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EXECUTIVE OFFICE FOR IMMIGRATION REVIEW

CHICAGO IMMIGRATION COURT

In re: XXXXXX

The Innocence Project respectfully submits this letter in support of Respondent Isabel XXXX, in the above-referenced action. The Innocence Project is a non-profit legal clinic affiliated with the Benjamin N. Cardozo School of Law at Yeshiva University. The Project is a national litigation and public policy organization dedicated to exonerating wrongfully convicted persons and reforming the justice system. In approximately one-half of the 362 convictions overturned through DNA evidence in the United States, forensic evidence distorted by flawed science—such as forensic odontology, hair analysis, fingerprint analysis, and more—played a role in the wrongful conviction.

For this reason, especially in science-dependent matters such as the present one, the Innocence Project is committed to ensuring, as an essential component of a fair and just determination of the facts, that judicial decisions are premised upon accurate forensic work and application of sound, proven scientific methodology, an interest directly implicated by use of



dental examinations for determination of age. Though the project has typically engaged in criminal litigation, the stakes are no less significant in the present matter. Moreover, the fundamental defect of many of the forensic techniques that have led to wrongful conviction, including specific subdisciplines within forensic odontology, is a lack of an appropriate statistical basis from which to draw valid conclusions, failure to consider the limitations and uncertainties of measurements and observations, lack of documentation and inability to replicate an analysis, and simply the misuse of statistical evidence to exaggerate the probative value of an expert's conclusions.

Our concerns regarding age estimation based on dental examination arise from our review of 8 reports prepared by dentists for Immigration and Customs Enforcement (ICE), including the report generated by Dr. Denise Murmann in the above-captioned case. Each of these 8 reports has been ostensibly in support of the ultimate conclusion that the asylum applicant is over 18 years old, and each has been scientifically indefensible. What is apparent from our review of these reports is that the dentists are each using the same software program to generate the reported statistics, as the statistics contain similar or identical errors, the reports use similar or identical language, and they utilize a common single-page template. What is equally apparent is that the dentists are simply assessing the individuals' molars and entering that data into the program, which generates statistics using a method of analysis that they do not understand and which produces results that are, at best, misleading.

The problems seen in all of these reports reflect a lack of statistical expertise necessary to come to valid conclusions concerning age estimations. We are particularly concerned about a lack of an appropriate statistical database from which to draw valid conclusions concerning the age of a young person from areas of the world for which relevant data pertaining to dental

maturation in relation to chronological age do not exist or are severely limited. In addition, each report, including Murmann's, offers specific statistics of probability to the *hundredth percentile* as to the likelihood that the individual is at least 18. Likewise, the precision of the age determinations is plainly invalid.

Put simply, dental age estimation can, at best, provide a rough, wide range when an individual has not reached the final stage of development, and only when appropriate reference population databases are available. We offer the following observations, based on the contemporary scientific consensus, basic statistics, and the deficiencies seen in reports prepared for ICE, on the significant limitations of the dental age estimation presented to the court in the report prepared by Murmann.

Key Statistical and Study Design Issues

Although the development and maturation of teeth can be an issue of clinical importance to dentists, as the stage of development may affect treatment decisions, the determination of chronological age of a patient is not typically part of clinical care, and requires additional expertise with respect to statistical analysis, interpretation of probabilities, and population distributions. The report prepared by Murmann reveals a lack of this necessary expertise.

The major issues regarding this type of age estimation analysis based on dental examination and the report prepared by Murmann are 1) failure to use a representative reference population or to account for between-population variability in third molar maturation, 2) failure to address uncertainty in the assessment of stage of dental development (misclassification or measurement error), 3) incorrect use of basic statistical terms, 4) inappropriate calculation of a "mean age", 5) misrepresentation of the precision of the results, and 6) lack of adherence to basic

principles of documentation of procedures allowing for independent replication of an analysis.

These issues are discussed below.

