Forensic Familial and Moderate Stringency DNA Searches


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Preface

This report documents the policies and procedures of familial DNA searches and moderate stringency searches conducted with local, state, and national databases in the United States, England, and Wales. The overall purpose of the project was to investigate the policy development, associated costs, limitations, and capabilities that DNA testing provides in order to offer relevant insight to criminal justice and law enforcement policymakers and researchers who are interested in the use of DNA testing to solve and deter crime.

In this report, we reviewed the relevant literature and interviewed relevant practitioners in the United States, England, and Wales. We administered a survey to local and state DNA database administrators to better understand the characteristics, policies, and practices in the United States. Finally, to help understand the extent that the use of DNA testing including familial and moderate stringency searches and the collection of DNA impinges on groups’ privacy rights, we developed a tool.

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Justice Policy Program

RAND Social and Economic Well-Being is a division of the RAND Corporation that seeks to actively improve the health and social and economic well-being of populations and communities throughout the world. This research was conducted in the Justice Policy Program within RAND Social and Economic Well-Being. The program focuses on such topics as access to justice, policing, corrections, drug policy, and court system reform, as well as other policy concerns pertaining to public safety and criminal and civil justice. For more information, email justicepolicy@rand.org.
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Summary

Forensic DNA testing has been one of the great success stories of law enforcement over the past 30 years. The United States national network of forensic DNA databases has helped law enforcement solve many crimes, often long after the investigative trail has gone cold. Intuitively, familial DNA and moderate stringency search protocols are logical extensions for cases in which there is no exact DNA match, but we know relatively little about their use. Where policies have been codified, regulatory constraints have arisen largely as a response to ethical and legal concerns surrounding the use of this method. In yet other jurisdictions, no formal policies are in place to regulate the practice. The lack of a consistent set of policies governing the use of familial searching may reflect lawmakers’ uncertainty about the effectiveness of the procedure, as well as uncertainty about its unintended implications. In order to aid policymakers, we conducted a study of practices on familial DNA and moderate stringency DNA testing and discuss their effects.

We conducted four related study tasks: (1) a literature review on familial and moderate stringency DNA searching, (2) a survey of varying familial and moderate stringency DNA policies and data from state and local forensic laboratories, (3) interviews from representatives of two states (California and Texas) that have used this technique in different ways, and (4) interviews with English and Welsh stakeholders.

Familial and moderate stringency searches offer a mechanism for reducing the number of case-to-case database matches for which the suspect remains unidentified, which makes this a potentially useful indicator of familial search efficacy. Among the states that responded, we determined whether familial search policies affected the number of serial offenders for which no suspect is identified. Other indices of the effectiveness of a state database’s use of familial and moderate stringency searches are the number and fraction of forensic partial DNA profiles and mixture profiles in the database that ultimately yield matches or that are successfully linked to a relative of someone in the database. These indices convey the degree to which moderate stringency searching, coupled with partial match candidate selection criteria, aids investigations. Note that because partial profiles and mixtures with genotypic ambiguity are ineligible for familial searching, these indices apply only to moderate stringency searching.

We also conducted semistructured interviews with administrators in two states with familial DNA testing policies to develop a more in-depth understanding of the effect of familial and moderate stringency DNA testing. One case study examined a state where familiar searching and moderate stringency match reporting is explicitly permitted. Our second case study focused on a state that allows reporting of moderate stringency matches suggestive of kinship in certain circumstances.
Finally, we conducted qualitative interviews in England and Wales. We conducted semistructured interviews with ten subject matter experts (SMEs) who are academics and practitioners with knowledge of familial searches. We asked about the history of the current policy regarding familial DNA searching and the perceived advantages and disadvantages of the present policy (or lack thereof). We also interviewed SMEs about implementation of the current policy. The qualitative interviews were thematically analyzed to examine how the issues of privacy, public safety, and budget consciousness have shaped the familial searching policies in England and Wales. The topics discussed during the semistructured interviews include:

- processes, stakeholders, and institutions involved in authorizing, conducting, and overseeing these searches
- national and European Union regulations on the use of DNA for these searches (e.g., data retention, national forensics strategy)
- types of cases these searches are used for
- technical processes, technology involved, and advances in technology (e.g., increased sensitivity)
- costs (e.g., how searches are funded and their cost-effectiveness)
- number of searches run every year
- how searches form part of criminal investigations
- ethical issues (e.g., privacy, government intrusion, proportionality, public vs. individual rights, consent, revealing personal relationships, civic responsibility to cooperate with police)
- attitudes of the public.

Summary of Results

SDIS and LDIS Survey Results

To ensure that our understanding of Combined DNA Index System (CODIS) terminology was consistent with Local DNA Index System (LDIS) laboratories, we asked LDIS laboratories whether they agree or disagree with statements about partial matches and moderate stringency searches taken from the wording of the Federal Bureau of Investigation (FBI) webpage on frequently asked questions on CODIS and the National DNA Index System (NDIS). A majority of responding LDIS laboratories agreed with both statements. When respondents disagreed with the partial match statement, it was because they currently report partial matches as “no match.” One responding LDIS laboratory disagreed with the moderate stringency statement and specified that moderate stringency searches also account for typing discrepancies (null alleles) arising from different DNA testing kits.

Of responding LDIS laboratories, 42 percent are using probabilistic genotyping software to interpret DNA profiles derived from crime scene evidence, 23 percent were in the process of validating probabilistic genotyping software at the time they were surveyed (and if validation proceeds according to schedule, they are now online), while just over a third of responding LDIS laboratories reported no immediate plans to switch from their current evidence profile interpretation method.

We were also interested in whether probabilistic genotyping software, CODIS 20 Short Tandem Repeats (STR), and the growing use of DNA testing on trace DNA samples in property crimes had increased the fraction of forensic partials and forensic mixtures in LDIS and State DNA Index System (SDIS) databases. LDIS laboratories were asked to report the number of forensic partial, forensic mixture, and forensic profiles they had uploaded to SDIS in the year 2010 and in the current year (2018) to date. SDIS laboratories were asked to report the number of uploads in each category in each year. The mean number of uploads increased in all three categories.\(^2\) However, the increase was uneven, with forensic partials comprising a slightly smaller share of the total and the share of forensic mixtures more than doubling, from 11 percent to 27 percent. Between 2010 and 2018, the number of forensic partials increased by a higher percentage among LDIS laboratories that do not yet have probabilistic genotyping software in use, whereas the number of forensic mixtures increased by a higher percentage in LDIS labs that were using probabilistic genotyping software in 2018.

The final items on the LDIS and SDIS surveys solicited input from laboratories about what changes they would like to see for improving efficiency and efficacy of CODIS operations and whether they are aware of any policy changes on the horizon. Responses to the first question about desired changes included process streamlining through automated intra- and inter-laboratory correspondence because, as one respondent noted, “Paperwork has become overwhelming as the number of matches has increased over the years.” Other respondents were interested in seeing improvements in CODIS software that would facilitate data queries and production of statistical reports. In response to the second question about knowledge of policy changes on the horizon, 10 of the 16 responding LDIS laboratories replied “No.” The remainder mentioned changes to CODIS software, including possible familial searching capability and the addition of a “Forensic Targeted” category for partial or mixture sample that does not meet SDIS/NDIS moderate match estimation thresholds but can meet match-rarity estimate thresholds if specific loci are searched at moderate stringency. SDIS laboratories were focused on hiring additional personnel because current staff struggle to keep pace with DNA testing and database management responsibilities.

\(^2\) These results were not driven by huge increases at one or two LDIS laboratories; the majority of responding LDIS laboratories, though not all, reported increases in all three categories.
California and Texas, the two largest states by population, also have the two largest SDIS databanks. California has one of the nation’s most proactive DNA sampling regimes, mandating DNA collection from all felony arrestees, regardless of adjudication. DNA database laws in Texas are more restrictive; the state collects DNA from convicted felons only if they are sentenced to prison, and felony arrestees are not sampled unless and until they are arraigned. Texas DNA profiles from felony arrestees who are acquitted or not proceeded against are automatically expunged, whereas California requires individuals to petition for expungement. Consequently, as of September 2018, California’s DNA database had 2,007,874 (5.1 percent of the population) convicted offender profiles and 760,395 (2 percent of the population) arrestee profiles, while the Texas state databank holds 884,548 (3 percent of the population) convicted offender profiles and roughly one-tenth as many arrestee samples. There is some unknown number of duplicates in these databanks, as arrestees are not purged from the arrestee database upon conviction or subsequent felony arrests.

In California and Texas, familial search inquiries begin with the submission of joint written requests from the investigating and prosecuting agencies. The request forms describe the conditions under which the familial search will be conducted and require applicants’ signatures to attest that they understand and agree to the terms.

The familial search policy in California instructs law enforcement agencies that only serious unsolved cases with “critical public safety implications” will be considered for a familial search of the database, implying that the tool will only be applied to the most serious crimes. The Texas wording is more explicit, stating that “the case with the evidentiary profile should be from unsolved homicides, sexual assaults, or other violent crime that has significant public safety concerns. Property crimes will not be considered.” Beyond specifying the precondition that cases be unsolved, California and Texas require applicants to affirm that all investigative leads in such cases have been exhausted, though Texas will make exceptions if the public safety concerns are extreme. To that end, the DNA evidence must be a single-source or deduced single-source forensic profile that has already been uploaded to NDIS without producing any exact matches through routine searches.

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England and Wales Interviews: History and Context of Familial DNA Testing

In England and Wales, the practice of familial DNA searching started without a legislative framework to cover it, and an SME noted that only after the method had been employed on a number of occasions did discussions around legislation begin to emerge. The Protection of Freedom Act 2012 sets out the legal framework relating to the collection, use, and retention of biometric samples; and this law governs the collection and utilization of DNA samples in England.

In England and Wales, the use of familial DNA searches is more nationalized. When a law enforcement agency wishes to conduct a familial DNA search with a crime-stain profile that is suitable for a database search, investigators must submit an application to the National DNA Database and meet a number of requirements. First, a regional representative of the National Crime Agency must have seen the request and be willing to provide their resources to support the search. In addition, the law enforcement agency applying will also require approval from the National Police Chiefs’ Council. In considering whether to approve the application, this law enforcement agency will consider the nature and gravity of the crime and whether there is a need to explore every investigative avenue to identify the offender, as well as the availability of funding and resources to pursue the search. The law enforcement agency will also need approval from the senior forensics manager.

SMEs who commented on the subject of partial and mixed profile searching drew a clear distinction between these types of searches and familial searches both in terms of the technologies involved and the ethical issues raised. One SME, a policy lead within the National Police Chiefs’ Council, reported that the number of mixed and partial profiles gathered has rapidly grown, describing the volume as “massive” and noting that where a partial profile has been gathered at a crime scene and a match is sought in the database, a threshold of 17 or 18 alleles matching is required for the profile to be of much utility as evidence to investigators. SMEs also noted that in practice, an extremely partial profile would be disregarded unless it related to a serious offense such as murder or sexual assault, for which every DNA result is scrutinized for its value and potential contribution to the investigation.

Conclusion and Implications for Criminal Justice Policy in the United States

While there are legitimate concerns about the privacy implications of the use of familial DNA searches should such use become widespread, in the United States today it is still quite rare. In fact, the considerable backlogs for conventional DNA testing that have been reported suggest that expanded conventional capabilities are probably the best short-term strategy. While California and Texas have slightly different policies, both have meaningfully restricted its use to situations where the public safety implications are most acute. The English and Welsh experience provides examples of polities with similar common-law backgrounds successfully but sparingly using the capabilities that it provides. Further research into the costs and benefits of
familial DNA searching would help provide policymakers with useful data about the most efficient crime-reduction expenditures.
We would like to especially acknowledge the assistance of our production editor Babitha Balan for efficiently and expeditiously coordinating the publication process. We would also like to thank Lori Uscher-Pines, our quality assurance coordinator; and our two reviewers, Stephanie Holliday and Debbie Kennett, for their help in making this a better product.
## Abbreviations

<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Description</th>
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<tbody>
<tr>
<td>BIA</td>
<td>Behavioral Investigative Adviser</td>
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<tr>
<td>CODIS</td>
<td>Combined DNA Index System</td>
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<tr>
<td>DNA</td>
<td>Deoxyribonucleic Acid</td>
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<tr>
<td>FBI</td>
<td>Federal Bureau of Investigation</td>
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<tr>
<td>FDS</td>
<td>Familial Database Searches</td>
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<tr>
<td>FNAEG</td>
<td>Fichier National Automatisé des Empreintes Génétiques</td>
</tr>
<tr>
<td>LDIS</td>
<td>Local DNA Index System</td>
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<tr>
<td>mtDNA</td>
<td>Mitochondrial DNA</td>
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<tr>
<td>NCIDD</td>
<td>National Criminal Investigation DNA Database</td>
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<tr>
<td>NDIS</td>
<td>National DNA Index System</td>
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<tr>
<td>SDIS</td>
<td>State DNA Index System</td>
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<tr>
<td>SME</td>
<td>Subject Matter Experts</td>
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<tr>
<td>SNP</td>
<td>Single Nucleotide Polymorphism</td>
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<tr>
<td>SWGDAM</td>
<td>Scientific Working Group on DNA Analysis Methods</td>
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<tr>
<td>Y-STR</td>
<td>Short Tandem Repeat on the Y-Chromosome</td>
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1. Introduction

Forensic DNA testing has been one of the great success stories of law enforcement over the past 25 years. The national network of forensic DNA databases in the United States has helped law enforcement solve many crimes, often long after the investigative trail has gone cold. Familial database searches and moderate stringency searches as crime-solving tools have been increasingly used by law enforcement when samples are not resulting in an exact DNA match. Intuitively, familial DNA searching, and other moderate stringency search protocols, could be a productive extension for cases in which there is no exact DNA match. Yet, despite some news stories and anecdotal reports of its use and efficacy, we know little about familial searching or moderate stringency search policies or practices.

