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Research on the Limitations of Bone Age Assessment in Confirming the Age of Criminal Responsibility

Wenxi Deng[1]

[1] South China Agricultural University, Guangzhou 510000, China
Correspondence: Wenxi Deng, South China Agricultural University, Guangzhou 510000, China.

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Abstract

Bone age assessment is a technical means to observe the growth age of human beings by utilizing biological laws. At present, there are identification methods such as the atlas method, the scoring method, and the CHN method. However, bone age assessment has limitations in accuracy when it comes to confirming the age of criminal responsibility, is ambiguous in terms of the basis for legal application, has difficulties in coordinating with other evidence and in cross-regional and cross-jurisdictional applications, and also has problems such as chaotic qualifications of institutions and personnel and a lack of unified standards. Therefore, bone age assessment can only serve as an auxiliary reference to corroborate or supplement other evidence chains, and can only become the basis for age determination under extreme circumstances.

Keywords: bone age assessment, forensic medicine, age of criminal responsibility, Criminal Procedure Law

1. Introduction of the Problem

Bone age identification is a technical means to infer an individual's biological age by observing and analyzing the growth and development characteristics of human bones. It mainly relies on the specific laws presented by bones at different growth stages, such as the appearance time of ossification centers, the closure of epiphyseal lines, and changes in the shape and size of bones. By comparing these with corresponding standards, the bone age of an individual can be obtained. As a relatively objective biological indicator, bone age has important applications in many fields, including anthropology, clinical medicine, sports science, and forensic medicine. In the field of forensic medicine, especially in cases involving juvenile crimes, bone age identification is often used in practice to assist in determining the age of criminal suspects, and further assess their criminal liability capacity. However, the bone age obtained from bone age identification is a biological age, while criminal liability capacity is determined based on chronological age, that is, the time of survival represented by the AD calendar. Affected by various factors, the two cannot replace each other (Zhou Xiaoping, 2001)[1]. In practice, some defense lawyers also oppose using bone age identification as the basis for determining the age of the parties.

However, in judicial practice, case situations are often complex. There are indeed cases where, except for bone age identification, there is no other effective evidence to prove the age of the

parties. We cannot simply and rudely deny the role of bone age identification. Based on the growth and development laws of human bones, bone age identification can, to a certain extent, provide reference information for age determination. Especially when other conventional evidence is lacking, it may become one of the few clues. However, we must clearly recognize that bone age identification has many inherent disadvantages. In terms of accuracy, it is comprehensively affected by various factors such as genetics, nutrition, and environment. As a result, the outcome usually can only be a rough age range, and it is difficult to be precise to the specific date required by the age of criminal responsibility. For example, during adolescence, the error of bone age identification may reach ±1 year or even larger, which is a huge obstacle to accurately determining the age of criminal responsibility. In terms of legal application, the relevant regulations are vague, lacking clear operating rules, resulting in inconsistent admissibility standards in judicial practice and prone to disputes. In terms of procedures and standards, the qualifications of appraisal institutions and personnel are chaotic, lacking unified norms and effective supervision. There are significant differences between different appraisal methods and in the application of the same method in different regions. Moreover, the update of standards lags behind, unable to adapt to the dynamic changes in the growth and development of children and adolescents. In view of this, it is necessary to explore what are the limitations of bone age identification? What is the application boundary of bone age identification?

2. Basic Principles and Methods of Bone Age Identification

2.1 Biological Basis of Bone Age Identification

The core biological basis of bone age identification lies in the fact that the growth and development of human bones follow a specific time sequence and rules. During an individual's growth process, bones gradually undergo the ossification process starting from the fetal period. The appearance of ossification centers is one of the key signs for judging bone age. The ossification centers of different bone parts appear sequentially at specific age stages. For example, in the development of long bones, the ossification centers in the epiphyseal area gradually form and grow larger with age. Generally, in infancy, some bones in the hands and wrists begin to show primary ossification centers, and subsequently, the development speed of these ossification centers is closely related to the individual's growth and development process.

