FORENSIC SKELETAL IDENTIFICATION IN NIGERIA: METHODS, CHALLENGES AND CASE STUDIES

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Abstract

Forensic skeletal identification plays a critical role in medico-legal investigations, particularly in cases involving decomposed, fragmented, or unidentified human remains. This study provides a critical appraisal of skeletal identification methods in Nigeria, focusing on their application, limitations, and relevance within the forensic and criminal justice systems. A narrative literature review was conducted using major databases, including PubMed, and Google Scholar, to synthesize current evidence on forensic anthropology and biological profiling. Findings indicate that skeletal identification in Nigeria relies primarily on morphological and metric approaches, with emerging use of advanced techniques such as DNA analysis and radiological imaging. However, their effectiveness is constrained by inadequate forensic infrastructure, shortage of trained personnel, incomplete skeletal remains, and lack of population-specific reference data. Case-based analyses, including criminal skeletal recovery and mass fatality scenarios, reveal significant gaps between established forensic methodologies and their practical implementation. The study concludes that while forensic skeletal identification methods are well established, their application in Nigeria remains limited by systemic challenges. Strengthening forensic infrastructure, developing population-specific databases, and integrating multidisciplinary approaches are essential to improve identification outcomes and support effective medico-legal investigations.
Keywords: Forensic anthropology, Skeletal identification, Biological profiling, Medico-legal investigation, Nigeria

Introduction

Forensic skeletal identification is a specialized domain within forensic anthropology that focuses on the analysis of human skeletal remains to establish the identity of unknown individuals, particularly in cases where soft tissues are lost due to decomposition, burning, or fragmentation (Jankova, 2024). Because bones and teeth exhibit high resistance to environmental and postmortem changes, they often serve as the most reliable sources of information in advanced stages of decomposition (Ajeesh, 2022). Through the application of scientifically validated methods, forensic experts reconstruct key biological characteristics that support identification, especially in scenarios such as criminal investigations, mass disasters, and missing persons cases where conventional approaches like fingerprinting or facial recognition are no longer feasible (Dahal et al., 2023; Márquez-Grant et al., 2022). Central to this process is biological profiling, which involves the estimation of age at death, sex, stature, and ancestry using a combination of morphological and metric analyses (Bonicelli et al., 2021; Dunn et al., 2020). These parameters collectively provide a framework for narrowing potential matches by comparing postmortem findings with antemortem records, with accuracy enhanced through the integration of multiple complementary techniques (Jankova, 2024; Kaul et al., 2021).

Beyond traditional anthropological approaches, recent advancements in forensic science have significantly expanded the scope and precision of skeletal identification. Molecular techniques, particularly DNA analysis, enable highly individualized identification even from degraded skeletal material (Pilli et al., 2025). Similarly, radiological methods such as computed tomography and three-dimensional imaging facilitate non-destructive examination and digital reconstruction of skeletal remains, improving both analytical accuracy and documentation (Crebert, 2025; Dedouit

et al., 2025). These multidisciplinary approaches have strengthened the evidentiary value of skeletal identification, allowing forensic practitioners to contribute not only to identity establishment but also to trauma analysis, reconstruction of events surrounding death, and the broader medico-legal investigative process (Dahal et al., 2023; Ajeesh, 2022). As a result, forensic skeletal identification plays a crucial role in supporting law enforcement, informing judicial proceedings, and advancing humanitarian efforts in disaster victim identification and missing persons investigations (Pilli et al., 2025).

Despite these global advancements, the application of forensic skeletal identification in Nigeria remains constrained by significant systemic and structural challenges. Limited forensic infrastructure, lack of standardized protocols, and a shortage of trained forensic anthropologists restrict the routine implementation of advanced analytical techniques (Wakili et al., 2025; Dahal et al., 2023). In addition, the absence of comprehensive, population specific reference databases reduce the accuracy of biological profiling, as many existing standards are derived from non-African populations and may not adequately reflect local variability (Salawu et al., 2025; Oladipo et al., 2025; Dunn et al., 2020). These limitations are further compounded by increasing demands arising from rising incidences of crime, mass casualty events, and unresolved missing persons cases, all of which require robust and efficient identification systems (Michael et al., 2022; Kaul et al., 2021). Consequently, there exists a critical gap between established forensic methodologies and their practical application within the Nigerian context (Wakili et al., 2025; Pilli et al., 2025). This study therefore provides a critical appraisal of forensic skeletal identification in Nigeria, examining methodological approaches, identifying key challenges, and highlighting opportunities for strengthening forensic practice through improved infrastructure, capacity building, and the development of locally relevant databases. This study aims to provide a critical appraisal of forensic skeletal identification within the Nigerian context, with emphasis on methodological approaches, practical applicability in medico-legal investigations, and systemic limitations. By integrating case-based insights, the study seeks to bridge the gap between established forensic principles and their real-world implementation in Nigeria.