A number of regulatory and resource constraints may limit its application and/or adversely impact other avenues of investigation. Where policies have been codified, regulatory constraints have arisen largely as a response to ethical and legal concerns surrounding the use of this method. In yet other jurisdictions, no formal policies are in place to regulate the practice. The lack of a consistent set of policies governing the use of familial searching may reflect lawmakers’ uncertainty about the effectiveness of the procedure or about its unintended implications.

To guide policymakers and improve practice in this area, we conducted a survey of familial and moderate stringency DNA testing practices and policies, conducted interviews with administrators of forensic databases in two states, and conducted interviews with subject matter experts in England and Wales.

Background

Local, State, and National DNA Testing Laboratories

For this report, we investigated the use of familial DNA search and moderate stringency search methods by local and state laboratories in the United States. The Federal Bureau of Investigation (FBI) maintains the Combined DNA Index System (CODIS), a computer program that contains local, state, and national databases of DNA profiles of missing persons and DNA collected from convicted offenders and from crime scene evidence. Having this program allows state, local, and national labs to compare DNA profiles from a specific crime to the entire database of DNA profiles. The National DNA Index System (NDIS) contains the DNA profiles contributed by federal, state, and local participating forensic laboratories. States also maintain DNA databases. The State DNA Index System (SDIS) is often maintained by state crime labs. And finally, individual jurisdictions, often at the county level, maintain a Local DNA Index
System (LDIS). At each level, policies may differ regarding inclusion criteria for DNA sample collection, such as whether the profile was taken from someone who was convicted or arrested or had prior convictions, the type of offense (violent or nonviolent), and the category of offense (felony or misdemeanor).¹

**Samples Contained in DNA Databases**

At inception in the United States, state forensic DNA databases held only the DNA profiles of convicted violent offenders, as defined by each state. Over time, databases have expanded to include virtually all convicted felons, indicted felons, and nearly all felony arrestees. In some states, certain convicted misdemeanants are also within the scope of the DNA databases. In contrast to the United States, where collection policies vary by state, in England and Wales, DNA is taken from all arrestees who have been charged with a recordable offense and all convicted offenders.²

Following practices originally used in England, U.S. forensic DNA databases have steadily increased in size and scope through revision of state statutes to expand the class of individuals for whom a DNA profile is collected.³ Improving public safety outcomes has been the justification behind each legislative change in the United States to expand the database. The use of DNA evidence could increase the likelihood that a crime can be solved and reduce the fraction of perpetrators who can evade detection.

**Forensic DNA Testing**

As a preface to describing the evolution of forensic DNA databases, it is helpful to have a basic understanding of forensic DNA samples and the types of tests used in analysis. Laboratories upload a variety of forensic DNA samples (e.g., complete, partial, or mixtures) from various evidence types (e.g., blood stains, sexual assault kits, “touch DNA”). As of January 1, 2017, CODIS database searches use 20 core loci (40 alleles) from the evidence and offender samples to determine a match.⁴ In England and Wales 10 loci were originally used (20 alleles) whereas now the DNA17 test is used (34 alleles). However, not all forensic samples are complete, single-source DNA samples. A **forensic partial profile** may occur if any locus is missing an allele, which can happen for a variety of reasons, such as when a sample is degraded.

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¹ In the United States, the federal government generally considers a crime punishable with incarceration for one year or less to be a misdemeanor. All other crimes are considered felonies. However, different states may define felonies and misdemeanors in slightly different ways.

² For a summary of the differences in the composition and operation of forensic DNA databases between the two countries, see Jeremiah Goulka et al., *Toward a Comparison of DNA Profiling and Databasing in U.S. and England*, Santa Monica, Calif.: RAND Corporation, TR-918-ISEC, 2010.

³ Goulka et al., 2010.

⁴ Federal Bureau of Investigation, “Frequently Asked Questions on CODIS and NDIS, Question 19,” undated. Question 19 asks, “What are the CODIS core loci?”
When evidence contains a mixture of DNA from more than one person it is referred to as a **forensic mixture**.

All evidence and offender profiles throughout the CODIS system are **Short Tandem Repeat (STR)** DNA profiles consisting of cyclical nucleotide sequences found throughout the human genome, chosen specifically by researchers for their high degree of interpersonal variation and for the fact that they do not convey any medically useful information, making them ideal for identification purposes. A second forensically useful subcategory of short tandem repeats is found only on the Y-chromosome (Y-STR) and is thus exclusive to males. Absent any mutations, Y-STR profiles are the same for all male first-degree relatives of the same paternal lineage (i.e., a father and his sons will all have the same Y-STR profiles, as will their sons). Y-STR profiles are the preferred method of confirming kinship between crime-scene-evidence profiles and candidate offender profiles, both of which are largely from men. On the occasion that either the source of the evidence profile or the candidate offender is female, forensic DNA laboratories may use mitochondrial DNA (**mtDNA**) testing to confirm kinship. Mitochondrial DNA is inherited through the maternal lineage to male and female offspring. Unlike Y-STRs, mtDNA can be used to link mothers to sons and daughters, and male and female siblings to each other. However, this method is less often used in association with familial searching because it carries a higher risk of contamination. Another method of DNA testing uses single nucleotide polymorphisms (**SNPs**) to generate DNA profiles from variation in hundreds of known point mutations in the human genome. SNPs are used for ancestry testing, mostly by private laboratories, not by local, state, or national forensic laboratories.

**Familial DNA Searches, Moderate Stringency Searches, and Partial Matches**

**Familial DNA searching** (see Box 1) expands the scope of forensic DNA databases to persons not currently in the database. Familial searching, modeled after similar efforts in England and Wales, is a variation of **moderate stringency** searching, which uses specialized software outside of CODIS to detect and statistically rank a list of potential candidates. More specifically, when a search lacks a perfect 20-loci DNA match between the crime scene sample and the offender database, called an exact match, authorities at the state level may look for **partial matches** (see Box 2) to determine whether the perpetrator might be a close genetic relative of an offender in the database. This technique has been used in several high-profile cases to identify suspects.

Familial searches and moderate stringency searches are similar conceptually, but not identical. Moderate stringency searches are simpler than familial searches of the database and use the CODIS software to find candidates sharing at least

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**Box 1** Definition: Familial DNA searching is an intentional or deliberate search of the database, in combination with kinship matching algorithms, for the purpose of potentially identifying suspects through partial matches to first-degree relatives who may be in the database.

**Box 2** Definition: The FBI defines a partial match as a match between two single-source profiles having at each locus all of the alleles of one sample represented in the other sample after a purposeful familial search or unintentional, general moderate stringency search. Partial matches are also referred to as near or close matches.
one allele at each locus. Some state policies also stipulate that these partial matches suggestive of
kinship must be discovered by happenstance, or routine moderate stringency searches, rather
than through a deliberate familial search for relatives. Familial searching, by contrast, uses
additional population genetics analysis to rank the partial matches by kinship likelihood. Results
from familial searches and moderate stringency searches are partial matches.

Legal and Ethical Considerations

The application of these new procedures raises difficult legal and ethical issues. Familial
searching and moderate stringency searching methods effectively increase the number of
individuals to investigate because they include individuals who have not been convicted,
arrested, or even suspected of committing a crime, which raises important concerns about
intrusiveness and privacy.5 Some have characterized the technique as racially biased genetic
surveillance because the offender DNA databases are disproportionately comprised of people of
color,6 and, as a result of this disproportion, increased use of familial DNA testing may
disproportionately lead to suspicion of suspects of color. This may, in turn, perpetuate existing
inequalities in both the allocation of punishment and the makeup of DNA databases.7 However,
it is worth noting that because people of color are more likely to be either imprisoned or the
victims of crime in the United States, familial searching could result in the exoneration of Black
and Latinx people at a disproportionate rate as well.8

Utilization of Familial DNA and Moderate Stringency Searches

Despite some anecdotal success stories, and emphatic assertions from government officials
about the value of familial searching,9 it is unclear whether familial or moderate stringency
searches are more cost-effective overall than the status quo, focusing only on exact 20-loci
(40-alleles) matches.

Familial DNA searching success stories have largely involved persons who had eluded law
enforcement in part because they had stopped offending years or sometimes decades earlier.
Thus far, familial searching has not played a significant role in addressing immediate threats to

5 R. Williams and P. Johnson, “Inclusiveness, Effectiveness, and Intrusiveness: Issues in the Developing Uses of
DNA Profiling in Support of Criminal Investigations,” Journal of Law, Medicine, and Ethics, Vol. 33, No. 3, 2005,
pp. 545–558.
6 H. Greely et al., “Family Ties: The Use of DNA Offender Databases to Catch Offenders’ Kin,” Journal of Law,
Medicine, and Ethics, Vol. 34, No. 2, 2006, pp. 248–262.
Litigants’ Access to DNA Database Searches to Prove Innocence,” Boston College Law Review, Vol. 60, No. 2,
9 Daniel Schorn, “A Not So Perfect Match: How Near DNA Match Can Incriminate Relatives of Criminals,” 60
Minutes, April 1, 2007; L. Kepler, “More States Use Familial DNA as Powerful Forensic Search Tool,” Reuters,
March 30, 2011.
public safety. Nonetheless, it is possible that the application of the method may indirectly increase public safety by freeing up resources devoted to investigating cold cases; it may also have a deterrent effect on criminal behavior by increasing the probability of detection.\textsuperscript{10}

To our knowledge, while familial and moderate stringency searching has shown promise as a method that can help law enforcement solve serious cases that might otherwise go unsolved, we currently have only a very limited understanding of the history, prevalence, and typical practice of this technique. In this study we examine several questions:

- What are the characteristics of the type of quality of DNA samples collected in the United States?
- What is the typical process for familial or moderate stringency searching and partial match reporting in the United States?
- How often is familial and moderate stringency search practiced in the United States?
- Can the history and practice in England and Wales inform decisionmaking for policymakers in the United States?

Before turning to these questions, we conducted a preliminary search of the literature to determine what is known about existing laws, regulations, and policies governing familial and moderate stringency match searches. We then addressed the research questions through a mixture of surveys and qualitative interviews.

2. Methods

Research Design

We conducted four study tasks: (1) a literature review that provides an overview of relevant laws, regulations, policies, and practices, at the state level; (2) analysis of survey data from participating state and local DNA index system laboratories with varying familial and moderate stringency DNA search policies; (3) analysis of interviews with representatives of two states, California and Texas, with varying familial search use and partial match reporting policies; and (4) analysis of interviews with English and Welsh stakeholders on the use of familial searching. With this combination of study tasks, we seek to provide guidance to policymakers considering policies on familial and moderate stringency DNA searches.

Review of the Literature

As part of this report, we provide an overview of forensic DNA laws, regulations, policies, and practices that govern the use of familial DNA or moderate stringency searches.