As the age further increases, the epiphyseal line between the epiphysis and the diaphysis gradually changes. During childhood and adolescence, the epiphyseal line is in a relatively active growth state, and the bones grow longitudinally continuously. When an individual approaches adulthood, the epiphyseal line gradually closes, which marks the gradual cessation of bone growth. This orderly process of the appearance of ossification centers, the growth, and closure of epiphyseal lines constitutes the biological foundation of bone age identification, making it possible to infer an individual's age by observing the state of bones.

2.2 Introduction to Common Bone Age Identification Methods

2.2.1 Greulich-Pyle Atlas Method

The atlas method is one of the more traditional and widely used methods in bone age identification. Take the G-P atlas published by Greulich and Pyle in 1950 as an example. It was compiled through long-term and systematic observation and analysis of X-ray films of the wrist bones of children from middle-and upper-class American families. In practical applications, appraisers compare the X-ray film of the wrist of the individual to be tested with the standard images in the G - P atlas. They observe features such as the shape, size of the bones on the tested X-ray film, the appearance and development degree of the ossification centers, and find the age corresponding to the most similar image in the atlas as the estimated bone age of the individual to be tested. The advantage of this method is that it is relatively simple and intuitive to operate, and it has certain convenience for beginners or in large-scale screenings. However, it is highly subjective because different appraisers may have different judgments on the degree of image similarity. Moreover, the samples on which the atlas is based have certain limitations and may not be fully applicable to people of different ethnic groups, regions, or socioeconomic backgrounds.

2.2.2 Tanner-Whitehouse Scoring Method

The TW series of bone age scoring methods

proposed by Tanner, Whitehouse, etc. play an important role in the field of bone age identification. For example, the TW2 method was developed based on in-depth research on the X-ray images of the wrist bones of 2,600 children in the UK and Western Europe. This method divides the maturity of 20 bones in the left wrist into 8 – 9 grades in detail and assigns corresponding scores to each grade. When conducting bone age identification, first, the development of each bone is accurately evaluated and scored, then the scores of all bones are accumulated, and finally, the individual's bone age is determined by referring to a special bone age score table or the SMS-age curve. The advantage of the TW scoring method is that its evaluation process is relatively quantitative, which improves the accuracy to a certain extent compared with the atlas method. However, it also has obvious disadvantages. On the one hand, it is greatly affected by factors such as the era and population. For example, when directly applied to the bone age determination of Chinese children, due to the differences in the growth and development characteristics between Chinese children and adolescents and those in the UK and Western Europe, relatively large errors may occur. On the other hand, its evaluation process is relatively complex, with high requirements for appraisers. Appraisers need to have rich experience and professional knowledge, and the operation is time-consuming.

2.2.3 CHN Method

At the end of the 1980s, Chinese researchers developed the "Evaluation Standard for the Bone Development of the Wrist in Chinese People," that is, the CHN method[2], with the TW2 method as an important reference and combined with the actual situation of more than 30,000 samples from 11 provinces and cities in China. During the identification process, appraisers carefully observe the X-ray images of 14 bones in the left wrist according to specific standards, determine the development grade of each bone, and calculate the bone age by referring to the corresponding scores. The outstanding feature of the CHN method is that it fully considers the growth and development characteristics of Chinese children and adolescents, is more in line with the actual situation of the Chinese population, and has played an important role in the field of bone age identification in China. However, with the passage of time, the accelerated changes in the growth and development of Chinese children and adolescents, and the continuous update of research methods, the CHN method has gradually shown some limitations. For example, the complexity of the evaluation makes it require more manpower and time in practical applications, and it lacks universality internationally, which is not conducive to international exchanges and comparisons.[3]

3. Accuracy Limitations of Bone Age Identification in Confirming the Age of Criminal Responsibility

3.1 Strict Accuracy Requirements for the Age of Criminal Responsibility

In the criminal justice system, the definition of the age of criminal responsibility follows extremely strict accuracy standards. Legal provisions clearly and explicitly stipulate that the determination of the age of criminal responsibility must be accurate to the specific date. This is because in the actual operation of judicial practice, even a time difference as small as one day is likely to have an essential impact on whether a criminal suspect needs to bear criminal responsibility. Especially in cases involving serious criminal acts such as intentional homicide, serious robbery, and rape, when the age of the criminal suspect is exactly near the critical value of the age of criminal responsibility, the accurate date of birth becomes the core and crucial factor in determining whether they should be subject to criminal punishment. For example, in some cases, if the criminal act occurs on or after the day when the criminal suspect turns 14 or 16 years old, according to legal provisions, they may face severe sanctions under criminal law. However, if the criminal act is committed before the critical age, then according to the principle of legality of crimes and punishments, the criminal suspect usually should not bear criminal responsibility. This requirement of accuracy to the specific date reflects the solemnity and preciseness of the law in determining criminal responsibility and ensures the fairness and accuracy of legal application.