Research Questions

1. What factors limit the accuracy and reliability of skeletal identification in Nigeria?
2. What gaps exist between forensic theory and practice in Nigerian case scenarios?
3. How can forensic identification practices be improved in Nigeria?

Methodology

This study employs a narrative literature review approach to provide a comprehensive synthesis of existing knowledge on forensic skeletal identification, with a particular focus on its application in Nigeria and the broader African context. Relevant literature was gathered from major academic databases, including Scopus, Web of Science, PubMed, and Google Scholar, to ensure broad coverage of peer-reviewed studies and scholarly publications. The search strategy used keywords such as “forensic anthropology,” “skeletal identification,” “biological profiling,” and “Nigeria,” combined with Boolean operators to refine results and capture studies most relevant to the topic. This method allowed for the identification of both global perspectives and region-specific challenges in forensic skeletal identification. Studies were selected based on clear inclusion and exclusion criteria. Included studies focused on forensic skeletal analysis, biological profiling, and human identification, particularly within African or Nigerian populations. Studies unrelated to skeletal identification or outside the forensic anthropology scope were excluded. Data extracted from the selected studies were analyzed qualitatively, enabling the identification of key themes, methodological trends, and gaps in the current literature. This approach provides a

structured framework to evaluate existing knowledge and supports recommendations for improving forensic skeletal identification practices in resource-limited settings.

Results

Dominance of Traditional Methods in Practice

Forensic skeletal identification frequently begins with morphological methods, which are based on detailed visual assessment of anatomical features of the skeleton to derive biological information about an individual. The pelvis and skull are among the most informative skeletal elements because their morphology exhibits pronounced sexual dimorphism, making them highly useful for sex estimation in forensic contexts (Wang *et al.*, 2024). Morphological evaluation also includes analysis of unique skeletal traits, sinus patterns, and healed trauma features that can help differentiate individuals when comparing postmortem findings with antemortem records (Adserias-Garriga *et al.*, 2024). Morphological methods remain foundational in forensic anthropology, especially in cases where skeletal preservation is sufficient to reveal clear anatomical landmarks for comparison and interpretation.

Metric methods provide quantitative support by applying standardized measurements to skeletal elements, allowing for statistically grounded interpretations that strengthen identification conclusions. Long bone measurements such as femur, tibia, and humerus lengths are widely used to estimate stature by applying regression formulas based on population-specific data, yielding reproducible results that aid in narrowing candidate identities (Yadav *et al.*, 2025). Odontometric approaches, which measure dental dimensions, also contribute to biological profiling and can be especially valuable when long bones are incomplete or fragmented (Adserias-Garriga *et al.*, 2024). The integration of metric data with morphological assessment enhances objectivity and allows forensic anthropologists to construct a more comprehensive biological profile even when remains are partial or degraded. Beyond traditional morphological and metric techniques, histological and biochemical methods offer advanced analytical capabilities that can significantly extend the information recovered from skeletal remains. Histological approaches examine bone microstructure, which can help assess preservation quality, estimate age-related changes, and validate the reliability of other identification indicators under varying taphonomic conditions (Reid *et al.*, 2023). Biochemical techniques including genomic DNA analysis, stable isotope profiling, and proteomic markers provide additional lines of evidence that can support or refine biological profiles beyond what is possible through morphology and metrics alone (Zupanič Pajnič *et al.*, 2026). Together, these multidisciplinary approaches improve the robustness of skeletal identification and expand its applicability across a range of forensic scenarios, including highly degraded, fragmentary, or complex cases.

Advanced Analytical Techniques in Skeletal Identification

Modern forensic skeletal identification increasingly incorporates DNA and molecular analysis to enhance accuracy and resolution, particularly when morphological and metric methods are limited. DNA profiling from skeletal material provides highly individualizing evidence by comparing genetic markers between unknown remains and reference samples, aiding both criminal investigations and missing-persons cases (Stan *et al.*, 2024). Advances in molecular methods, including short tandem repeat (STR) analysis and next-generation sequencing, have improved the ability to generate profiles from degraded or limited bone and dental samples (Stan *et al.*, 2024). Mitochondrial DNA (mtDNA) analysis is particularly useful when nuclear DNA is too fragmented, as higher copy numbers increase the chance of recovery from ancient remains (Vinueza-Espinosa *et al.*, 2023). Moreover, integrating DNA data with other anthropological evidence helps corroborate skeletal findings and enhances the overall strength of