SDIS and LDIS Laboratory Survey

We invited all SDIS and LDIS administrators to participate in this study.1 The survey sample was defined by all 195 state and local forensic facilities that listed DNA testing as one of their services in the 2014 Census of Publicly Funded Crime Laboratories.2 Each one of the states has one SDIS laboratory, which in some cases also serves as the only LDIS laboratory in the state (e.g., Alaska, Connecticut, Wyoming). These laboratories were asked to return both LDIS and SDIS surveys.3

We administered the survey by using a multimode approach: online and hard copy.4 After verifying the names and addresses of the proper recipients, we mailed a copy of the survey to each CODIS state administrator. Accompanying the survey was a cover letter briefly explaining the purpose of the research and the importance of getting a response from as many of the state labs as possible. The cover letter also provided instructions for accessing the survey online. We

1 The District of Columbia, while it has its own SDIS, is essentially a local DNA database.
3 The surveys were nearly identical but included a handful of questions that were tailored to whether it was an LDIS or SDIS lab. The survey instruments are included as Appendix A.
4 While a multimode survey approach can be problematic if there is reason to believe that responses might vary by mode, such concerns are minimal in this context. Our survey exclusively asks questions of a factual nature, which are less subject to measurement error arising from modal response variation.
sent a follow-up letter two weeks after the original launch. After four weeks, we followed up by phone in order to collect the survey information from as many states as possible.

Qualitative U.S. State Laboratory Interviews

We conducted semistructured interviews with administrators in two states with familial DNA testing policies to gain a more in-depth understanding of the procedures of familial and moderate stringency DNA searches. The case studies permitted collecting more data than was possible for all 50 states.

One case study examined a state where familial searching and moderate stringency match reporting is explicitly permitted. A second case study focused on a state that allows reporting of moderate stringency matches suggestive of kinship in certain circumstances to understand the implications of this policy option.

The topics discussed during the interviews were

- processes on the use of familial moderate stringency searches and the resulting partial matches
- stakeholders involved in authorizing, conducting, and overseeing familial or moderate stringency searches
- types of cases for which these searches are used
- technical processes, technology involved, and advances in technology (e.g., increased sensitivity)
- costs and cost-effectiveness
- ethical issues (e.g., privacy, government intrusion, discrimination, public vs. individual rights, consent, revealing personal relationships, civic responsibility to cooperate with police)
- any knowledge of changes to local or state policies on the use of familial moderate stringency searches and the resulting partial matches.

The interviews were informally analyzed to identify themes.

Qualitative England and Wales Stakeholder Interviews

We conducted semistructured interviews with eight English and Welsh subject matter experts (SMEs) who are academics, practitioners, a biometrics expert, and policy professionals within the National Police Chiefs’ Council.\(^5\) We asked about the history of the current policy regarding familial DNA searching and the perceived advantages and disadvantages of the present policy (or lack thereof). We also interviewed SMEs about implementation of the current policy. The topics discussed during the semistructured interviews were

\(^5\) We used a convenience sample of recognized subject matter experts within the National Police Chiefs’ Council.
• processes, stakeholders and institutions involved in authorizing, conducting, and overseeing these searches
• national and European Union regulations on the use of DNA for these searches (e.g., data retention, national forensics strategy)
• types of cases for which these searches are used
• technical processes, technology involved, and advances in technology (e.g., increased sensitivity)
• costs (e.g., how searches are funded and their cost-effectiveness)
• number of searches run every year
• how searches form part of criminal investigations
• ethical issues (e.g., privacy, government intrusion, proportionality, public vs. individual rights, consent, revealing personal relationships, civic responsibility to cooperate with police)
• attitudes of the public.

The qualitative interviews were informally analyzed by theme to examine how the issues of privacy, public safety, and budget consciousness have shaped the familial searching policies in England and Wales.
3. Results

Review of the Relevant Literature

History and Context of DNA Search Policies

Familial DNA searches were “imported” to the United States from England, where there were some high-profile successes using the technique as an investigative tool. Familial searches were first used in England in 2002 and led police to the perpetrator of three cold-case homicides through the DNA of his son, who committed auto theft and whose DNA was already in the database.¹

Moderate stringency searching for relatives was first used in the United States in 2006, after Denver’s district attorney learned that the CODIS administrators would not release the names of three partial database matches to DNA found at a crime scene in a Colorado serial rape investigation. The district attorney successfully petitioned the FBI to let states determine their own moderate stringency search policies. In the Colorado case, none of the results of the searches led to a suspect.²

In the spring of 2008, the FBI, under the advisement of the Scientific Working Group on DNA Analysis Methods Ad Hoc Committee on Partial Matches, revised CODIS protocols to let states decide whether to use their SDIS databases to conduct familial searches, though the practice has not been adopted at the federal (NDIS) level. Shortly thereafter, California’s then–Attorney General Jerry Brown approved its use by the California Department of Justice Bureau of Forensic Services.³ SDIS database management personnel, working with California Department of Justice attorneys, developed a familial search policy that was sensitive to Fourth Amendment and privacy concerns, had adequate checks and balances, and erred on the side of caution.⁴

California was the first state to authorize intentional familial searching, and in 2010, the technique led to the identification of the “Grim Sleeper,” a serial killer who murdered several women in south Los Angeles over a span of three decades. However, the state’s first nine

⁴ California Department of Justice, Bureau of Forensic Services, 2011.
familial searches were unsuccessful.\textsuperscript{5} Prior to 2008, the California SDIS laboratory had handled partial matches suggestive of kinship on a case-by-case basis. If an LDIS laboratory wanted the name of the offender associated with such a match, Y-STR testing would have to show concordance. The familial searching memo formalized partial match reporting policy.

In early 2010, with policies of Colorado and California as models, the director of the Texas Department of Public Safety asked the SDIS administrators to devise a procedure for familial search in response to a series of unsolved sexual assaults of elderly women. With the assistance of attorneys from the Texas Department of Public Safety, SDIS administrators devised formal familial search and partial match policies that were implemented by late summer 2010. Once the policies were finalized, both SDIS laboratories conducted outreach to raise awareness of familial DNA searches as a new investigative tool among criminal justice agencies around the state.

Since 2010, several researchers have completed national surveys of familial and moderate stringency searching policies and people’s perceptions of the search technique, highlighting the variety and vagaries of the rules governing its use.\textsuperscript{6} State policies showed a preference for allowing moderate stringency partial match reporting over deliberate familial searching of the DNA database. In 2010, 15 states allowed incidental partial match reporting up to 24 states,\textsuperscript{7} and by 2015, 11 states—California, Colorado, Florida, Michigan, Minnesota, Pennsylvania, Texas, Utah, Virginia, Wyoming, and Wisconsin—had familial searching efforts.\textsuperscript{8}

While it didn’t become law, in 2011, Democratic Congressman from California Adam Schiff introduced House Bill 3361, the first of its kind to attempt to enact uniform procedures across federal and state lines that explicitly outline the protocols and parameters for a partial match search.\textsuperscript{9} Perhaps it is time for policies to permit familial DNA searching at the national level and for explicit and uniform policies for all SDIS and LDIS laboratories, at least in the most serious cases.

Compared to efforts to expand the scope of DNA databases in the United States by including even felony arrestees and convicted misdemeanants, the adoption of familial DNA searching has been more limited. The practice has only been explicitly authorized by a handful of states,\textsuperscript{10} and

\begin{itemize}
\item \textsuperscript{7} Ram, 2011; Debus-Sherrill and Field, 2019; Michael B. Field et al., “Study of Familial DNA Searching Policies and Practices: Case Study Brief Series,” ICF, 2017.
\item \textsuperscript{9} Utilizing DNA Technology to Solve Cold Cases Act of 2011, H.R. 3361, 112th Congress (2011).
\item \textsuperscript{10} Federal Bureau of Investigation, “Laboratory Services: Familial Searching,” 2011.
\end{itemize}
several states have explicitly prohibited its use. The closely related technique of moderate stringency searches, however, appears to be more widespread.\textsuperscript{11}

\textit{DNA Testing}

The FBI has organized the Combined DNA Index System (CODIS) database, enabling forensic laboratories to compare unknown crime scene DNA samples to known individual DNA samples contained within the databases. CODIS was originally intended to store samples from known sex offenders, but many states have since extended their local and state DNA database to include violent and nonviolent offenders. While forensic DNA testing capacity in the United States has grown considerably over the last decade, it has not kept pace with demand. A substantial amount of DNA evidence awaits testing.\textsuperscript{12} In 2010, Nelson and colleagues estimated that offender samples rose from about 600,000 to 1 million between 2007 and 2009.\textsuperscript{13} In 2015, the White House estimated untested sexual assault samples at over 400,000 nationally.\textsuperscript{14}

\textit{Measuring the Effect of DNA Policies}

Over the past decade, few empirical studies of the impact of DNA database performance have been undertaken. Peterson and colleagues examined outcomes for a random sample of 602 sexual assault cases and 400 homicides that occurred in Los Angeles County and Indiana between 2000 and 2005.\textsuperscript{15} Only 12 cases had DNA uploaded to the CODIS database, and only four had matched to offenders. Because DNA testing capacity is limited, questions have arisen as to whether it should be applied to less serious offenses. Roman and colleagues investigated the impact of DNA testing on property crimes and found that offenders were five times more likely to be identified and nine times more likely to be arrested with DNA testing as opposed to fingerprint evidence.\textsuperscript{16} In addition, perpetrators identified through DNA testing tended to have more serious criminal histories, averaging two more prior felony convictions and about four

\textsuperscript{11} Ram, 2011.
\textsuperscript{13} Nelson, 2010.
more prior felony arrests than perpetrators identified through other investigative means. The study concluded that DNA testing is a cost-effective approach to property crime investigation, but as the authors point out, if DNA testing of property crime evidence becomes routine (particular where it involves testing of items the perpetrator may have briefly handled for “touch DNA”), it could overwhelm not only the crime laboratories but the criminal justice system as a whole.17

Researchers have capitalized on the timing of database expansion, which can differentially affect offenders released from prison within days of each other, to examine the probative and deterrent effects of DNA databases. **Probative effects** refer to the ability of DNA databases to identify and convict the true perpetrator, and **deterrent effects** refer to the ability of these databases to compel those in it to desist from crime for fear of being detected. Thus, these studies estimate the likelihood that a parolee in the DNA database will reoffend (and be apprehended) as compared to the likelihood a parolee convicted of the same offense, who, because he was released just before the change in eligibility went into effect, is not in the DNA database. A report prepared for The Urban Institute estimated a small deterrent effect (2–3 percent decrease) for the offenses of robbery and burglary only, but large probative effects (20–30 percent increase) for other felonies.18

A more thorough analysis completed by Jennifer Doleac in 2012 showed that the deterrent and probative effects of DNA databases mask each other, such that any estimated increase in the likelihood of reoffending is a lower bound on the probative effect, and any estimated decrease in the likelihood of reoffending is an upper bound on the deterrent effect.19 Using a regression discontinuity design that compared offenders released from custody just before and just after enactment of DNA database statutes that made them eligible for sampling, Doleac estimated that DNA-profiled offenders are 23 percent more likely to be convicted of another crime within three years of release. This suggests that the probative effect of the DNA database outweighs any deterrent effect. Using the plausibly exogenous timing of state database expansions, she finds that the combined deterrent and probative effects of adding felony convicts decreased violent and volume property crime rates. A 12-percent increase in database size (i.e., the approximate impact of adding felony arrestees to state databases) decreased murders by 3.2 percent, rapes by 6.6 percent, aggravated assaults by 2.9 percent, and vehicle thefts by 5.4 percent.20

17 Roman et al., 2018.
19 Doleac, 2012.
20 Doleac, 2012.
Statisticians and population geneticists have examined familial and moderate stringency search algorithms on simulated and actual DNA databases.\textsuperscript{21} A common conclusion among these studies is the importance of striking a balance between false positives and negatives. Search parameters that are too loose will yield a flood of spurious candidates, while an overly stringent algorithm risks excluding actual first-degree relatives. Use of identity by state (the number of alleles that are the same) in combination with a kinship likelihood ratio, which also takes allele frequencies into account, is preferable to either method by itself, but neither method is foolproof.\textsuperscript{22} Furthermore, familial searching methods do not distinguish related and unrelated individuals as well for subpopulations with lower genetic variation, such as Native Americans.\textsuperscript{23}

**Legal, Social, and Policy Effects of Expanding Genetic-Based Investigation**

There is substantial literature characterizing some of the legal and policy concerns raised by familial searching. The conventional justification for mandated collection of DNA samples from convicted or arrested offenders is that they have a diminished expectation of privacy as a result of their conviction or arrest. This justification obviously does not apply to offenders’ relatives who may be implicated in familial searches, raising ethical and constitutional concerns over what the searches may uncover about differences in genetic and social family relationships.\textsuperscript{24} To the extent that people of color are overrepresented in the offender database, they are differentially affected by the use of familial searching.\textsuperscript{25} Greely and colleagues hypothesized that the percentage of Black people identified as suspects through this method would be approximately four or five times as high as the percentage of people of European descent.\textsuperscript{26}

A noteworthy aspect of the policy debate is the distinction drawn between “partial matches” suggestive of kinship that occur by happenstance in the course of moderate stringency database searches and “partial matches” that occur after deliberate familial searches are undertaken with


\textsuperscript{22} See Myers et al., 2011; Ge et al., 2011.


the intent of finding potential first-degree relatives within the offender database. A number of states (as well as the federal government) authorize the reporting of these informal, fortuitous partial matches but do not allow deliberate familial searches of the DNA database, a policy response that has been interpreted as a strategy for conducting familial searches with less scrutiny and controversy. Researchers have suggested that this distinction between the accidental discovery of familial matches via moderate stringency searches and deliberate efforts to conduct familial searches is illogical.