3.2 Accuracy Defects of Bone Age Identification

3.2.1 Technical Principle Limitations

Firstly, bone age identification mainly infers an individual's age based on the growth and development laws of human bones. Its core principle lies in observing the characteristic

changes of bones at different growth stages, such as the appearance time of ossification centers, the closure of epiphyseal lines, and the shape and size of bones.[4] However, the changes in these bone characteristics do not follow an absolutely fixed time process but are comprehensively affected by multiple factors.

Secondly, in terms of genetic factors, due to differences in genetic genes, the bone development speed and process of different individuals may vary significantly from birth. Some families may have a genetic tendency of early or late bone development, causing the relationship between the bone age and the actual age of family members to deviate from the general standard. For example, children in some families may have significantly advanced bone development among their peers, with the appearance of ossification centers and the closure of epiphyseal lines earlier than the average level. In other families, the opposite situation may occur, with relatively slow bone development.

Thirdly, nutritional status also plays a crucial role in bone development. During an individual's growth process, if there is a long-term lack of key nutrients such as calcium, phosphorus, and vitamin D, the growth and mineralization process of bones will be hindered, resulting in the bone age lagging behind the actual age. Conversely, individuals with sufficient and balanced nutrition may have relatively normal or slightly advanced bone development. For example, in some poor areas, due to the single-diet structure and insufficient nutrition intake of children, their bone age is often lower than that of their peers living in nutritionally rich environments.

Finally, environmental factors cannot be ignored. Geographical environment factors such as altitude and climate conditions can affect bone development. The hypoxic environment in high-altitude areas may inhibit bone growth, causing the bone age of local adolescents to be relatively delayed. The warm climate and abundant sunlight in tropical areas may, to a certain extent, promote bone development, resulting in a relatively advanced bone age. In addition, lifestyle factors such as exercise volume and labor intensity can also interfere with the normal bone development process. Adolescents engaged in long-term high-intensity physical labor or a large amount of physical exercise may have an increased mechanical stress on their bones, which may stimulate bone growth and cause a certain degree of deviation in bone age.[5]

3.2.2 Actual Error Manifestations

Due to the complex influence of the above-mentioned multiple factors, there are obvious errors in the practical application of bone age identification. Currently, even with relatively advanced bone age identification technologies and methods, the results can only provide a rough age range, usually difficult to be accurate to the specific year, and far from meeting the requirement of accuracy to the day for the age of criminal responsibility.

A large number of clinical studies and statistical data of actual cases show that the error range of bone age identification varies in different age groups. In infancy, due to the relatively fast bone growth speed and relatively small individual differences, the error of bone age identification may be relatively small, generally around ±1 month. During adolescence, as the bone development speed gradually slows down but individual differences increase, the error of bone age identification may expand to ±1 year or even larger. After adulthood, bone development basically stops, and the accuracy of bone age identification further decreases, with the error range possibly reaching ±5 years or even wider.[6] Such a large error range makes bone age identification inadequate when facing the precise determination of the age of criminal responsibility.

3.3 Difficulty in Applying Bone Age Identification to Confirm the Age of Criminal Responsibility

Given the huge gap in accuracy requirements between bone age identification and the age of criminal responsibility, bone age identification faces many insurmountable difficulties in the process of confirming the age of criminal responsibility and is difficult to be directly used as a reliable basis for determining the age of criminal responsibility.