1) Failure to use an appropriate reference population or to account for between-population variability

Murmann chose a study in African-Americans as the reference data in her report in this case. Reference data are the data describing the chronological age corresponding to the observed stage of third molar maturation. The applicability of these reference data to someone from The Democratic Republic of Congo has not been established. There are considerable data, however, indicating variability in rate of dental maturation between different populations.¹ Genetic and environmental factors as well as their interaction contribute to the variability in the timing of development between populations. In her report, Murmann provides no information supporting the similarity in these factors between African-Americans and Congolese.

The available data support the importance of addressing the applicability of the reference data to the individual under assessment. If an appropriate database is not available, the analysis should account for the uncertainty created by this limitation by using a wider distribution that incorporates between-population variability. Murmann's analysis does not account for this limitation: she gives no explanation for her choice to use African-American reference data, and she also gives no description of how, or even if, she took between-population variability into account. Failure to take into account this

¹ See Fadil Elamin, Mark P. Hector & Helen M. Liversidge, *The timing of mandibular tooth formation in two African groups*, 44 ANN. HUM. BIOL. 261–272 (2017); H. M. Liversidge, *Timing of human mandibular third molar formation*, 35 ANN. HUM. BIOL. 294–321 (2008).

increased variability, particularly with respect to the earlier age of tooth maturation seen in many populations, would result in overestimates of chronological age and of the probability of being over 18 years of age.

2) Failure to address uncertainty (misclassification or measurement error)

The basis of age estimation based on dental analysis is the assessment of the stage of development of the third molars. This involves a subjective classification by an individual trained in this type of assessment and, like all subjective measurements, will necessarily include some measurement error. Repeatability, or intra-rater reliability, is the extent of agreement between assessments made by one rater at two different times. Reproducibility, or inter-rater reliability, is the extent of agreement between assessments made by two different raters. With respect to the question before the court, experts may arrive at different conclusions based on measurements of the same teeth. The extent of misclassification may be quite significant, as was seen in a study of the reliability of two trained raters (pediatric dentists) based on 127 third molars shown in 73 x-rays of individuals aged 9-24 years.² The intra-rater reliability for a commonly used method for assessing tooth maturation based on an 8-level staging criteria for crown and root formation (Stages A through H), described by Demirjian, Goldstein and Tanner, 1973 (hereinafter referred to as the “Demirjian method”)³ was 0.74 (or Kappa = 0.70; the Kappa statistic accounts for agreement that is due to chance). Inter-rater reliability was 0.73 (Kappa = 0.68). For Stage H, specifically, (the latest development stage) the two raters agreed in 13 out of

² K S Dhanjal, M K Bhardwaj & H M Liversidge, *Reproducibility of radiographic stage assessment of third molars*, 159S FORENSIC SCI. INT. S74–S77 (2006).

³ A. Demirjian, H. Goldstein & J. M. Tanner, *A New System of Dental Age Assessment*, 45 HUM. BIOL. 211–227 (1973).

15 (86%) assessments. This means in 2 out of the 15 assessments (14%), one of the raters determined a tooth was at a lower stage of development.

Murmann’s report in this case uses the Dermirjian method, and, as with the other reports we have reviewed, we see no evidence of an accounting for intra-rater and inter-rater sources of uncertainty in her analysis. An analysis presented to the court should account for potential misclassification error through the use of two or more independent assessments by different raters, and with the appropriate statistical adjustment to account for the imprecision of the measure. Failure to take into account the impact of this imprecision is another factor that would result in an overestimate of the chronological age of the individual under review.

3) Incorrect usage of common statistical terms

The range of a distribution refers to the distance between the smallest value (the minimum) and the largest value. It can be reported either as the difference between the minimum and the maximum values (e.g., a range of 10 years), or as these two values (e.g., minimum 15 years, maximum 25 years), from which the difference can be easily calculated. It is misleading to report, as the report at issue here does, that the “range of possible ages for such a male is 15.55 to 26.25 years.” The values 15.55 and 26.25 in fact represent the lower 5th percentile and the upper a 95th percentile of the distribution – not the minimum and maximum values as (wrongly) reported by Murmann. The actual range is wider than the 95% confidence interval around the mean value, making an effort to correctly estimate someone’s age based on the 95% confidence interval even more imprecise.