**International Use of Familial and Moderate Stringency Searches**

Forensic DNA databases are now well established in many countries in the world. The first government database was set up by the United Kingdom in 1995 followed by New Zealand. France has the second-largest DNA database in Europe, with the Fichier National Automatisé des Empreintes Génétiques (FNAEG) established in 1998. The Australian National Criminal Investigation DNA Database (NCIDDD) has been in use nationally since April 2001, and since then more than 1.2 million DNA profiles have been uploaded. In 2018, an investigation conducted by the South Australian Police resulted in the intelligence lead, arrest, and conviction of an individual, which is believed to be the first conviction using familial search techniques in Australia.

Granja and Machado review the use of familial searching in the United Kingdom and Poland. They argue that the use of familial searching depends in part on the national context and examine its use in missing persons cases.

Amankwaa and McCartney discuss the implications of the European Court of Human Rights decision in *S. and Marper v. the United Kingdom*. This case had the effect of changing the rules about indefinite retention of DNA information and subsequent changes in the relevant U.K. laws. In a separate paper, they have also analyzed the effectiveness of the U.K. national

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database, noting that there is a lack of good data necessary to draw strong conclusions on the effectiveness of the database.\textsuperscript{34}

\section*{Survey Results}

\textbf{SDIS Respondent Summary}

We received responses from nine of the 50 SDIS laboratories. None of the surveys we received were complete. Eight of the ten SDIS surveys returned were filled out by the CODIS manager or administrator, one by the biology unit supervisor, and one by the laboratory director. Figure 3.1 shows which states responded.

\begin{figure}[h]
\centering
\includegraphics[width=\textwidth]{Fig31.png}
\caption{SDIS Laboratory Respondents (2018)}
\end{figure}

\section*{SDIS Laboratory Characteristics}

SDIS laboratories were asked to report the number of forensic uploads in each category in 2010 and 2018. The survey requested that respondents indicate the number of forensic partials, forensic mixtures, and forensic profiles for various evidence types (e.g., blood stains, sexual

\begin{footnotesize}
\end{footnotesize}
assault kits, “touch DNA”). None of the SDIS laboratories reported this information. For SDIS laboratories, both the average number and the share of single-source forensic profiles declined; forensic partial profiles outpaced forensic mixtures between 2010 and 2018 at the SDIS level (Figure 3.2). One SDIS laboratory stated that it does not accept mixture profiles, which may in part explain this finding.

Figure 3.2. SDIS Laboratories: Average Number of Forensic Uploads by Category, 2010 vs. 2018

SDIS Partial Match/Familial Search Practices

SDIS laboratories were asked to indicate whether they had ever shared the names of offenders linked to fortuitous partial matches with investigators, and whether they had ever helped investigators seek and identify potential suspects through a familial search of the SDIS database.

Three SDIS laboratories report fortuitous partial matches to aid investigations, and none conducted deliberate familial searches. SDIS laboratories that use fortuitous partial matches were asked whether they conducted Y-STR or mtDNA testing to confirm the likelihood of kinship before releasing the candidate’s name to investigators. One of the three SDIS laboratories that reported fortuitous partial matches uses Y-STR testing to confirm kinship, whereas the other two require that the results are inspected and certified by two equally qualified DNA analysts.

State Matches by Type

SDIS laboratories were asked to provide counts of the number of exact matches (total and confirmed) and moderate matches (total and confirmed) at the state/national levels. If a match exists, laboratories perform a confirmation process intended to verify that no administrative...
errors occurred while analyzing the offender sample. That process varies among laboratories. Table 3.1 lists the total counts and change in share of total reported matches between 2010 and 2018 (prorated) for state and national matches. The share of exact matches increased between 2010 and 2018. Both the absolute number and the share of moderate and partial matches decreased in 2018. A lower (and decreasing) rate of return on moderate and partial matches is observed among the responding SDIS laboratories. The bottom row shows the percent change in the number of total matches between 2010 and 2018.

**Table 3.1. SDIS Laboratories: Total Counts for DNA Database Matches, 2010 and 2018 (Prorated)**

<table>
<thead>
<tr>
<th></th>
<th>2010 (Prorated)</th>
<th>2018 (Prorated)</th>
<th>Percent Change in Share of Total Matches</th>
</tr>
</thead>
<tbody>
<tr>
<td>Exact NDIS/SDIS matches</td>
<td>844</td>
<td>1415</td>
<td>48%&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
<tr>
<td>Exact NDIS/SDIS matches confirmed</td>
<td>464</td>
<td>557</td>
<td>–11%</td>
</tr>
<tr>
<td>Moderate and partial SDIS/NDIS candidate matches</td>
<td>909</td>
<td>956</td>
<td>–22%</td>
</tr>
<tr>
<td>Moderate and partial SDIS/NDIS matches confirmed</td>
<td>330</td>
<td>140</td>
<td>–69%</td>
</tr>
<tr>
<td>Total matches</td>
<td>1,753</td>
<td>2,371</td>
<td>35%&lt;sup&gt;b&lt;/sup&gt;</td>
</tr>
</tbody>
</table>

<sup>a</sup> The third column is a percent change in a percentage, derived by taking, for example, exact matches 2010/total matches 2010, then exact matches 2018/total matches 2018, and from that calculating (2018 percentage – 2010 percentage)/2010 percentage. Example: (844/1753) = .48 and (1441/2371) = .59; (.59-.48)/.48 = .24 or 24% change as a share of total matches.

<sup>b</sup> Percent increase in total matches, 2018 vs. 2010. Confirmations are a subset of matches and thus do not count toward the total.

SDIS laboratories were asked to remark on why they could not complete all items in this portion of the survey. The six of ten SDIS laboratories that responded to the item indicated that it was either “too time-consuming” or “required data they do not collect.”

**Future Changes for SDIS Laboratories**

The final items on the SDIS surveys requested data from laboratories regarding what changes they would like to see for improving efficiency and efficacy of CODIS operations and what policy changes are on the horizon. Responding SDIS laboratories were focused on hiring additional personnel because current staff struggle to keep pace with DNA testing and database management responsibilities.
**LDIS Respondent Summary**

We received responses from 26 LDIS laboratories. None of the surveys we received were complete. Half of the 26 LDIS surveys returned were filled out by a person with CODIS manager or CODIS administrator in their job title. Figure 3.3 shows which states responded.

![Figure 3.3. LDIS Laboratory Respondents by State](image)

**LDIS Laboratory Characteristics**

Technology has permeated steadily and has the potential to affect the number and quality of the forensic profiles, partials, and mixtures. LDIS labs were asked about whether probabilistic genotyping software was in use or in the validation stage. As Figure 3.4 shows, 11 responding LDIS laboratories are using probabilistic genotyping software to interpret DNA profiles derived from crime scene evidence, six were in the process of validating probabilistic genotyping software at the time they were surveyed (and if validation proceeds according to schedule they are now online), while nine responding LDIS laboratories reported no immediate plans to switch from their current evidence profile interpretation method.
Partial matches and familial search candidate pools can be reduced and resolved through testing of additional loci. Effective in 2017, the FBI mandated the use of CODIS 20 STRs for NDIS-participating laboratories. \textsuperscript{35} LDIS laboratories have also been encouraged to add Y-STR testing to their forensic DNA to facilitate partial match and familial search confirmations. \textsuperscript{36}

Figure 3.5 shows 25 of 26 LDIS laboratories that responded to the survey currently use CODIS 20 STRs. Eighteen of the responding LDIS laboratories conduct Y-STR testing as well, with another four relying on contract laboratories for the service. With regard to mtDNA testing, only six responding LDIS laboratories conduct or outsource this method. Even fewer of responding LDIS laboratories have adopted newer DNA analysis technologies such as SNPs and next-generation sequencing.

\textsuperscript{35} Federal Bureau of Investigation, “Frequently Asked Questions on CODIS and NDIS, Question 19,” undated.

The LDIS survey asked laboratories to list the categories of DNA profiles contained in their LDIS databases, which are determined by the LDIS laboratories themselves. Figure 3.6 shows the breakdown of LDIS databases by category among responding laboratories.

37 FBI audits of LDIS laboratories are intended to ensure that “(1) Laboratory is in compliance with the NDIS participation requirements; (2) Laboratory is in compliance with the Quality Assurance Standards (QAS) issued by
By design, local public crime laboratories that derive DNA samples from casework will enter complete forensic profiles, partials, and mixtures in their LDIS databases for upload to the SDIS, and NDIS databases, if the samples meet the current match estimate threshold.\textsuperscript{38} Thus, these results are expected from LDIS laboratories. Eighteen of the LDIS laboratories that responded indicated that they also retain forensic profiles, partials, and mixtures ineligible for SDIS and NDIS. The same fraction reported also maintaining elimination/contamination profiles from laboratory and law enforcement personnel; two LDIS labs retain profiles of persons involved in the manufacturing of DNA testing reagents and equipment. Thirteen of the responding LDIS laboratories retain suspect/person-of-interest profiles, and a subset of eight reported retaining suspect profiles in LDIS only, while the remaining five LDIS laboratories reported that they shared some suspect profiles with SDIS in accordance with the law.

As a means of ensuring that our understanding of CODIS terminology was consistent with LDIS laboratories, our survey asked LDIS laboratories whether they agree or disagree with statements about partial matches and moderate stringency searches taken from the wording of the FBI webpage on CODIS and NDIS.\textsuperscript{39} Figures 3.7 and 3.8 show that a majority of responding LDIS laboratories agreed with both statements. When respondents disagreed with the partial match statement, it was because they currently report partial matches as “no match.” One LDIS laboratory that disagreed with the moderate stringency statement replied that “moderate stringency searches also account for typing discrepancies (null alleles) arising from different DNA testing kits.”

\textsuperscript{38} The National DNA Index System and most State DNA Index System laboratories have, of necessity, switched from heuristics of minimum number of loci (for forensic partials) and minimum number of loci with four alleles (for forensic mixtures) to database match estimator (DME) tools, which divide the CODIS software random match probability for the partial or mixture profile by the number of profiles in the database. Forensic profiles and forensic mixtures with a DME greater than 1 are discouraged from being uploaded.

\textsuperscript{39} Federal Bureau of Investigation, “Frequently Asked Questions on CODIS and NDIS, Questions 25 and 28,” undated.
Figure 3.7. LDIS Laboratory Responses (A partial match is a search of a DNA database that results in one or more hits between offender and forensic DNA profiles that share at least one allele at each locus, suggesting a potential parent-child relationship)

Figure 3.8. LDIS Laboratory Responses (The default moderate stringency setting for searching DNA profiles in CODIS accounts for the fact that crime scene profiles are often partially degraded and/or contain DNA from more than one contributor)
Our research team was interested in whether probabilistic genotyping software, CODIS 20 STRs, and the growing use of DNA testing on trace DNA samples in property crimes had increased the fraction of forensic partials and forensic mixtures in LDIS and SDIS databases. LDIS laboratories were asked to report the number of forensic partials, forensic mixtures, and forensic profiles they had uploaded to SDIS in the year 2010 and in the current year (2018) to date.

The survey requested that respondents indicate a number for forensic partials, forensic mixtures, and forensic profiles for various evidence types (e.g., blood stains, sexual assault kits, “touch DNA”), but only one responding LDIS laboratory with a very small LDIS database had the necessary metadata to provide this information. Figure 3.10 shows the change in the average number of forensic profiles, mixtures, and partials from 2010 to 2018 among responding LDIS laboratories, prorated according to the date the survey was received. The mean number of uploads increased in all three categories.40 However, as Figure 3.10 shows, the increase was somewhat uneven, with forensic partials comprising a slightly smaller share of the total and the share of forensic mixtures more than doubling, from 11 percent to 27 percent. Between 2010 and 2018, the number of forensic partials increased by a higher percentage among LDIS laboratories that do not yet have probabilistic genotyping software in use, whereas the number of forensic

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40 These results were not driven by huge increases at one or two LDIS laboratories; the majority of responding LDIS laboratories, though not all, reported increases in all three categories.
mixtures increased by a higher percentage in LDIS laboratories that were using probabilistic genotyping software in 2018.