In actual judicial cases, when the bone age identification result is in the critical interval of the age of criminal responsibility, its ambiguity will cause great confusion in judicial determination. For example, if the bone age identification result shows that the criminal suspect's bone age is around 14 years old, but it is impossible to accurately determine whether they have reached 14 years old, in this case, judicial personnel cannot determine whether the

criminal suspect should bear criminal responsibility solely based on the bone age identification result. This not only triggers a large number of disputes and uncertainties in judicial practice, may lead to the stalemate of case trials, but also may produce unjust judgment results, seriously affecting the fairness and authority of justice.

In some complex cases, criminal suspects may take advantage of the accuracy defects of bone age identification to evade legal sanctions. They may deliberately provide false information or interfere with the bone age identification process, making the identification results more ambiguous. For victims and their families, because bone age identification cannot accurately determine the criminal suspect's age of criminal responsibility, it may lead to their suspicion of the fairness of justice, thereby affecting the trust foundation of the rule of law in society. Therefore, at the current technical level, the limitations of bone age identification in confirming the age of criminal responsibility are obvious, and there is an urgent need to find more accurate and reliable methods to solve this problem.

4. Dilemmas in the Legal Application of Bone Age Identification

4.1 Vagueness and Uncertainty of Legal Basis

At the level of legal application, bone age identification faces many dilemmas, and the first one is the vagueness and uncertainty of the legal basis. Although the Supreme People's Procuratorate has issued relevant replies [1], stipulating that bone age identification can be used as evidence to determine the age of criminal suspects under specific circumstances, the key expressions therein lack clear definitions. For example, regarding the requirement of "accurately determining" the age of criminal suspects, no specific measurement standards or accuracy ranges are given. In actual operations, the understanding and grasp of this by different regions and judicial personnel vary greatly. Some judicial personnel may consider that the bone age identification result within a certain error range can be regarded as accurate determination, while others may require a higher accuracy level. This has led to great arbitrariness in the admissibility of bone age identification results in judicial practice.

At the same time, the "prudent handling" mentioned in the reply also does not clearly define the specific operation process and judgment criteria. When the bone age identification conclusion is near the critical value of the age of criminal responsibility and cannot be accurately judged, judicial personnel lack unified guidance in deciding whether to conduct further investigations, how to comprehensively consider other evidence, and finally how to determine the age of criminal suspects. This makes similar cases may be handled completely differently in different judicial jurisdictions, seriously affecting the fairness and consistency of justice.

4.2 Coordination Problems with Other Evidence

There are great difficulties in coordinating bone age identification with other common types of evidence in the process of determining the age of criminal responsibility. Household registration certificates are usually regarded as key documentary evidence for determining age and have high authority. However, in reality, there are many loopholes in household registration management. On the one hand, in some remote areas or places where household registration management was not standardized in the early days, registration errors may occur, such as deviations in the recorded date of birth, confusion between the lunar and Gregorian calendars, etc. On the other hand, there are phenomena of artificial tampering with household registration information, such as changing the age for the purpose of evading family planning penalties, enrolling in school early, or joining the army early. When the bone age identification result is inconsistent with the household registration certificate, judicial personnel find it difficult to make a choice. If they completely rely on the household registration certificate, they may ignore the real physiological development situation of the individual reflected by the bone age identification. However, if they overly rely on bone age identification, it may trigger doubts about the stability of the household registration management system, resulting in confusion in legal application.[7]

Testimony of witnesses, as another important type of evidence, also has problems in age

[1] See the Reply of the Supreme People's Procuratorate on Whether "Bone Age Identification" Can Be Used as Evidence for Determining the Age of Criminal Responsibility (No. 6 [2000], Research and Development of the Supreme People's Procuratorate), issued on February 21, 2000.

determination. Witnesses may provide partial testimony due to their close relationship with the criminal suspect, or the testimony may be inaccurate due to factors such as the passage of time, vague memories, and different observation angles. In some cases, the bone age identification result contradicts the witness testimony. In the absence of clear evidence admissibility rules, judicial personnel often find it difficult to judge the probative force of the two, thus affecting the trial process of the case and the fairness of the judgment result.

