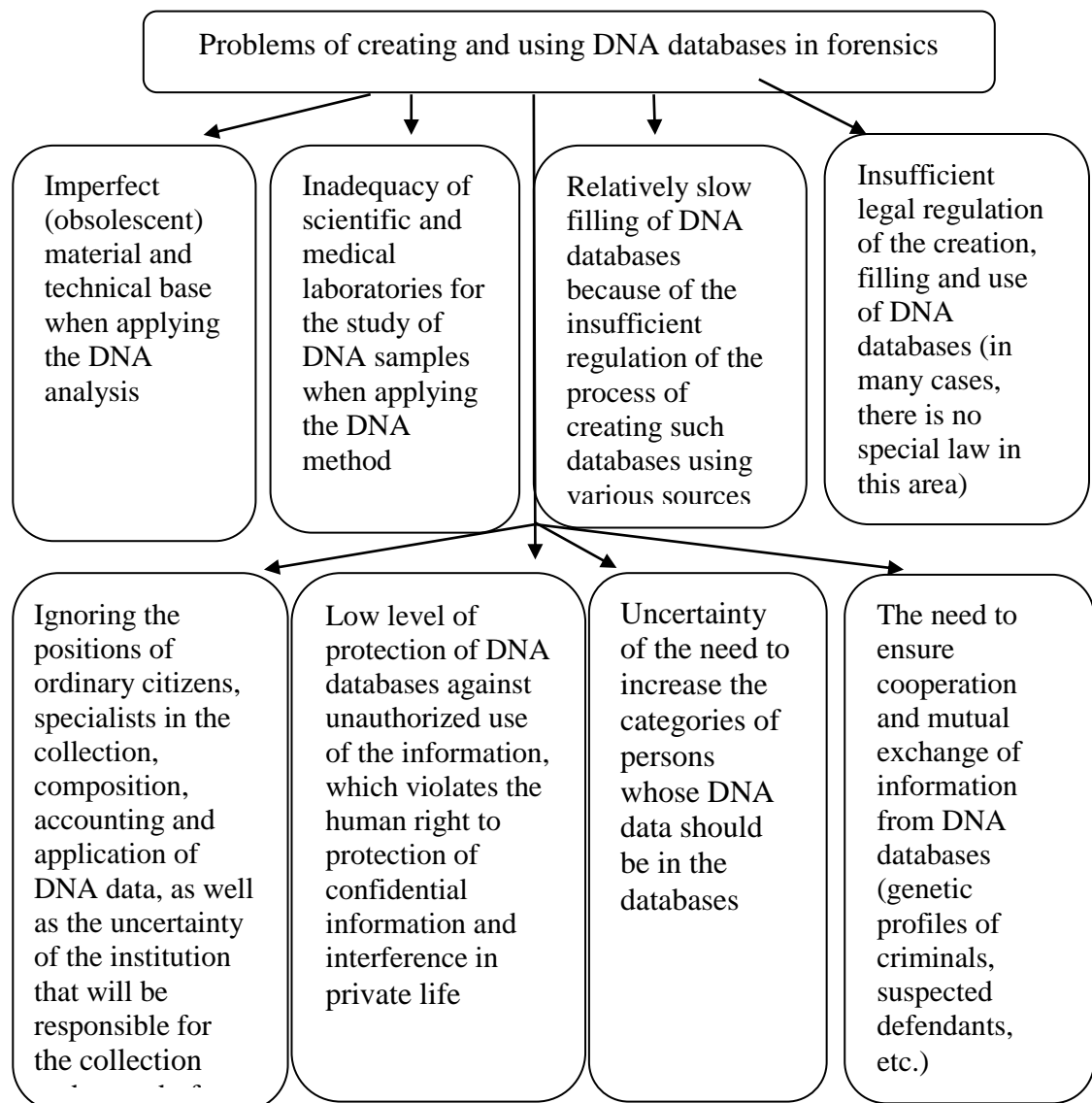
Country/City	Year of creation	The number of persons entered into the database (profiles)
Great Britain	1995	6,600,000
New Zealand	1995	237,269
USA	1996	50,000,000
Australia	1997	837,000
Canada	1998	642,758
Dubai	1998	3,000,000
Federal Republic of Germany	1998	1,213,331
Israel	2007	491,380
Kuwait	2015	4,200,000
France	1998	4,247,382
Netherlands	2001	316,000
Japan	1987	1,213,928
Switzerland	2000	208,417
Spain	2005	627,163
Norway	1999	109,180
Poland	2007	89,957
Estonia	1999	67,758
Greece	2008	34,647
Hungary	2009	212,196
Austria	1997	384,038