4) Inappropriate calculation of a “mean age”

Murmann’s calculation of a “mean age,” and its accompanying standard deviation and confidence interval, is based on a fundamental misunderstanding of statistical principles.

Assuming that XXXX third molars are at the latest stage of development, the only valid inference to be drawn is that she is at least as old as the youngest documented age for development to this stage (around 13 or 14 years of age in the populations studied to date).

The Blankenship, Mincer et al. study Murmann relied upon to arrive at the “mean age” examines dental radiographs of 637 African Americans and 563 white Americans, age 14-24 years. It uses the 8-level staging criteria for crown and root formation (Stages A through H), described by Demirjian, Goldstein and Tanner, 1973⁴; these staging criteria were also used by Murmann. Murmann classified each of XXXX third molars as Stage H, the final adult stage of maturation. Once a tooth has reached stage H it does not change further. Thus the concept of a “mean age” for this stage of development has no meaning. The age at which this level of development is seen is, consistent with the laws of statistics, “unbounded” – that is, once it is achieved, it remains through the rest of the lifespan. Age 20.90 years, which Murmann presents as XXXX’s “mean age” would apply equally to an individual in this stage who was 15, 25, or 55 years old. But choosing to use a mean, a number included in Murmann’s report that was apparently generated by the software program, requires an assessment of the assumptions needed to support the appropriateness of this measure, specifically, the assumption of a normal distribution of the underlying population data. No such assessment was provided here.

5) Misleading representation of the precision of the results

⁴ A. Demirjian, H. Goldstein & J. M. Tanner, *A New System of Dental Age Assessment*, 45 HUM. BIOL. 211–227 (1973).

Even assuming the underlying analysis is correct, it is misleading to present values that are, at best, approximations, as having a degree of precision that warrants three or more significant digits. The presentation of an estimated age to the hundredth place (e.g., 15.55 or 20.90 or 26.25) is inappropriate. Similarly, the presentation of a probability as accurate to the level of one-hundredth percent (e.g., 86.00%) is misleading and unwarranted. The reports we have seen, including this one, make both mistakes (i.e. they present estimated ages in the range of possible ages as numbers with three or more significant digits, and they provide the probability that a person is over 18 to the level of one-hundredth percent).

6) Inadequate documentation of analysis details

One of the fundamental principles of scientific analysis is the need to describe the particulars of a method in sufficient detail to allow independent replication of results. The report in this case and the other reports we have seen have failed markedly in this matter. The reports include a citation to a study with a reference population, but the specific data used from the study and the assumptions needed for the extrapolation and modeling of these data were not provided. This level of documentation of analytic methods does not meet standards needed for scientific review.

Summary

In summary, age estimation analysis based on dental examination of third molar development is a flawed technique that can overestimate the likelihood of being over 18 years of age by failing to address inter-population variability and failing to address misclassification error. The reports we have reviewed, including the report prepared by Murmann for the above-



referenced case, incorrectly use basic statistical terminology and in so doing misrepresent the true variability within a population in third molar maturation; present a level of precision that is not supported and is misleading; either inappropriately calculate a mean value (in situations in which such a calculation is meaningless) or provide no assessment of the appropriateness of the choice of a mean or of the assumption of a normal distribution; and fail to provide an adequate level of documentation. The report at issue in this case suffers from all of these deficiencies, and is therefore not scientifically reliable. These deficiencies arise from the lack of statistical expertise needed to conduct a meaningful analysis, including of limitations and sources of uncertainties, and lack of adherence to scientific standards for presentation of methods and results (including the imprecision of estimates). We urge the Court to reject the determination of the Respondent's age based on dental analysis and to hold submissions to a higher standard, one in which scientific methods are appropriately applied, valid statistical inferences are made, and results are communicated with an explanation of a method's limitations and applicability.

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