identification outcomes (Stan *et al.*, 2024). In addition to genetic techniques, radiological methods such as computed tomography (CT) and 3D imaging have transformed how skeletal remains are visualized and analyzed non-destructively. CT scanning enables the creation of detailed three-dimensional reconstructions of bones, permitting virtual examination of internal and external features without requiring physical manipulation of fragile specimens (Crebert, 2025). Advanced imaging modalities also include structured light scanning and photogrammetry, which produce accurate 3D models that can facilitate measurements and comparative assessments for biological profile construction (Crebert, 2025). These radiological tools improve documentation, allow repeated analysis, and support ante-mortem to post-mortem comparisons crucial for positive identification, although access and cost may limit their widespread use in some settings (Dedouit *et al.*, 2025).

Challenges Associated with Skeletal Identification

One major challenge in forensic skeletal identification is the lack of adequate forensic infrastructure, which limits the capacity to recover, analyze, and interpret human remains effectively. Many forensic systems, particularly in developing regions, lack modern laboratories, trained personnel, and access to advanced analytical tools, resulting in delayed case resolutions and reduced accuracy of identifications (Cevallos, 2026). Without sufficient infrastructure and institutional support, crucial processes such as evidence processing, DNA extraction, and radiological imaging remain under-utilized or unavailable, weakening the overall investigative framework. This limitation often forces reliance on basic field methods, which may be insufficient for complex or highly degraded remains, underscoring the need for investment in facilities and capacity building. Incomplete skeletal remains present another significant challenge, as fragmentation or loss of bones can severely hinder the establishment of biological profiles and identification outcomes. Fragmentation frequently results from environmental exposure, taphonomic processes, or trauma prior to recovery, complicating inventory, completeness estimation, and analytical interpretation (Baker, 2024). Forensic anthropologists may face difficulties constructing reliable profiles when key skeletal elements such as the skull or pelvis are missing, which are critical for estimating sex, age, and ancestry. Furthermore, there is no universally accepted standard for reporting the degree of completeness in fragmented assemblages, leading to inconsistent assessments between practitioners and potentially affecting downstream analyses (Palmiotto *et al.*, 2024). Another pervasive problem is the lack of population-specific forensic data, which limits the accuracy of biological profiling and statistical models used in skeletal identification. Many current reference datasets are based on populations outside Africa or under-represented groups, leading to potential biases and reduced precision when applied to diverse population groups (Siddiqui et al., 2026). The absence of localized osteological collections, standardized metrics, and demographic databases impedes the development of forensic standards tailored to specific regions or ethnicities. Addressing this gap requires concerted research efforts to build comprehensive, population-specific databases that improve the relevance and reliability of forensic analyses across varied demographic contexts.

Case-Based Applications in the Nigerian Context

Study 1: Disaster Victim Identification Constraints Following the Abule Ado Explosion

Mass fatality incidents represent one of the most complex scenarios in forensic science, requiring structured and multidisciplinary identification systems. The Abule Ado explosion in Lagos in 2020 resulted in extensive thermal destruction, fragmentation of human remains, and loss of identifiable soft tissues (The Guardian Nigeria, 2020), thereby limiting conventional identification approaches such as visual recognition and fingerprint analysis. Under such conditions, forensic skeletal identification becomes central to establishing victim identity. Globally, disaster

victim identification is guided by standardized protocols developed by the INTERPOL, which outline four key phases: scene investigation, postmortem data collection, antemortem data collection, and reconciliation. Within this framework, skeletal remains are systematically recovered and analyzed using biological profiling, dental comparison, and DNA analysis. Radiological techniques such as computed tomography further enhance reconstruction and trauma assessment in fragmented remains (Garvin & Stock, 2016). However, forensic response capacity in Nigeria remains limited by inadequate infrastructure, lack of centralized databases, and insufficient integration of forensic experts into emergency systems. These constraints may lead to delayed identification, reliance on non-standard methods, and, in some cases, failure to establish identity (Onosome, 2025). This case highlights a critical disconnect between international forensic standards and local implementation, emphasizing the urgent need for institutionalized DVI frameworks and improved forensic preparedness.