**Source:** Forensic Genetics Policy Initiative (2020), Interpol (2019).

The special legislation of several countries provides for genotyposcopic analysis (DNA analysis) during pre-trial investigation and collection of evidence in criminal cases. For example, the Criminal Code of France, the Criminal Code of the Federal Republic of Germany, and the Criminal Code of Switzerland provide a clear list of crimes that require DNA analysis to identify suspects. As a rule, such an analysis is necessarily used in the investigation of serious and particularly serious crimes, crimes against life, health, and sexual integrity, especially in those cases when there is a need to distinguish between the biological samples of the criminal and the victim (Horpyniuk, 2019). The urgency of creating DNA

databases is determined by the events of recent years (natural and man-made disasters, terrorist attacks, wars), the information from which is used to identify victims and their number, search for missing persons, establish guilty persons, identify people who cannot provide personal data about themselves, etc.

There are several problematic aspects related to their creation, new data entrance, and the use of the data contained in them (see Figure 1).



**Figure 1.** Problems of creating and using DNA databases in forensics

**Source:** Husieva (2021)



Solving the specified problematic aspects is quite possible. The problem of unauthorised use of DNA databases has two sides. On the one hand, law enforcement agencies must ensure the protection of personal confidential data from theft and illegal use for criminal purposes. On the other hand, the use of DNA data by law enforcement agencies must also be protected from their unauthorised use within the limits of criminal proceedings. Therefore, it is important to ensure a balance between such two state interests as personal integrity, human honour and dignity, and combating crime. This can be a legislative regulation of the functioning of accounting and the use of human genetic data and the activities of law enforcement agencies in this area in the relevant legal acts. The main principles of such potential national legal acts are enshrined in Directive 95/46/EU of the European Parliament and the Council on the Protection of Individuals about the Processing of Personal Data and on the Free Movement of Such Data of October 24, 1995. This includes special strict conditions for storing DNA data; restriction of storage of DNA data by law enforcement agencies; use of DNA data in the investigation of a crime only in cases of extreme necessity; notification of a person about the use of his/her DNA data for the investigation of crimes; timely mandatory destruction of samples. The absence or inadequate legal regulation of the creation and use of DNA databases are closely related to the previous problem.

The issue of insufficient data entry into the DNA databases is no less acute than the previous ones. Currently, DNA samples of certain categories of people — unidentified persons and persons whose DNA was found at the scene — are subject to mandatory registration and entry into the relevant database. Opinions are expressed regarding the mandatory entry into the DNA database of such persons as law enforcement officers, judges, and prosecutors; military personnel, conscripts; missing persons (by ensuring the collection of DNA samples from their personal belongings); persons with mental disorders, including age-related disorders; persons sentenced to imprisonment.

Insufficient material and technical support and the lack of a sufficient number of laboratories and experts in this field affect the quality of research and the cost of such examinations. Maintaining such databases is quite expensive, as DNA samples require special storage conditions, and the equipment for this is expensive. The latest developments in this field and the training of relevant specialists will reduce the cost of maintaining and using such databases.

A survey can solve the issue of not considering the position of the public. But before that, public awareness work should be carried out to explain how these DNA data will be collected, which categories of the population are subject to

mandatory registration in such a database, in which cases they will be used, and how to protect them by law.

The basic principles of the creation and use of DNA databases, which will become the basis for the legislative support of such activities and the practical application of the information contained in such databases, can be considered the legality of using DNA databases in forensics, the quality of such analysis, the performance of such analysis by employees with the necessary knowledge and skills, etc. (Stepaniuk & Husieva, 2023).

Despite the complications and several controversial issues related to the creation and use of DNA data, such databases are already widely used in forensics. At the same time, the analysis of DNA samples and their comparison with those contained in databases are designed to perform many tasks that law enforcement agencies face when investigating crimes. This includes not only establishing the identity of the deceased but also identifying DNA samples to identify the criminal. This is also the reliability of the DNA-based evidence, the identification of all persons who were at the scene, and the narrowing of the circle of suspects (for more details, see Figure 2).

The conditions for the extraction and storage of DNA materials should be improved in the future to send appropriate biological samples for research and ensure the effective fulfillment of the specified tasks. There is also a need to train specialists both in the field of forensic medicine and among law enforcement officers to carry out such activities.