4.3 Difficulties in Cross-Regional and Cross-Jurisdictional Applications

With the development of society, population mobility has become increasingly frequent, and the legal application problems of bone age identification in cross-regional criminal cases have become more prominent. Different regions may adopt different bone age identification standards and methods, making it extremely complex to compare and comprehensively judge bone age identification results in cases involving multiple regions. For example, some economically developed regions may use more advanced technologies and standards for bone age identification, while the identification methods and accuracy in some relatively backward regions may be different. When a criminal suspect commits crimes in different regions and the bone age identification results of each region are inconsistent, how to determine a unified and credible age determination result has become a thorny problem in judicial practice.

In international judicial cooperation, the cross-jurisdictional application dilemma of bone age identification is more obvious. The legal systems, cultural backgrounds, and bone age identification technical standards of different countries vary greatly. In transnational criminal cases, when it is necessary to refer to bone age identification results to determine the criminal suspect's age of criminal responsibility, how to coordinate the differences among countries to ensure the fairness and justice of legal application has become an important challenge in international judicial cooperation. Currently, there is a lack of unified legal application rules and coordination mechanisms for bone age identification internationally, which has, to a certain extent, hindered the effective handling of transnational criminal cases and also affected the stability of the international judicial order.

5. Defects in the Procedures and Standards of Bone Age Identification

5.1 Chaos in the Qualifications of Appraisal Institutions and Personnel

In the current field of bone age identification, there is a lack of unified norms for the qualifications of appraisal institutions and personnel, presenting a rather chaotic situation. Many institutions have set foot in the bone age identification business, but many of them have not obtained professional and authoritative judicial appraisal qualification certifications. In the market, in addition to some regular scientific research institutions and professional medical institutions, some commercial testing centers do not even have the necessary professional equipment and technical conditions but still provide bone age identification services.

The backgrounds of personnel engaged in bone age identification are also diverse. Some personnel may have only received simple training and lack the support of a systematic professional knowledge system in medicine, anthropology, forensic medicine, etc. When conducting appraisals, they may not be able to accurately identify and interpret the subtle features on bone X-ray films, nor can they comprehensively consider various factors affecting bone age, thus greatly reducing the reliability of the appraisal results. For example, in some small and non-professional appraisal institutions, the staff may not have passed strict professional assessments, have a poor understanding of the standards and methods of bone age identification, and only make judgments based on limited experience. In such cases, the appraisal conclusions are likely to be biased.

Due to the lack of an effective supervision mechanism and industry access threshold, the bone age identification reports issued by these institutions and personnel with doubtful qualifications may be mistakenly believed or misused by some judicial personnel in judicial practice, seriously interfering with the realization of judicial justice and increasing the risk of misjudgment.

5.2 Lack of Unified Appraisal Standards and Norms

There are serious problems of non-uniformity in the standards and norms of bone age identification. There are significant differences between different appraisal methods. The atlas method, scoring method, CHN method, etc.,

each have their own unique operation processes and judgment bases, but there is a lack of effective integration and coordination among these methods. For example, the atlas method is relatively intuitive and simple, but it is highly subjective. Different appraisers may have large differences in the interpretation of the atlas. The scoring method is relatively quantitative, but the setting of scores and the allocation of weights may vary due to factors such as regions and populations, resulting in different appraisal results in practical applications.

Even for the same appraisal method, there may be differences in its application in different regions or institutions. Some regions may have made local adjustments to the appraisal standards based on their own experience and research, but such adjustments have not been widely verified and uniformly recognized. This makes it extremely difficult to compare and adopt bone age identification results in cross-regional judicial cases. For example, in a criminal case involving multiple regions, different regional appraisal institutions use the same appraisal method but obtain different bone age identification results. Judicial personnel are often at a loss when making judgments and cannot determine which result is more reliable, thus affecting the trial process of the case and the fairness of the judgment.[8]

In addition, with the passage of time and the development of science and technology, the growth and development of children and adolescents are constantly changing, but the update of bone age identification standards lags behind. The old standards may not be able to accurately reflect the bone development characteristics of contemporary people, further increasing the errors and uncertainties in the practical application of bone age identification and severely weakening its role in determining the age of criminal responsibility.