Figure 3.10. LDIS Laboratories: Average Number of Forensic Uploads by Category, 2010 vs. 2018

![Bar chart showing forensic uploads by category for 2010 and 2018.]

**LDIS Familial Search and Partial Matches**

LDIS laboratories were asked to indicate whether they had ever shared the names of offenders linked to fortuitous partial matches with investigators and whether they had ever helped investigators seek and identify potential suspects through a familial search. Responses for LDIS laboratories are summarized in Figure 3.11. More than twice as many of the responding LDIS laboratories reported using familial search as fortuitous partial matches to aid investigations, though fewer than half acknowledged using either. No labs that participate in conducting familial searches rely on fortuitous partial matches, and vice versa, thus the two methods were mutually exclusive among responding LDIS laboratories. All three of the responding LDIS laboratories that use fortuitous partial matches performed or outsourced Y-STR testing, but only seven of the 16 responding LDIS laboratories that performed outsourced Y-STRs use familial searching (data not shown).
LDIS laboratories that use fortuitous partial matches were asked whether they conducted Y-STR or mtDNA testing to confirm the likelihood of kinship prior to releasing the candidate’s name to investigators. Only one of the three responded, and they indicated they did not. When asked about the review process before releasing candidate names to investigators, LDIS laboratories indicated that either two analysts or an analyst and a supervisor would review the data before notifying the state to re-run the candidate sample and release the name if consistent.

The same questions were put to the 30 percent of responding LDIS laboratories that use familial searching. Six of eight responded that Y-STR testing on the evidence sample is a prerequisite for undertaking the familial search. Of the remaining two, one laboratory indicated that it performs Y-STR testing if possible, and both of the labs indicated that they verify candidate plausibility (age and residence when crime occurred) through criminal records before releasing names to investigators (investigators are instructed to take surreptitious samples, such as discarded cigarettes or eating utensils, for confirmation).

**Local Matches by Type**

LDIS laboratories provide counts of the number of exact matches and moderate matches at the local and state/national levels. Table 3.2 lists the total counts and change in share of total reported matches between 2010 and 2018 (prorated) for local and state/national matches.
Table 3.2. Total Counts for Local and State DNA Database Matches Among Responding LDIS Laboratories, 2010 and 2018 (Prorated)

<table>
<thead>
<tr>
<th>Category</th>
<th>2010</th>
<th>2018 (Prorated)</th>
<th>Percent Change in Share of Total Matches</th>
</tr>
</thead>
<tbody>
<tr>
<td>LDIS matches involving persons of interest ineligible for SDIS</td>
<td>1</td>
<td>19</td>
<td>1,188%</td>
</tr>
<tr>
<td>LDIS matches involving forensic partial or forensic mixture profiles ineligible for SDIS</td>
<td>1,095</td>
<td>995</td>
<td>−37%</td>
</tr>
<tr>
<td>Exact NDIS/SDIS matches</td>
<td>10,482</td>
<td>11,096</td>
<td>−27%</td>
</tr>
<tr>
<td>Exact NDIS/SDIS matches confirmed</td>
<td>7,690</td>
<td>5,943</td>
<td>−26%</td>
</tr>
<tr>
<td>Moderate and partial SDIS/NDIS candidate matches</td>
<td>20,710</td>
<td>34,475</td>
<td>16%</td>
</tr>
<tr>
<td>Moderate and partial SDIS/NDIS matches confirmed</td>
<td>2,065</td>
<td>3,252</td>
<td>9%</td>
</tr>
<tr>
<td>Familial search candidates</td>
<td>0</td>
<td>1</td>
<td>NA</td>
</tr>
<tr>
<td>Familial search candidates confirmed</td>
<td>0</td>
<td>0</td>
<td>NA</td>
</tr>
<tr>
<td>Total matches</td>
<td>32,288</td>
<td>46,586</td>
<td>44% a</td>
</tr>
</tbody>
</table>

a The third column is a percent change in a percentage, derived by taking, for example, exact LDIS matches 2010/total matches 2010, then exact LDIS matches 2018/total matches 2018, and from that calculating (2018 percentage − 2010 percentage)/2010 percentage. Example: 1095/32,288 = .03 and 995/46,586 = .02; (.02 − .03)/.03 = −.37 or −37% change in share of total matches.

As a follow-up question, LDIS laboratories were asked to comment on why they could not complete all items in this portion of the survey. Seven of eight responding LDIS laboratories replied that it was either “too time-consuming” or “required data they do not collect.” One responding LDIS laboratory commented on the definition of “confirmed,” stating that “according to their definition, there is no distinction between candidate matches and true matches.”

**Future Changes for LDIS Laboratories**

The final items on the LDIS survey solicited input from laboratories about what changes they would like to see for improving efficiency and efficacy of CODIS operations and what policy changes are on the horizon. Responses to the first question included process streamlining through automated intra- and inter-laboratory correspondence, because, as one respondent noted, “Paperwork has become overwhelming as the number of matches has increased over the years.” Other respondents were interested in seeing improvements in CODIS software that would
facilitate data queries and production of statistical reports. Most (10/16) of the responding LDIS laboratories replied “No” to the second question. The remainder mentioned changes to CODIS software including possible familial searching capability and the addition of a “Forensic Targeted” category, for partial or mixture sample that does not meet SDIS/NDIS moderate match estimation thresholds but can meet match rarity estimate thresholds if specific loci are search at moderate stringency.

U.S. Interviews

California and Texas, the two largest states by population, also have the two largest SDIS databanks. California has one of the nation’s most proactive DNA sampling regimes, mandating DNA collection from all felony arrestees, regardless of adjudication. DNA database laws in Texas are more restrictive; the state collects DNA from convicted felons only if they are sentenced to prison, and felony arrestees are not sampled unless and until they are arraigned. In Texas, DNA profiles from felony arrestees who are acquitted or not proceeded against are automatically expunged, whereas California requires individuals to petition for expungement. Consequently, as of September 2018, California’s DNA database had 2,007,874 (5.1 percent of the population) convicted offender profiles and 760,395 (2 percent) arrestee profiles, while the Texas state databank holds 884,548 (3 percent) convicted offender profiles and roughly 85,000 (0.3 percent) arrestee samples. There is some unknown number of duplicates in these databanks, as arrestees are not purged from the arrestee database upon conviction or subsequent felony arrests.

The rapid expansion of their DNA databanks, combined with the fact that each state also has several major metropolitan LDIS laboratories uploading hundreds of forensic profiles every month, means that California and Texas generate numerous “hits” every month (hundreds in the case of California), some portion of which are not exact matches. Thus, these SDIS laboratory administrators have dealt extensively with moderate stringency matches. Both Texas and California were early adopters of familial searching as well. California added familial searching to its capabilities in 2008 and Texas followed in 2010.

Moderate Stringency Matches

Management from the California and Texas SDIS laboratories both stated that moderate stringency matches were a routine part of database administration. They pointed out that inspection and disposition of moderate matches is primarily the responsibility of the submitting LDIS laboratory. The SDIS laboratories only have to indicate “No Match” for those determined to be adventitious (LDIS labs can also do this) and type the offender sample again to confirm

those deemed legitimate by the LDIS laboratories, just as they would for exact matches. Neither state’s SDIS laboratory had data available on the number of moderate matches in relation to the total or the percentage of moderate matches that are confirmed. The state CODIS administrator in California stated that moderate stringency matches were a small fraction of the total, whereas the state CODIS administrator in Texas felt the majority of matches were moderate stringency and becoming more frequent because of growth in the database.

**Policies and Procedures**

California and Texas have very similar policies and procedures for partial matches suggestive of kinship and for familial searching, though there are some key differences. Similarities and differences are summarized in Table 3.3.

<table>
<thead>
<tr>
<th></th>
<th>California</th>
<th>Texas</th>
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<tbody>
<tr>
<td><strong>FDS searches include arrestee database</strong></td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td><strong>FDS searches include females</strong></td>
<td>Yes</td>
<td>No</td>
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<tr>
<td><strong>FDS committee approves requests</strong></td>
<td>Yes</td>
<td>Yes</td>
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<tr>
<td><strong>FDS committee meets in person</strong></td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td><strong>FDS candidate threshold for Y-STR testing</strong></td>
<td>Top 168 by expected kinship ratio</td>
<td>Test as many as exceed expected kinship ratio</td>
</tr>
<tr>
<td><strong>Notification</strong></td>
<td>Law enforcement agency, district attorney, and LDIS lab reps travel to SDIS lab</td>
<td>SDIS administrator travels to LDIS lab</td>
</tr>
</tbody>
</table>

*aThe Texas arrestee database is much smaller than the California arrestee database because Texas law requires an indictment before a sample is taken and because expungement is automatic without a conviction (Texas Government Code Ann. § 411.1471; California Penal Code §§ 296, 296.1, 299).
*bThe expected kinship ratio threshold is a function of database size, which grows continuously.

In California and Texas, familial search inquiries begin with the submission of joint written requests from the investigating and prosecuting agencies. The request forms describe the conditions under which the familial search will be conducted and require applicants’ signatures to attest that they understand and agree to the terms.43

The familial search policy in California instructs law enforcement agencies that only serious unsolved cases with “critical public safety implications” will be considered for a familial search of the database, implying that the tool will only be applied to the most serious crimes. The state

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43 Texas Department of Public Safety, 2012; California Department of Justice, Bureau of Forensic Services, 2011.
of Texas uses wording that is more explicit, stating that “the case with the evidentiary profile should be from unsolved homicides, sexual assaults, or other violent crime that has significant public safety concerns. Property crimes will not be considered.”

Beyond the precondition of being unsolved, California and Texas require applicants to affirm that all investigative leads in such cases have been exhausted, though Texas will make exceptions if the public safety concerns are extreme. To that end, the DNA evidence must be a single-source or deduced single-source forensic profile that has already been uploaded to NDIS without producing any exact matches through routine searches.

Applications in Texas must include a case summary and a copy of the electropherogram (the instrumental data from which the DNA profile is derived). In California, familial search applicants must provide extensive information about the case, “including, but not limited to,” the following:

- suspect physical description, age, and ethnicity (if known)
- modus operandi
- type, time, and location of crime(s)
- weapon(s) used
- victim demographics
- vehicle(s) or transportation
- all existing laboratory reports
- potentially related crimes
- a list of excluded subjects along with the basis for exclusion, as well as any suspects who have not been excluded.44

Both states require the LDIS laboratory to conduct Y-STR testing of the DNA evidence to ensure concordance with potential first-degree male relatives identified through the familial search. California requires mtDNA testing when either the evidence profile or familial search leads originate from females, while Texas familial searching is only applied to males. Lastly, California applicants agree to pursue any leads developed by the familial search in a timely manner and, if fruitful, to refer the case to the prosecuting agency for filing consideration. Texas applicants agree only to further investigate the case pursuant to any leads generated through the familial search.

Applications for familial search are reviewed by FDS committees. In Texas, the FDS committee consists of the state CODIS administrator, the laboratory information management specialist, the DNA technical lead, and three other SDIS laboratory personnel. In California, there are seven people on the FDS committee, including the state CODIS administrator, DNA technical lead, and other SDIS laboratory personnel, but also a Bureau of Forensic Services attorney and a Department of Justice (DOJ) special agent who works in the Investigative Bureau.

44 California Department of Justice, Bureau of Forensic Services, 2011.
California’s FDS committee holds scheduled meetings that typically last about an hour, always with a quorum even if some members are teleconferencing. Texas lets FDS committee members evaluate the applications independently at their leisure, for a week, directing any questions and concerns to the state CODIS administrator.

Applications approved by the committees are subjected to familial search. Both states have search algorithms that calculate likelihood ratios for parent-child and full-sibling relationships between databank DNA profiles and the evidence DNA profile. Based on its own validation studies, California performs Y-STR testing on the top 168 candidates identified in the familial search, which is conveniently two full trays’ worth of samples, whereas Texas carries out Y-STR tests on candidates that exceed a particular likelihood ratio. Thus, familial search cases in Texas have required as few as 31 confirmatory Y-STR tests and as many as 127, depending on the rarity of the alleles in the evidence profile.

Both Texas and California FDS policies stipulate that the SDIS laboratory will attempt FDS again after a year on request if the search yields no potential first-degree relatives (i.e., none of the STR profiles identified by their algorithms exhibit Y-concordance with the evidence profile). If FDS identifies one or more Y-STR concordant profiles, California will refer the matter to the Investigative Bureau at Cal-DOJ to research the offender’s family and verify the existence of a first-degree male relative fitting the suspect description (if there is one) and possessed of the means and opportunity to commit the crime(s) (e.g., not too old or too young, not serving a tour of duty in the military). Texas has a less involved process, assigning the task of investigative follow-up to a CODIS liaison who has access to databases enabling this person to confirm that the candidate has a living father, brother, or son who could conceivably have committed the crime.