Based on the foregoing, the use of DNA databases in the investigation of crimes affects:

- the effectiveness of the investigation of certain crimes, mainly serious and particularly serious (against life, health, sexual integrity, public safety, war crimes, terrorism, genocide, etc.).
- shortening the time frame for investigation of crimes and identification of the guilty person.
- ensuring justice with proper and reliable evidence that does not have a statute of limitations, which contributes to the establishment of the truth in the case and the adoption of a fair court decision;
- ensures an increase in the effectiveness of combating crime in general.

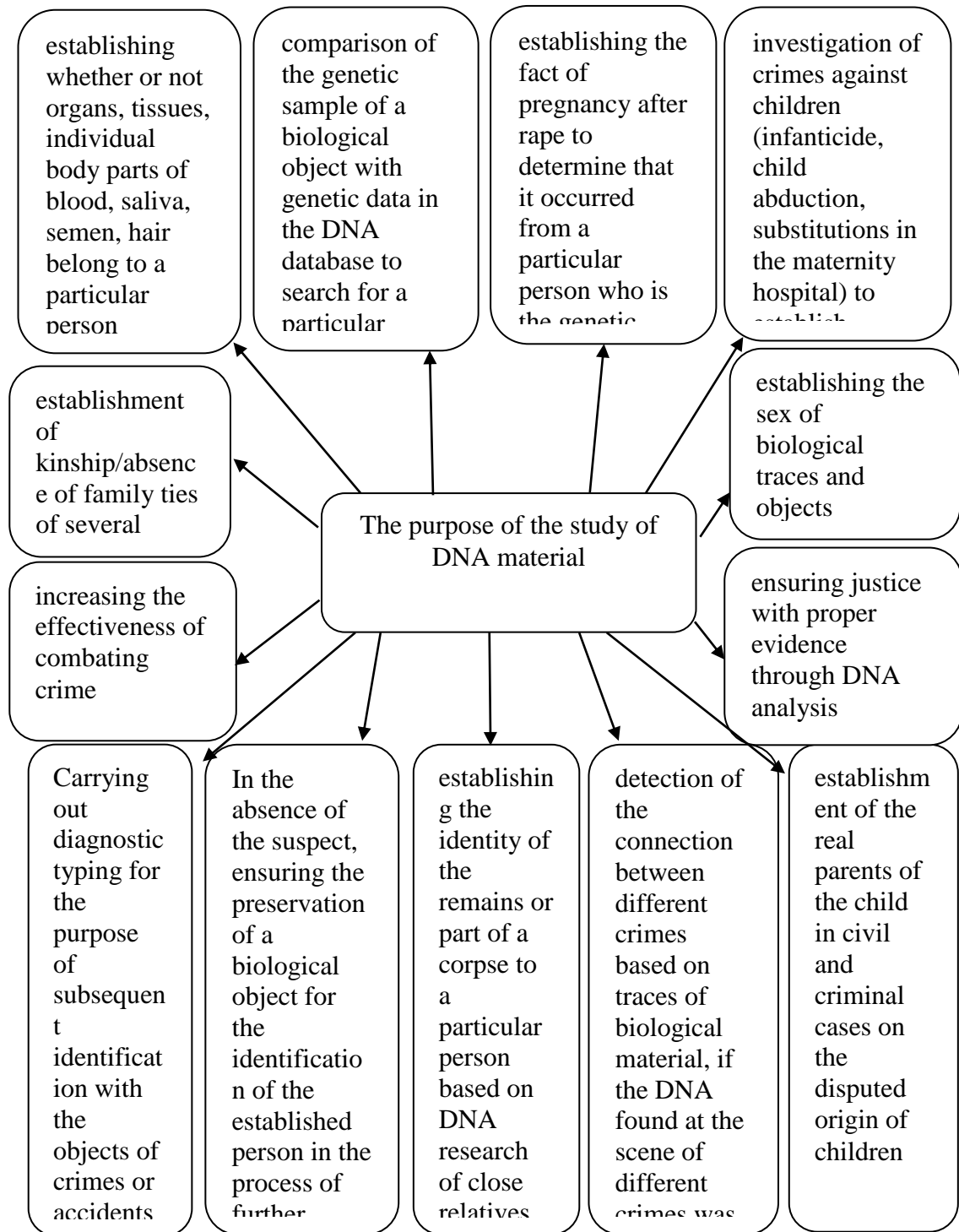


Figure 2. Tasks of genotyposcopic examination in forensics

For the further development and improvement of the application of DNA analysis in forensics, considering the previous experience in the creation and use of DNA databases, a special document should be created, which will include recommendatory provisions on the creation and use of DNA databases at the national level and the establishment of international cooperation in exchange and use of this data for the investigation of crimes. This can be a document like the International Strategy for the Impact of the Use of DNA Databases and Ensuring International Cooperation on the Exchange of DNA Data in Forensics. The proposed document includes the following provisions:

- defining and substantiating the purpose of forming a DNA database and explaining its importance for achieving the goals of forensic examination.
- setting tasks to be solved using DNA analysis using DNA databases.
- key principles and foundations of DNA database formation in forensics.
- adequate guarantees regarding the security of DNA data to prevent their unauthorised use and ensure the rights to the inviolability of private information.
- determination of categories of persons subject to mandatory DNA submission.
- establishing the procedure for the creation of DNA examination laboratories.
- basic regulations regarding the training of specialists who will carry out the examination.
- key forms of international cooperation in the field of data exchange of DNA databases.

### **Discussion**

The analysis carried out in the study proves the effectiveness of DNA databases during the investigation of crimes (Doleac, 2017) because the use of data from such databases helps to:

- increase the efficiency of the investigation of crimes, including serious and especially serious crimes.
- prevent prosecution of persons who did not commit crimes.
- fight crime more effectively.
- establish the truth.
- ensure fair justice.

At the same time, it is difficult to fully agree with the reasoning that the use of DNA databases in forensics contributes not only to the identification of

criminals but also to deter them from committing crimes (Tegner Anker et al., 2021). It can probably have a preventive effect to some extent, but it is not effective enough.

It is noted that there is also a negative side to using this method. This is related to the possible matches of individual indicators in the DNA sample and the DNA profile in the database, which can lead to the accusation of an innocent person. Although such coincidences are infrequent, this method should not be used often (Murphy, 2015). However, one cannot fully agree with this position: such matches are extremely rare, and more markers should be used to avoid misidentification (Stanley et al., 2020; 2021; Wilson, 2023).

Attention is paid to the social aspects of the use of such data during the investigation of crimes, as this is personal information about a person (Samuel et al., 2018). Therefore, it is determined whether the use of DNA data even to identify criminals is possible from the perspective of human rights and freedoms. The ethical side is another negative aspect of the use of DNA data in the investigation of crimes, which consists of violating the privacy of the personal and family life of a person whose DNA profile is compared with the samples found at the crime scene (Ahmed, 2019). It is also added that the use of the method of genotyposcopic examination can increase racial inequality (Murphy & Tong, 2020; Yunin et al., 2022). However, these problems can be avoided thanks to legislative regulation that protects human rights and freedoms during the use of DNA data in investigations. Therefore, one cannot agree that such an examination is ineffective.

### **Conclusions**

The above study demonstrated that the use of DNA databases in forensics in the investigation of crimes is currently one of the most effective forensic methods. Despite the controversial issues, the importance of such analysis in the investigation of crimes is that it enables establishing the identity of the deceased or a person who cannot report himself; determining how many people were at the scene; establishing whether traces with DNA samples belong to the suspect; establishing a connection between several crimes by matching DNA samples taken from the scene; establishing those accused of crimes against children, sexual freedom and integrity, human life, and health.

It is proposed to develop an international regulatory recommendatory legal act to ensure the fulfillment of the tasks assigned to genotyposcopic forensic examination and to strengthen the impact of the use of DNA databases on the effectiveness of law enforcement activities and the administration of justice. It can be the International Strategy for the Impact of the Use of DNA Databases and

Ensuring International Cooperation for the Exchange of DNA Data in Forensics. It shall contain an explanation of the essence and purpose of creating and using the DNA database; establishing the importance of using DNA data during the forensic medical examination for law enforcement and justice; basic principles of creation and principles of using DNA bases in forensics; guarantees of protection of DNA data from unauthorised use in the investigation of crimes and ensuring the human right to preserve confidential information, honour, and dignity; the list of categories of people whose DNA profiles must be in the DNA databases; the procedure for the creation and functioning of forensic laboratories for the study of DNA samples and the training of experts to carry out genotyposcopic examination; the main directions of international cooperation and data exchange of DNA databases, creation of a joint international DNA database.

This study on the importance and impact of using DNA databases for crime investigation and justice is not comprehensive. This is determined by the relative novelty of the investigated issues, as well as several problems that must be solved to ensure the legality of the use of this method. Instead, this study opens prospects for further research in the field of forensic methods in the investigation of crimes, in particular, legislative regulation and coordination of certain, first of all, moral and ethical aspects of the use of DNA databases in forensics.

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