6. Case Analysis

6.1 Basic Case Situation

In the case of Fang Moumou's intentional homicide, robbery, and corpse-insulting, the core controversial focus of the case is whether the defendant Fang Moumou was over 18 years old when committing the crime. This point is directly related to whether the death penalty, a crucial punishment, can be applied to him. In terms of evidence, the prosecution mainly relied on Fang Moumou's household registration certificate materials and school enrollment materials. These materials showed that he was born in February 2001. Calculated from this, when he committed the crime in September 2019, he was already over 18 years and 6 months old. Moreover, the prosecution also presented that the bone age identification result corroborated that Fang Moumou was over 18 years old when committing the crime, trying to construct a complete chain of evidence from multiple aspects to support its accusation. However, the defender proposed that Fang Moumou's household registration certificate and school enrollment materials were deliberately fabricated by his mother to enable Fang Moumou to enter school early. And due to many uncertainties and reliability issues in the bone age identification result, it should not be used as the key basis for determining Fang Moumou's age. The defender further provided the hospital vaccination registration materials as strong evidence and claimed that the age shown in this vaccination registration was Fang Moumou's real age. Based on this inference, Fang Moumou was under 18 years old when committing the crime. Due to the above disputes, this case was reviewed by the Supreme People's Court and remanded for retrial to further clarify the facts of the case and ensure judicial fairness and accuracy.

6.2 Analysis of Bone Age Identification Problems

6.2.1 Disputes over the Applicability of Standards

When conducting the bone age identification of Fang Moumou in this case, the appraiser used the "Evaluation Method for the Maturity of Wrist Bones of Chinese Adolescents and Children" of the sports industry standard. The defender, based on the clear provisions of the "General Rules for Forensic Appraisal Procedures," precisely pointed out that the application premise of this appraisal standard is based on the "professional field," and since Fang Moumou was not an athlete, the application of this standard in this case was obviously incorrect. In contrast, after a large number of document reviews and case retrievals, the defender found that the "Technical Regulations for Bone Age Identification of Han Adolescents in Forensic Science (GA/T 1583 - 2019)" was the appropriate standard for this case. This standard is clearly applicable to Han adolescents aged 12 – 20 and is used in the fields of forensic science and justice. Its appraisal results are unique.

According to this standard, when X-ray photos were taken of Fang Moumou on August 12, 2020, his bone age was 19.5±1 years old (18.5 years old). From this, it was inferred that his date of birth was February 12, 2002, indicating that Fang Moumou was very likely under 18 years old when committing the crime on September 11, 2019. This fully highlights the crucial importance of the selection of bone age identification standards in judicial practice. Different standards may lead to completely different age determination results, thus having a decisive impact on the outcome of the case.

6.2.2 Doubts About Appraisal Qualifications

The defender searched on the "National Forensic Appraisers and Forensic Appraisal Institutions Inquiry Platform" and found that the practicing category of the appraiser Huang in this case was forensic toxicology, not the forensic clinical appraisal field to which bone age identification belongs. According to relevant regulations, Huang clearly did not have the qualifications for bone age identification. This key issue seriously undermined the legal and reliable basis of the bone age identification result. In the judicial process, the compliance of the qualifications of appraisers is an important prerequisite for ensuring the validity of appraisal results. The appraisal opinions issued by appraisers without qualifications should not be adopted by judicial organs as the basis for deciding cases.

6.2.3 Impact of Appraisal Time on Accuracy

Fang Moumou's bone age identification was carried out nearly one year after the crime. Such a long time interval greatly reduced the accuracy of the identification result. In criminal cases, especially those involving age critical points, the time node of bone age identification is of great significance. Because during this period, the human bones may change due to various factors, such as changes in the individual's living environment and fluctuations in nutritional status. These factors may interfere with the accuracy of the bone age identification result. Therefore, in such a situation, bone age identification must not be used as the only standard for determining age. Otherwise, it is very likely to lead to misjudgments and seriously damage judicial justice.

6.3 Case Review

In the case of Fang Moumou's intentional homicide, there were many problems in the bone age identification when determining Fang Moumou's age, making it impossible to be a reliable basis.

Firstly, bone age identification itself has accuracy limitations. Affected by multiple factors such as genetics, nutrition, and environment, the results are often only a rough age range and are difficult to be precise to the specific date required by the age of criminal responsibility. In this case, even if the so-called standard was used for identification, it was impossible to accurately determine whether Fang Moumou was over 18 years old when committing the crime. This ambiguity made it unable to meet the high-precision requirements of age determination in judicial practice.