Barring a negative follow-up investigation, the next step is to notify the submitting agencies of the prospective match. For a meeting at the SDIS laboratory, California requests the attendance of the lead detectives, the analyst, and LDIS administrator from the local laboratory, and a representative from the office of the district attorney. The offender name is revealed at the conclusion of an informational session, after making sure investigators and prosecutors understand the significance of the prospective FDS match and the proper ways to go about confirming it. For example, a prospective FDS match is not grounds for conducting a raid on a residence the way an exact database match might be. Texas reveals the name of the prospective FDS match to law enforcement by mail—not email or telephone—with similar caveats. In Texas, the state CODIS administrator also meets with officials from the submitting agencies at the LDIS laboratory. As with exact or moderate SDIS database matches, it is up to the LDIS laboratory in the submitting jurisdiction to test reference samples from the first-degree relatives implicated in the FDS to confirm a match to the crime scene DNA profile.
Outcomes

As of our conversations with California and Texas SDIS personnel, in October 2016 and March 2017, respectively, California had reviewed approximately 125 cases and approved FDS on the vast majority. A couple dozen cases had also undergone repeat searches. Texas had completed 21 FDS with four cases pending review. Most of the searches in California and Texas had not, and still have not, yielded viable candidates. However, by October 2016, FDS had led investigators to two murderers and five rapists in California, four of whom have been convicted and one who was deceased.45 In Texas, FDS had led police to four perpetrators, at least two of whom had been convicted, by the first quarter of 2017. Administrators were quick to acknowledge that these successes make a negligible contribution relative to the number of investigations aided through routine database searches, but nonetheless demonstrate that FDS can be an effective tool when routine searches are unavailing. Thus far there have been no legal challenges to the use of FDS in either state. No further details about these cases were provided.

Because the Texas and California SDIS laboratories are explicit about the criteria for approving familial database search requests, administrators report that denials have been rare. The quality of the evidence (probative value) and/or the quality of the forensic DNA profile—and in one Texas case, the severity of the crime—were cited as reasons for rejecting applications.

Administrators at both of the SDIS laboratories expressed satisfaction with how the FDS process was working. Their FDS policies, they felt, gave them sufficient authority and contained adequate safeguards to prevent the technology from being misused.

England and Wales Interview Findings

History and Context of Familial DNA Testing in England and Wales

In England and Wales, the practice of familial DNA searching started without a legislative framework to cover it, and Interviewee 1 noted that it was only after the technique had been employed on a number of occasions that discussions around legislation emerged. The Protection of Freedom Act 2012 sets out the legal framework relating to the collection, use, and retention of biometric samples.

Volume and Purposes of Familial DNA Testing

According to the most recent figures provided by the National DNA Database Strategy Board, a total of 13 familial searches were carried out in 2017 and 2018.46

In addition to supporting criminal investigations, familial DNA testing may also be used to support the identification of victims where there is no other means to do so. This practice was reported to have evolved following the 2004 Indian Ocean tsunami, when familial DNA testing was the only way for investigators to identify some deceased victims from the United Kingdom (Interviewee 3). Familial DNA searches have also been conducted to establish the identity of abandoned infants, although it was reported that the Strategy Board has more recently restricted this practice (Interviewee 7).

Interviewee 2 reported that a number of requests from other organizations for purposes other than the investigation of a crime have been rejected by the Strategy Board. One such example was a request by an immigration agency to conduct a familial DNA test on an individual in order to prove the person’s country of origin, in support of a deportation action. According to Interviewee 2, the Strategy Board rejected the request immediately, on the grounds that it was not an appropriate use of the National DNA Database.

**Familial DNA Search Policies and Practice**

Governance and oversight of the National DNA Database in England and Wales is provided by the Forensic Information Database Strategy Group, referred to in statute as the National DNA Database Strategy Group. This group comprises representatives of the National Police Chiefs’ Council; the Home Office; the Biometrics and Forensics Ethics Group; the Association of Police and Crime Commissioners; the Forensic Science Regulator; the Information Commissioner’s Office; the Biometrics Commissioner; and the police and devolved administrations of Scotland and Northern Ireland and other invited members. The National DNA Database Strategy Board is chaired by a senior police officer, who is the DNA “lead” for the National Police Chiefs’ Council (NPCC), a national coordination body for law enforcement. Testing is undertaken by forensic service providers who are properly accredited and have authorization to take genetic material and generate a profile that is loaded and stored in the National DNA Database.

When a law enforcement agency wishes to conduct a familial DNA search with a crime-stain profile that is suitable for a database search, investigators must submit an application to the National DNA Database and meet a number of requirements. First, a regional representative of the National Crime Agency must have seen the request and be willing to provide the resources to support the search. In addition, the law enforcement agency applying will also require approval from the National Police Chiefs’ Council. In considering whether to approve the application, the NPCC will consider the nature and gravity of the crime and whether there is a need to explore every investigative avenue to identify the offender, as well as the availability of funding and resources to pursue the search. The law enforcement agency will also need approval from its senior forensics manager (Interviewee 6).

Interviewee 6 noted that while previously a full profile was required for a familial DNA search, in certain circumstances a search may be permitted if an almost full profile is available.
Two interviewees noted that the decision on whether to conduct a familial DNA test, in cases that meet the standard for approval, is ultimately one for the relevant local law enforcement agency, which typically must take the costs out of its own operating budget. Therefore, there is variation between law enforcement agencies in the volume of familial DNA searches each conduct (Interviewees 3 and 6).

Where approval has been granted, the investigators will continue to liaise with the National Crime Agency over the course of the investigation. The agency will provide resources including a behavioral investigative adviser (BIA) who has expertise in familial inquiries. Interviewee 7, who performs such a role, noted that the National Crime Agency will often be involved in the investigation even before a decision to pursue a familial DNA search is made, providing investigative advice, profiling, and suspect prioritization. With a familial search, the interviewee reported that the work will also entail examining the details of a case and make inferences, particularly in relation to the age and geographical location of the offender, which may be relevant for an investigation. The interviewee stated,

We developed a methodology to combine the genetic similarity of people’s DNA in the database, with their geographical association with the crime scene and the degree to which their age fits the inferred age of the offender. We would look to predict the age of the likely offender and then use statistical data, for example, Office of National Statistics data on birth and marriages, et cetera, to make some informed considerations. For example, if you have an offender in his 30s [with a profile in the National DNA Database], and the offense happened 15 years ago, what are the chances that a child of that offender would be 20 or 25 now? Those sorts of calculations.

Interviewee 5 provided more detail on the methodology and the parameters established to refine a search based on age and geography. One hundred years of data on births, deaths, and marriages in England and Wales were gathered and used to produce a bell curve showing the probability of an individual having a child at a particular age, and, based on the predicted age of the offender, the probability of the age of the offender’s parents or siblings. The interviewee described this data as stable, changing little over the past hundred years, and noted that this process is only intended to assist with prioritization of results, rather than to be used as evidence.

In relation to the geographical component of the prioritization, Interviewee 5 reported that the BIA will use the Police National Computer, the central criminal history database in the United Kingdom, to investigate a potential suspect’s links to the location of the crime:

When doing a familial search and you pull back a potential offender, the geography you have on them is where they were first swabbed for the sample. So, if they lived in London and went to university in Liverpool and got arrested and swabbed there, forever in the [National] DNA Database they will be referred to as a Liverpool nominal. They may have not gone near Liverpool in the last 20 years, but if an offense happened around the corner from them in London, they won’t be geographically interesting as they are seen as being from Liverpool. So, what we do is run the search and find that not only do they have a connection to Liverpool, but also to London.
Interviewee 7 reported that where there is a witness who can provide information about the apparent age of an offender, this can then be used to draw out parameters based on certain confidence levels on how likely it is that the offender is approximately that age. When there are no witnesses, there are factors to consider, such as competence, risk, forensic and criminal awareness, and whether the offense is part of a series. The interviewee commented, “Sometimes you see an offense which is consistent with a very young, inexperienced, impulsive type offender. Other times you see competence, high risk, or a sadistic element that is more likely to be someone older.”

When a familial DNA search is run and results come back to investigators, Interviewee 7 reported that where a relevant hit exists, it may be far down the list of potential matches before the results are prioritized. The interviewee noted that “it is not unusual to see [the relevant hit at] 200, 300, 500. I think the lowest one we’ve found is 1,100th on the list.” In some cases, if the DNA profile has distinction—for example, some unusual components—a relevant hit may move closer to the top of the list. Adding age and geographical parameters was also reported by the interviewee to be likely to move a hit much higher up the list.

Interviewee 5 reported most investigators only look at the top 100 results from a familial DNA search, and noted that while few investigations rely solely on a list that has not been enhanced through prioritization, there are cases where the genetic similarity between the crime scene sample and a profile in the National DNA Database is so high that investigators do not wait for the enhanced list to be prepared (which typically takes approximately three weeks) before investigating the individual further.

Interviewee 1 noted that when police have a lead resulting from a familial DNA search, they may pursue the investigation through covert and overt strategies. A covert strategy would entail using methods such as placing the individual under surveillance or using other forms of intelligence gathering, such as informants. An overt strategy would entail directly approaching suspects and giving a clear account of why they have been approached, the particular offense being investigated, and an explanation of police expectation in relation to their participation in the investigation. A suspect may be asked to provide a DNA swab to investigators, which is voluntary. During the course of an investigation, hundreds of individuals may be approached by the police to provide a swab (Interviewee 6). Interviewee 4 reported that in practice, almost all provide a swab.

In practice, familial inquiries are conducted in tandem with other investigative activities, rather than as a sole avenue of investigation (Interviewees 6 and 5). For serious cold cases, familial searches will often be repeated at intervals of a year or more, as more profiles are added to the database. However, there is no specific policy for the frequency of conducting the searches, and Interviewee 6 reported that many cold cases “end up on desks with a lack of resources and don’t get fully explored—that’s the danger of it.”
Limitations of Familial DNA Searches

Interviewee 7 commented that many familial searches are conducted without identifying a potential link to an offender, although the interviewee was not able to provide a precise number of the proportion of unsuccessful searches. Interviewee 7 also noted that a search can produce hundreds or thousands of results, even with the support of BIAs and other forms of intelligence, and it can be difficult for investigators to decide how far down the list they need to investigate: “It’s an impossible question. Number one will always be more likely than number two, but this is a probabilistic thing.” Furthermore, the interviewee stated that the efficacy of a familial inquiry will be significantly lower when looking at sibling relationships rather than parent-child relationships, noting the similarity in the DNA of siblings may be so low that a match will never be found in a familial search.

Interviewee 7 also commented on the challenges of historic cases in terms of how many profiles from individuals of a suitable age are likely to be in the National DNA Database:

For example, if there is a case from the 1980s and we think the person was in his 30s at the time, they are likely to be in their 50s or 60s now. The chances of finding a brother or sister is really quite low because very few people in the database are in their 50s or 60s, but the chance of finding a son or daughter is quite high, as they were more likely to be sampled as they would be in their late 20s or early 30s, which is exactly when most people come onto the database. The date of the offense and likely age of the offender will have an impact on the likely success rate of searches.

In addition, according to Interviewee 1, the efficacy of familial DNA searches may be more limited in communities and societies where ancestries are relatively more mixed. The interviewee also noted that the increasing sensitivity of DNA technology leads to potentially more profiles gathered and added to DNA databases, including more mixed profiles that need to be untangled. Relatedly, interviewees also highlighted the issue of the ease at which DNA can transfer from person to person and detected with sensitive technology, creating further difficulty in accurately interpreting DNA evidence.

Interviewee 7 noted the potentially detrimental effect that inexperienced investigators may have with familial DNA searches, reporting that the vast majority have not undertaken such a search. The interviewee commented that investigators may lack awareness of how a search works and how it should inform an investigation:

Some investigations will put lots of energy into the familial DNA search, but when looking at the investigation as a whole, you wonder why they aren’t doing other things which are easier, cheaper, quicker, and more likely to lead directly to the offender rather than a relative. One of the main rules we have is trying to get investigators to understand what place the familial search has in the full-scale investigation; don’t just [put] all your eggs in one basket and wait for the search to solve the case. On the flip side of that, don’t assume it won’t do anything for the investigation and carry on with the same investigation stuff that has been going on for years.
**Associated Costs**

The costs associated with familial DNA searches are variable and depend on the length and complexity of the relevant police investigation. Several interviewees highlighted the relative expense of running a familial inquiry (Interviewees 1 and 6). In terms of contributing costs, Interviewee 1 noted that cold cases may be investigated by retired detectives who have been hired as consultants and their fees for potentially lengthy and resource-intensive investigations will need to be covered. In addition, the associated costs also extend to laboratory fees for running the searches. Interviewee 6 also commented that the approval process for such a search may be costly. As noted previously, the relevant law enforcement agency typically covers the cost of a familial DNA search, although it may seek additional funding from another agency, such as the Home Office, which only rarely provides financial support for such a purpose (Interviewee 6).