Figure 1: Aftermath of the Abule Ado Explosion in Lagos, Nigeria (The Guardian Nigeria, 2020)

Study 2: Skeletal Recovery from the Soka Forest, Ibadan-Implications for Forensic Identification

The discovery of multiple humans remains in Soka Forest, Ibadan, represents one of Nigeria's most disturbing criminal cases involving unidentified skeletal remains. The site, uncovered in 2014, reportedly contained decomposing and skeletal bodies believed to be victims of abduction and prolonged captivity. The condition of the remains ranged from partially decomposed bodies to fully skeletonized individuals, indicating varying postmortem intervals and prolonged exposure (Daily Trust, 2014). From a forensic perspective, this case exemplifies the critical role of skeletal identification in complex crime scenes involving multiple victims. A systematic forensic approach would require controlled scene excavation, proper documentation of body positions, and reconstruction of skeletal elements to determine the minimum number of individuals. Biological profiling techniques, including sex estimation using pelvic morphology and age estimation through skeletal degeneration, would be essential in narrowing victim identity (Spradley, 2016). Additionally, trauma analysis could provide insights into patterns of violence and possible causes of death. However, reports from the activities following the incident suggested limited application of

structured forensic protocols, including inadequate preservation of the scene and lack of comprehensive anthropological analysis (Daily Trust, 2014). The absence of coordinated forensic documentation and centralized missing persons databases likely hindered accurate identification of victims. This case highlights the urgent need for integrating forensic anthropology into criminal investigations in Nigeria, particularly in cases involving multiple skeletal remains and potential serial offenses.

Discussion

Forensic skeletal identification remains a cornerstone of human identification in cases where conventional methods are not feasible. Morphological assessments of the pelvis, skull, and other skeletal elements provided crucial insights into sex, age, and ancestry, confirming the continued relevance of traditional anatomical methods in forensic investigations (Wang *et al.,* 2024). Metric analyses of long bones and odontometrics further supported biological profiling by allowing reproducible, population-specific estimations of stature and other parameters (Adserias-Garriga *et al.,* 2024). The integration of morphological and metric data enhances objectivity and improves the reliability of identification outcomes, particularly when skeletal remains are fragmented or partially degraded (Vinueza-Espinosa *et al.,* 2023). Advanced analytical methods, such as DNA profiling and radiological imaging, complemented traditional approaches and improved resolution in complex forensic scenarios. Short tandem repeat (STR) analysis and mitochondrial DNA profiling enabled the recovery of genetic profiles from degraded skeletal material, facilitating accurate individual identification even in challenging contexts (Vinueza-Espinosa *et al.,* 2023). Radiological methods, including computed tomography (CT) and 3D imaging, allowed non-destructive examination and virtual reconstruction of skeletal remains, providing additional support for trauma assessment, ante-mortem comparison, and biological profiling (Crebert, 2025; Dedouit *et al.,* 2025). These multidisciplinary techniques highlight the increasing importance of combining morphological, metric, molecular, and radiological evidence to achieve robust forensic identifications. Despite these advances, practical challenges remain, particularly in resource-limited settings such as Nigeria. Limited forensic infrastructure and a shortage of trained personnel restrict the consistent application of advanced techniques and reduce overall case resolution efficiency (Cevallos, 2026). Incomplete or fragmented skeletal remains further complicate profile reconstruction, making age, sex, stature, and ancestry estimation more difficult and less reliable. Additionally, the scarcity of population-specific reference datasets hampers the accuracy of biological profiling, as many available standards are derived from non-African populations, potentially introducing bias in forensic analyses (Siddiqui *et al.,* 2026; Salawu *et al.,* 2025). Addressing these limitations requires targeted investment in local databases, training programs, and multidisciplinary forensic capacity.

Conclusion and Recommendations

Forensic skeletal identification remains a vital component of medico-legal and criminal investigations, providing reliable methods to establish the identity of unknown individuals, particularly in cases involving decomposed, fragmented, or otherwise unrecognizable remains. The integration of morphological, metric, molecular, and radiological techniques enables the construction of comprehensive biological profiles, enhancing the accuracy and reliability of identifications. Despite its importance, challenges such as limited forensic infrastructure, incomplete skeletal remains, and the absence of population-specific reference data constrain the full application of these methods, particularly in resource-limited settings like Nigeria. Addressing these gaps through investment in infrastructure, capacity building, and the development of localized databases is essential to strengthen forensic practice, improve investigative outcomes, and support justice and humanitarian efforts. To enhance the effectiveness

of forensic skeletal identification, investment in modern forensic infrastructure is essential, including the establishment of well-equipped laboratories and access to advanced analytical technologies. Developing comprehensive, population-specific skeletal and genetic databases will improve the accuracy of biological profiling and support more reliable identifications. Training and capacity-building programs for forensic anthropologists, pathologists, and related personnel should be prioritized to strengthen local expertise. Additionally, adopting multidisciplinary approaches that integrate morphological, metric, molecular, and radiological methods will ensure robust and reproducible results. Finally, national policies and frameworks should be implemented to standardize forensic procedures, promote collaboration among agencies, and ensure sustainable development of forensic science in the country.

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