Secondly, there were serious errors in the procedures of the bone age identification in this case. On the one hand, the appraiser used the "Evaluation Method for the Maturity of Wrist Bones of Chinese Adolescents and Children" of the sports industry standard, and since Fang Moumou was not an athlete, this standard was obviously not applicable to this case. According to the "General Rules for Forensic Appraisal Procedures," a standard that conforms to the professional field and is applicable to judicial practice, such as the "Technical Regulations for Bone Age Identification of Han Adolescents in Forensic Science (GA/T 1583 - 2019)," should be used. However, the appraiser did not follow this principle, resulting in the ineffectiveness of the identification result. On the other hand, it was found through inquiry that the practicing category of the appraiser Huang was forensic toxicology, not the forensic clinical appraisal field to which bone age identification belongs. He did not have the qualifications for bone age identification. This seriously violated the normative requirements of the appraisal procedure, making the bone age identification lose its legal basis from the source of the procedure.

Thirdly, there were other evidences in this case that could prove Fang Moumou's age. The hospital vaccination registration materials provided by the defender showed different age information from that of the prosecution, and there were reasonable grounds to indicate that this material might reflect Fang Moumou's real age. In contrast, given the above-mentioned accuracy and procedural problems of bone age identification, its reliability was far lower than that of these evidences with clear directivity.

In conclusion, due to the accuracy limitations, procedural errors of bone age identification itself, and the existence of other more persuasive evidences, in the case of Fang Moumou's intentional homicide, bone age identification could not be used as the basis for determining Fang Moumou's age. This case serves as a wake-up call for judicial practice. When using bone age identification, it is necessary to strictly review its standards, procedures, and the relationship with other evidences to ensure the accuracy and fairness of age determination and avoid judicial injustice caused by the wrong adoption of bone age identification.

7. Conclusion

This article deeply analyzes the situation of bone age identification in the confirmation of the age of criminal responsibility, clearly reveals its limitations in many aspects, and based on this, preliminarily explores its reasonable application boundaries.

The limitations of bone age identification are significant and complex. In terms of accuracy, affected by the interweaving of factors such as genetics, nutrition, and environment, its results can only provide a rough age range. For example, during adolescence, the error can reach ±1 year or even wider, making it difficult to precisely meet the specific date requirements of the age of criminal responsibility, resulting in a lack of accuracy and reliability in the determination of critical ages. In terms of legal application, the key details of relevant regulations are vague. The lack of quantitative definition for "accurately determining" and the absence of operation guidelines for "prudent handling" have led to chaotic admissibility standards in judicial practice. Different regions and personnel handle cases differently, seriously undermining judicial fairness and unity. At the level of procedures and standards, the supervision of the qualifications of appraisal institutions and personnel is lacking. A large number of unqualified entities participate. There are significant differences between different appraisal methods and in their regional applications, and the standard update lags behind, unable to adapt to the growth and development changes of adolescents. This has greatly weakened the scientific nature and authority of the appraisal results, making it difficult to effectively support the determination of the age of criminal responsibility.

Regarding the application boundary of bone age identification, given its limitations, when there are other reliable evidences (such as accurate household registration certificates, flawless birth medical certificates, credible witness testimonies, etc.) that can clearly determine the age, bone age identification should not be used as the primary or key evidence. It can only serve as an auxiliary reference to corroborate or supplement other evidence chains. Only in extreme cases where other conventional age-determining evidences are completely lacking or seriously doubtful, and the bone age identification can follow strict procedural norms (conducted by qualified personnel in accordance with judicial-applicable standards within a reasonable time frame), can it be carefully considered for inclusion in the comprehensive consideration of age determination. However, it still needs to be comprehensively weighed and carefully judged in combination with the overall situation of the case and other indirect evidences. By no means can the age of criminal responsibility be determined unilaterally based on the bone age identification result. In this way, it can ensure the precision, fairness, and legality of judicial judgments in the age-determination link, and safeguard the dignity of the law and social fairness and justice.

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