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**Case Study**

In September 2001 an 87-year-old woman was murdered in Mansfield, Nottinghamshire. She had been sexually assaulted in her own home and found dead after being beaten. The previous April, the woman had been attacked in her home, and during the assault, she managed to pull an earring out of the offender’s ear. DNA evidence recovered from this earlier attack was matched with a full DNA profile from semen gathered after the subsequent sexual assault and murder, but no results were found in a search of the DNA database. The following year, a familial DNA inquiry commenced, and after approximately three months, a suspect was identified. At the time of the investigation, prior to the involvement of BIAs in familial inquiries, the familial list (parent/child and sibling lists) was presented in allele count order, with a full match considered at 20 alleles. In this case, there was no such match, so investigators examined the highest results, prioritizing the highest alleles in the local area.

The highest match that investigators found was 15 out of 20 alleles, but the profile in the National DNA Database belonged to an individual who was not from the area, and this result was put aside. The second highest match was 14 alleles, and the profile belonged to an individual from Mansfield. DNA swabs were taken from that family, but no match was identified. The next highest match was 13 alleles, and the profile was also from a Mansfield resident. The brother and father of that individual voluntarily provided a DNA swab, and the offender was established to be the brother of that match.

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**Ethical Concerns Around Familial DNA Searches**

Interviewee 1 mentioned that a non-suspect with a DNA profile similar to an offender may be asked to cooperate because citizens have a larger social obligation to support criminal
inquiries by providing relevant evidence where possible. The interviewee also noted that in their investigations, police typically look at family members of individuals linked to a crime; from a policing perspective, then, the argument could be made that conducting an investigation with the use of a familial DNA search is an extension of normal police operations. However, the interviewee raised two matters of concern. First, for those who are asked to participate in an investigation in this way, obligations to one’s community and its safety may need to be balanced against their obligations and loyalty to their family member, who they may implicate in a crime. The interviewee stated that “there is a significant tension there, about who we owe to whom. How do these obligations play off each other?”

Second, the interviewee expressed the view that the burden of becoming involved in a criminal investigation, even when one is not a suspect, is considerable and must be taken into account. According to Interviewee 1, “Any involvement in a criminal investigation is an intrusion, which people react to in different ways, but usually with a set of anxieties.” The interviewee added that in their view, police are not often concerned “that being caught up in an investigation is an unpleasant burden which should only happen when it is necessary and proportionate. All investigations are intrusive in one way or another, but that is also a reason not to catch people up in them.” However, Interviewee 2, a senior policing practitioner, stated that police recognize the intrusiveness of the process, which explains the relative rarity of such tests, and noted that in deciding whether to pursue a test, there is always “a debate around the proportionality of what you’re doing and the necessity of it.”

Interviewee 3, a senior policymaker in the field of biometrics, highlighted the right to privacy of all individuals in the United Kingdom, but noted that people also have a right to “go about their lives without fear of being a victim of crime, and they have an expectation that criminals will be caught.”

The risk of exposing previously unknown familial relationships was not considered by interviewees who discussed the issue to be significant, although Interviewee 1 noted that “I don’t know if it has become an issue and we haven’t heard, or it’s just not an issue.” Interviewee 8, an expert on bioethics, commented,

We need to separate clearly the fears and what actually may happen. It is very unlikely that previously unknown family connections would be revealed through this process. As you start going through potential matches, the pool is so broad. The actual risk of being found out is very small.

Interviewees 3 and 8 raised the concern that familial DNA testing could be used to identify susceptible groups in an unjust way—for example, an ethnic group that is overrepresented in the National DNA Database is more likely to become caught up in a familial DNA police investigation. Interviewee 8 noted that there are a number of estimates available on the proportion of young Black men from urban areas in the National DNA database, which suggests that they constitute between one-quarter and one-third of profiles in the database. The
interviewee also described broader concerns about policing policies in relation to particular groups—for example, stop and search, as well as the concern that when police scale back on operations that may be seen to target an ethnic group, crime victimization among this group may increase. Relatedly, the interviewee noted that the quality of the data on ethnicity in the National DNA Database is poor, especially as ethnicities in England and Wales are increasingly mixed and identification more complex.

Interviewee 3 stated that if the process does raise the risk of amplifying racial and geographic biases, it may still be a justifiable course of action; risks must be identified at the earliest possible stage of the process to ensure that they are minimized, and reasons for pursuing a familial DNA test must be properly articulated to all stakeholders. Interviewee 5, a policing practitioner, rejected any suggestion that familial DNA searching may target a particular group of people, stating, “You still need evidence for whether the offender committed the crime. No matter their race, they either did it or they didn’t, and you can prove that scientifically. You’re not targeting a racial group. I don’t see the relevance of that at all.”

**Partial and Mixed Profile Searches**

Interviewees who commented on the subject of forensic partial and forensic mixture profile searching drew a clear distinction between these types of searches and familial searches, both in terms of the technologies involved and the ethical issues raised. One view was expressed by Interviewee 2, a senior policing practitioner:

> I don’t think they are similar at all. With familial testing, there is not a risk of false positives as such, but there is intrusion against someone you know hasn’t committed a crime. With mixed samples, it is something beyond your control; you are attempting to unravel a scenario based on what you’ve got. You are not deliberately going out to target a person who hasn’t committed a crime, you are just trying to systematically eliminate a person whose DNA has gotten intertwined with the crime scene. With familial searching, it is a deliberate act, so the justification needs to be strong.

However, Interviewee 1, an academic expert, noted that “there is a similarity in the notion that there are a large number of unmatched crime scene stains and where they look to be relevant to an investigation, [investigators] then look for ways to utilize that information.”

Interviewee 2 described such searches as more of the “day-to-day” work of police investigators than familial testing, noting that as technology has advanced and become more sensitive, increasingly mixed and partial samples are being gathered and used in investigations. Initially, these searches were predominantly used in sexual offense cases, but they are now increasingly common across a wide range of offenses.
Mixed Profiles

Interviewee 4, a policy lead within the National Police Chiefs’ Council, reported that the number of mixed and partial profiles gathered has rapidly grown, describing the volume as “massive”:

Since we’ve introduced the more sensitive DNA profiling technique—DNA17—which we use at the moment, the amount of background DNA in the samples has caused the number of mixed profiles to go up to 60%. Some of these are resolvable and will take a scientist who can identify a major profile in these and match it to the [National] DNA Database. I know from an operational point of view, the frustration of getting results we can do nothing with and the frustration of spending a lot of money on this.

Interviewee 4 commented that when a sample contains the DNA of more than two people, this process becomes less efficient and requires more human analysis.

What it does is pendulum list searching: The software looks at likely combinations of alleles in the mixed profile and you can then compare all the likely combinations with the [National] DNA Database. There is still a lot of human intervention which is difficult with complex DNA profiles, which are common. It does help to attach some sort of statistical significance to that match. There is still human intervention at the end, [we] need to do a very traditional mixtures interpretation. Software helps get a name from the database, and the human needs to look at the subject profile compared to the mixture and check . . . they actually match.

The forensic scientist may be able to identify a major contribution of DNA from one person in a mixed sample in the peaks on a DNA profile graph: In a major-minor profile, one individual’s profile would have very high peaks, and the other individuals’ profile(s) would have very low peaks. At this point, a search would be automated, and if there is a match in the database, the results are sent to the investigating law enforcement agency, Interviewee 4 reported that from an investigator’s perspective, a major-minor match is equivalent to a clean person profile. However, the interviewee noted that investigators must be prepared to address a claim by the suspect’s defense team that the individual with a minor profile is the real offender.

The interviewee also commented on the complexity that arises when the contributors to a DNA profile are so similar that they cannot be separated. In these cases, software is available that can help in deciding how to search the database; however, if a name is identified, the individual may not be the major contributor.

In this area, Interviewee 2 described the National DNA Database Strategy Board as taking the lead role in minimizing risk associated with using mixed samples by establishing strong elimination procedures. The interviewee noted that the threshold for defining a match is high, and as a result, there are many samples that are not taken forward in an investigation. This view was supported by Interviewee 4, who commented,
At the economic end, we are spending lots of money on DNA profiles which we can’t do anything with, but a large percentage of profiles are mixed, so we are missing out on a lot of matches. Also, we don’t capitalize on partial DNA profiles that aren’t suitable to load onto the [National] DNA Database—we have lots of cases with partial profiles which are kept on file, often on paper, but nobody looks across to make those links. The best we can hope for is speculative searches of the database which can give a list of names, which is often long and difficult to investigate, and it is over to the police investigator to decide if any of those names are interesting.

The National DNA Database is developing algorithms that can take a partial fingerprint, a partial DNA sample, and a closed-circuit television (CCTV) image to, according to Interviewee 2, “create a mathematical position that supports a person being a suspect.”

Partial Profiles

Interviewee 4 reported that where a partial profile has been gathered at a crime scene and a match is sought in the database, a threshold of 17 or 18 alleles matching is required for the profile to be of much utility as evidence to investigators. The interviewee also noted that in practice, an extremely partial profile would be disregarded unless it related to a serious offense such as murder or sexual assault, for which every DNA result is scrutinized for its value and potential contribution to the investigation.

Interviewee 4 also reported that the development of more advanced technology has changed the concept of a partial profile: While DNA 17, which looks at 34 areas of DNA, is used by some, the majority of users work with a profiling system called Second Generation Multiplex Plus (SGM+), which looks at only 20 areas. Therefore, theoretically, a full profile using SGM+ is viewed as a partial profile with a 20/20 match, which is still a one-in-a-billion statistic.
4. Discussion

Implications for Criminal Justice Policy and Practice in the United States

This project has substantial implications for criminal justice policy and practice in the United States. It is a key step toward better understanding the use and efficacy of familial DNA testing in the United States. Proponents of familial DNA testing argue that it has the promise of simultaneously increasing the accuracy of the criminal justice process while reducing costs. Currently, criminal justice policymakers are hampered from adopting evidence-based familial DNA practices by our lack of knowledge about the use and effect of this evidence. Our project’s related studies sought to increase that knowledge base.

Our findings from a national survey provided a baseline for criminal justice policymakers to understand the ways in which familial DNA and moderate stringency searches are being used in the field today. The England and Wales qualitative interviews provided more detailed information about how this is being accomplished in a country with similar characteristics to the United States.

Limitations

Response Rate

We note that the low response rate (about 20 percent for both surveys) limits the generalizability of the survey results. As such, the value of this report may be best as a characterization of the state of familial searches and moderate stringency matches. Still, some potentially interesting insights were gleaned from the responses of participating laboratories. Maintaining detailed records on the correlations between evidence type and DNA evidence quality seemed not to be a priority for LDIS or SDIS laboratories. Most of the responding LDIS laboratories are, or will soon be, using probabilistic genotyping software, which encourages more objective DNA interpretation but may be increasing the prevalence of forensic mixtures. Because none of these LDIS laboratories specifically track convictions as a result of investigations from confirmed partial matches, the investigative value of partial matches remains unknown.

Responding LDIS laboratories seem to desire more functionality from CODIS software to reduce the time and paperwork involved in CODIS operations, which some say are growing unwieldy because of the sheer number of candidate matches they are generating. Our research is unable to determine the reason for the low response rate.
Law Enforcement Use of Genealogy DNA Databases and Private DNA Databases

The policy implications for the use of genealogy DNA databases are beyond the scope of this report. Nonetheless, we believe policy consideration is warranted with the rise of commercial DNA ancestry testing services, such as FamilyTreeDNA, GEDmatch, AncestryDNA, or 23andMe. The largest of these databases is comparable in size to CODIS (AncestryDNA claims a database of over 15 million DNA profiles; CODIS contains almost 14 million offender profiles). More important, these commercial databases are constructed from much more detailed genetic profiles than are found in CODIS, so they are capable of searches that can link the evidence profile not just to first-degree relatives in their database (i.e., parent-child, full siblings) but to second-degree relatives (half siblings, nieces/nephews, grandparents), third-degree relatives (great-grandparents, first cousins), and even sixth-degree relatives (second cousins, once removed). The genetic genealogy databases can also provide matches with more distant cousins. These trends raise issues of privacy, bias, and efficacy. Additionally, while familial searching within LDIS, SDIS, and NDIS mostly affects those who already have a criminal record, genetic genealogy searches can potentially implicate an entire population.

Furthermore, the analysis of the use of privately operated DNA databases is outside of the scope of this report. Nonetheless, a growing number of law enforcement officers populate these privately run databases with samples obtained from individuals during traffic stops and other routine encounters. These person-of-interest samples can then be compared to evidence profiles from minor crimes that the public laboratory either lacks the capacity to analyze or that may be of insufficient quality for inclusion in SDIS. While we acknowledge that some law enforcement agencies use forensic DNA databases to store or conduct forensic DNA analysis outside of the

7 Kennett, 2019.
8 Kennett, 2019.
CODIS system (and therefore not subject to FBI regulations and audits) and that the use of private databases is increasing,⁹ we focus this report on LDIS and SDIS databases.

Concerns with Racial Bias, Privacy, and Accountability

**Impact of Familial and Moderate Stringency Searches on Black and Latinx People**

The inclusion of felony (and some misdemeanor) arrestees in most state DNA databases has raised concerns that known racial disparities that exist within the criminal justice systems will result in racially biased genetic population surveillance. In California, for example, Black people account for about 20 percent of felony arrestees, but only 6 percent of the state’s population.¹⁰ Moreover, about one in three felony arrestees are not ultimately convicted, yet California places the burden of applying for DNA database expungement on the accused.¹¹ A study published in 2015 found only a minute fraction of those eligible had undergone the bureaucratic process of getting their DNA profiles expunged from California’s offender database, especially in comparison to states like Missouri and Maryland, which automatically expunge DNA profiles of those not convicted.¹² Thus a nontrivial and racially skewed segment of the population has their DNA profile in the state’s offender database without having been convicted of a qualifying offense or perhaps of any offense.¹³

There is a strong argument to recommend that California follow the example set by Texas and automatically expunge profiles for those who have not been convicted. This would also be in line with the practice in Europe, following the ruling of the European Court of Human Rights,¹⁴ which resulted in the removal of 1.7 million profiles from the United Kingdom’s National DNA Database.¹⁵

If California’s familial search policy were broadened to include arrestees, a disproportionate number of Black and Latinx first-degree relatives could be possibly involved in investigations. It

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¹³ The California Department of Justice was sued in December 2018 for its retention of DNA profiles from arrestees who were not ultimately convicted. The plaintiffs argue the state’s failure to expunge such profiles “exploits and reinforces systemic racial and socioeconomic biases.” See Eric Sernoffsky, “California Sued over DNA Database’s Inclusion of People Never Convicted of a Felony,” *San Francisco Chronicle*, December 10, 2018.
¹⁴ S. and Marper v. the United Kingdom (European Court of Human Rights, 2008).
may also be the case that the exoneration of Black and Latinx people could be possible. Occasionally, the addition of new samples has revealed wrongful convictions—cases when crime scene evidence did not match the convicted person but instead matched another offender in the database. Ultimately, adding more DNA samples to forensic databases should balance public perceptions, public safety, and civil liberties.

**Privacy Concerns**

In general DNA searching can occur by comparing the unknown DNA sample with a variety of different DNA databases—local DNA databases that are not part of the national DNA system, the LDIS, SDIS, and national CODIS databases, or genealogy databases (e.g., MyHeritage, FamilyTreeDNA, 23andMe, Ancestry.com). DNA searches, like other technologies, such as license plate readers and facial recognition systems, raise privacy issues that the courts and commentators have yet to completely resolve. The technologies have dramatically lowered the cost of achieving a potentially worrisome level of surveillance over mass populations.

The use of familial DNA searching raises important privacy and surveillance concerns. Comparing an unknown DNA sample to a database of former offenders who were forced to yield DNA samples as a result of their conviction is relatively uncontroversial. Concerns are greater if inclusions into the DNA database are expanded to arrestees, particularly if the population of arrestees may not be racially proportionate to the population and if many of the arrestees (roughly 30 percent) are not ultimately convicted.

Using familial DNA matching to expand the potential pool of matches to relatives of the suspect raises its own issues. First, while a convicted felon may have a reduced expectation of privacy, the same is not true of a relative of that felon who may have led a blameless life. Second, depending on the stringency of the search, the pool of matches expands dramatically. This potentially exacerbates the risk of racial disproportionalality. To the extent that Blacks and Latinx are overrepresented in DNA databases, this would increase the likelihood that individuals from those racial groups would be identified and arrested in an investigation. Third, this approach may require police scrutiny of completely innocent individuals. For example, suppose person X was convicted of a crime and his profile is included in a DNA database. His brother’s DNA is found at a crime scene and person X is identified as a familial match. Police will investigate person X’s relatives despite knowing that person X himself is not a suspect. Finally, another concern is potential expansive investigation, or overreach. Rather than identifying a few suspects based on an investigation of a crime, it can subject large numbers of people to

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16 Schorn, April 1, 2007.
potentially intrusive police suspicion.\textsuperscript{18} To help understand the extent to which the collection of DNA impinges on group's privacy rights, we developed a tool that is accessible online at www.rand.org/t/TL343.

It is also interesting to compare the privacy implications of familial searching with that of using genetic genealogy databases. While familial searching primarily affects relatives of those with a criminal record or with law enforcement involvement, researchers have noted that genetic genealogy searches can affect entire populations.\textsuperscript{19} However, the racial disproportionality issues that arise in the use of criminal justice DNA databases are lessened because the databases are very extensive.

\textit{Policy}

There is immense potential that these approaches have to help law enforcement develop leads in investigations that would otherwise go unsolved. However, the acknowledgment of racial disparities and privacy issues in the administration of familial and moderate stringency searches raises concerns about the potential misadministration of such searches. A key to effective policies is accountability and transparency, thus any legislation that seeks to regulate familial or moderate stringency searching capabilities must be enacted with great care.

To assist in addressing the feasibility of familial DNA searching at the national level, the Scientific Working Group on DNA Analysis Methods (SWGDAM) was established and provides the FBI with guidance. In March 2008, with guidance from SWGDAM, the FBI specified that familial searching policies should be decided by individual states.\textsuperscript{20} By 2012, California, Colorado, Texas, and Virginia had policies permitting familial searching; and Maryland and Washington, D.C., had banned familial searching.\textsuperscript{21} Other researchers including the DNA Commission of the International Society for Forensic Genetics,\textsuperscript{22} Amy Liberty,\textsuperscript{23} and Dane Barca\textsuperscript{24} published work emphasizing the need for consistent policies that appropriately protect privacy rights of individuals and minimize racial bias.

In 2011, Democratic Congressman Adam Schiff of California introduced the Utilizing DNA Technology to Solve Cold Cases Act of 2011 in the U.S. House of Representatives. The national

\textsuperscript{18} See Kennett, 2019.
\textsuperscript{19} See Erlich et al., 2018; Edge and Coop, 2019.
\textsuperscript{20} Scientific Working Group on DNA Analysis Methods Ad Hoc Committee on Partial Matches, 2009.
\textsuperscript{21} Ram, 2011.
debate defends a national protocol for partial match DNA testing as the only means to ensure transparency in the use of this technology. Although the House Bill did not pass, it was the first of its kind to attempt to enact uniform procedures across federal and state lines that explicitly outline the protocols and parameters for familial or moderate stringency searches. The expansion of databases by including more samples, and the additional use of private databases and the use of familial or moderate stringency searching within these databases, requires both special care and the awareness that such searches might affect fundamental rights without a complete understanding of the implications of those expansions.

To date, Arizona, California, Colorado, Florida, Minnesota, New York, Ohio, Texas, Utah, Virginia, Wisconsin, and Wyoming are the only states that have solved cold cases using familial DNA searches. Illinois and Louisiana are currently pondering whether to use the technique.\(^{25}\)

**Future Research**

**Cost Estimates**

Another set of important unanswered empirical questions are the direct and indirect costs associated with familial and moderate stringency DNA testing. To address these issues, future research should collect more detailed cost information. Familial searching costs include the upfront investment of the software purchased to perform kinship analysis, unit costs for the reagents and instrumentation, and most critically, labor costs. Collecting information about these categories of costs may improve policy decisions based on evidence-based cost analysis.

Existing research suggests that expanding DNA testing of sexual assault kits is cost-justified\(^{26}\) and might help identify serial rapists. However, evidence based on the expenses associated with familial and moderate stringency searching is very limited in the United States, England, and Wales. In the United States, specifically, because CODIS software was not designed to rank partial matches by kinship likelihood, familial searching requires new statistical analysis software and the candidate pool is usually subjected to further DNA testing for kinship confirmation. California, for example, limits familial searching to major violent crimes when “all other investigative leads have been exhausted,” convenes a committee to review familial search requests and results,\(^{27}\) and uses supplemental testing of Y-chromosome DNA.\(^{28}\) Depending on


\(^{27}\)E. G. Brown, 2008.

\(^{28}\)Myers et al., 2011.
how large a potential candidate population is defined and the number of male relatives the candidates have, a familial search may generate substantial investigative costs.

Two analyses of forensic DNA database performance have found that adding crime scene samples makes a bigger contribution to aiding investigations than expanding the database by including more offenders.\(^29\) Given that many states lack the resources to analyze crime scene DNA in a timely manner, familial DNA searching may be an inefficient use of resources better spent on conventional DNA testing. Some accounting of familial searching expenses is needed to better appreciate the costs and benefits of this forensic DNA database application. Future research could examine whether such an expansion of the United States DNA databases would be acceptable by society and investigate how many crimes could potentially be solved or prevented.

Further, analysis of this sort would facilitate comparison between the cost-effectiveness of the different policies toward familial and moderate stringency searching. Based on costs accruing to the SDIS and LDIS laboratories and law enforcement, it would be possible to ascertain which blend of familial searching/partial matching has yielded the most benefit, in terms of case-to-offender matches per cost of state database operation and follow-up on any promising leads.

While the cost estimates are likely to be imperfect and ignore the privacy concerns discussed here, they can be combined with the measures of familial and moderate stringency DNA search efficacy to provide valuable guidance to policymakers considering best policies in this emerging area.

Conclusion

A notable finding from our state case studies is that although familial searching is permissible according to state policy, it is sparingly used. At the time of our meetings, Texas and California SDIS administrators had approved and conducted fewer than a total of 100 familial searches nearly a decade after the method was approved. Furthermore, administrators noted they had emphasized to law enforcement the inexact nature of the investigative lead in searches that yielded candidates and counseled caution. Thus, concerns about privacy and government overreach implied by the policies seem genuine.

Additionally, given the pace of technological advancements in forensic DNA testing and the ways in which testing can impact DNA database composition and frequency of adventitious matches (e.g., the rise in use of probabilistic genotyping that encourages more agnostic interpretation of evidence, increasing the frequency of forensic mixture profiles), the research team anticipated a greater response rate from DNA database administrators. Based on our survey findings, most state and local DNA index laboratories did not collect metadata on the inputs and

outputs of their databases, suggesting that most cannot easily ascertain what evidence and profile types are in their databases. From our interviews with SDIS officials, we infer that disposition of moderate stringency matches is viewed as a manageable, although perhaps tedious, task of database administration.

Continual advancements in forensic DNA testing suggest familial searching as conducted by SDIS laboratories will likely be replaced by more powerful alternatives in the not-too-distant future. The emergence of rapid, portable, relatively inexpensive DNA analysis technology may make DNA testing more common. Private-sector DNA laboratories such as Parabon NanoLabs have recently begun using SNPs to identify and investigate leads in cold cases. Already the method has been able to link much more distant relatives and claims a significantly higher success rate than the more limited familial search tool available to law enforcement through public-sector forensic laboratories. Meanwhile, as offender DNA databases continue to grow and backlogs become cleared, the number of exact matches may increase, and the utility of familial searches may decrease.

Our findings from a national survey and interviews with U.S. CODIS administrators demonstrate the difficulty in obtaining reliable statistics from the different U.S. databases. Accountability and transparency are important for public confidence in law enforcement. Looking forward and following the example set by the U.K. National DNA Database Annual Report,30 the United States could benefit from publishing annual reports that include information about the methodology used, the number of searches done each year, and the match rates. These reports should have standardized reporting formats across all the databases in order to inform research and to gain better insight into the efficacy of familial and moderate stringency searching and reporting of partial match results. Additionally, it is our recommendation for the future improvement of policies that this information should be made publicly available online.

Overall, this report sought to provide policymakers with additional information on which to make informed decisions with respect to familial DNA and moderate stringency search policy.

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