Análisis de imágenes de fuente abierta en antropología forense.

ANALYSING OPEN-SOURCE IMAGES IN FORENSIC ANTHROPOLOGY.

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RESUMEN: Resulta cada vez más frecuente la participación de investigadores forenses, incluidos los antropólogos forenses, en la interpretación de imágenes que ilustran restos humanos en el dominio público. La magnitud actual sin precedentes de material digital disponible en línea, y en particular en las redes sociales, sobre el conflicto en Ucrania y anteriormente en Siria, y las diversas dificultades logísticas para verificar los presuntos abusos de derechos humanos y crímenes que pueden haber ocurrido en estos casos, sugieren la necesidad de un mayor conocimiento y comprensión de la utilidad de las imágenes de fuente (o código) abierto en el campo de la antropología forense.Este artículo presenta los resultados de una encuesta con 10 imágenes de fuentes abiertas enfocadas a restos humanos y enviada a profesionales con distinta formación y experiencia en antropología forense para evaluar la utilidad de las imágenes para fines de investigación antropológica forense. Se utilizaron métodos cualitativos y cuantitativos. Los resultados mostraron que la mayoría de los participantes pudieron proporcionar interpretaciones de diagnóstico a partir de imágenes y consideraron sus análisis útiles en diversos grados. Se observaron diferencias mínimas al comparar las respuestas según la experiencia y/o formación. El estudio reveló que se debe dar una mayor consideración al análisis forense de imágenes de fuentes abiertas, particularmente dada la creciente demanda de expertos en antropología forense y los desarrollos tecnológicos actuales.

PALABRAS CLAVE: INTELIGENCIA DE FUENTES ABIERTAS, RESTOS HUMANOS, INVESTIGACIÓN DE DERECHOS HUMANOS, OPERACIÓN DE BANDERA FALSA, DESINFORMACIÓN, CONFLICTO, IMÁGENES.

ABSTRACT: Forensic scientists, including forensic anthropologists, are increasingly being called on to comment on images depicting human remains taken from public domains. The current unprecedented scale of digital material available online and on social media regarding the conflict in Ukraine and previously in Syria, and the various logistical difficulties for verifying alleged human rights abuses and crimes that may have occurred there, suggest the need for further knowledge and understanding of the utility of open-source images in the field of forensic anthropology. This study surveyed 10 conflict-related open-source images among professionals with varying backgrounds in forensic anthropology to assess their usefulness for forensic anthropological investigative purposes. Qualitative and quantitative methods were used. The results revealed that most participants were able to provide diagnostic interpretations from open-source images and considered their analyses useful to varying degrees. Minimal differences were observed in comparing responses with experience and/or qualifications. The study revealed that a greater consideration must be given to the forensic analysis of open-source images, particularly given the increasing demand for forensic anthropological expertise and current technological developments.

KEY WORDS: OPEN SOURCES INTELLIGENCE, HUMAN REMAINS, HUMAN RIGHTS INVESTIGATIONS, FALSE FLAGS, DISINFORMATION, CONFLICT, IMAGES.

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1. INTRODUCTION.

Today, the Internet provides unprecedented openly available visual content and real-time access to information from conflicts [1]. As the uploading of digital open-source images and footage is now ubiquitous among users of social media platforms and online networks [2], the preservation and analysis of this content has becoming increasingly important for human rights investigations and other investigative work [3,4 5].

Defined as openly accessible and publicly available [2], open-source material has proven useful for identifying deceased and missing individuals [6]. However, under

challenging circumstances like in conflict areas, information and evidence-gathering can be challenging, and security and access for those directly involved can often be hampered (3). As such, investigations into alleged human rights and humanitarian issues have sought new ways to obtain evidence and to help bring justice [7].

In the sphere of global humanitarian and human rights issues, forensic anthropology has had a longstanding role that has evolved since the 1980s [8,9,10]. In these contexts, forensic anthropology has assisted in the identification of the deceased and the understanding of what may have happened, documenting evidence that is legally acceptable to prevent further atrocities taking place and hold perpetrators to account [8,11,12]. From the 2000s, it became common for forensic anthropologists to be asked to examine photographs, CCTV, and satellite imagery in police investigations to support domestic criminal proceedings [9,13]. Today, qualified forensic anthropologists are frequently required in searches for missing persons and at major crime scenes [14, 15, 3], and are increasingly being consulted on images to support ongoing investigations [16]. Furthermore, with online open-source material becoming a key source for global news reporting, forensic scientists have been consulted more broadly for their expert opinions on digital images/footage openly available in the public domain [17,18].

This paper examines how forensic anthropologists can work with open-source images depicting human remains to assist criminal and humanitarian investigations. To address this aim, this study has the following objectives:

- Survey a selection of open-source images among forensic anthropologist to assess what methods can be applied;
- Analyse survey results to assess what participants can tell from images;
- Discuss the implications of using open-source images in investigations and courtrooms.

2. AN INTRODUCTION TO DIGITAL OPEN-SOURCE INFORMATION FROM WAR AND CONFLICT.

The almost global daily use of smartphones and social media platforms has enabled conflict events to be viewed remotely across the globe. This phenomenon has allowed eyewitnesses, first responders, and other non-professionals to record and document events first-hand and share information online [3]. According to Ristovska [19], the ability for eyewitnesses to document events on smartphones and quickly share images and footage via the Internet has resulted in a 'new era of digital witnessing'.

Defined by The Berkeley Protocol on Digital Open-Source Investigations as 'information on the internet, which can be accessed, for example, on public websites, Internet databases, or social media platforms' [20]. This would include video footage and digital images uploaded online on social media, and other online information-sharing platforms [20]. When verified and analysed, open-source information can be useful for identifying deceased and missing persons [6, 10] and for reconstructing events [21]. For example, Bellingcat sought expert opinions to assess graphic images of burnt and damaged human remains uploaded on social media from separatist-held Ukraine [17]. It can also help overcome challenges of relying on on-the-ground reports. For example, Amnesty International drew attention to human rights abuses in remote and inaccessible areas of Nigeria [22].

The reliability of open-source information is problematic for fact-finding, however, and investigative work and authenticity often difficult to assess. Historically, disinformation campaigns have been used to influence the masses and images can now be easily manipulated and are extensively used in open-source spaces for global influence, giving a new meaning to false flag claims (tactics to misguide attribution to the real perpetrators) [23]. As such, vigorous verification techniques are now openly available to check the veracity of visual digital content [2]. Nevertheless, findings by Nakhaeizadeh and colleagues [24, 25], suggest that where data and image quality is ambiguous, interpretations can be influenced by contextual information provided before anthropological assessment.

3. APPLYING FORENSIC ANTHROPOLOGICAL METHODS AND TECHNIQUES WITH IMAGES.

Two-dimensional images and footage are now more frequently used to help to identify living individuals, to identify whether skeletal remains are human or non-human, to assess trauma and to assist with identification of the deceased [26, 27]. Forensic anthropologists can often provide unique expertise on forensic cases, physically and remotely via images, or through a mix of both [13, 28]. For example, UK law enforcement often send images to qualified forensic anthropologists for professional rapid assessment and advice on appropriate actions, for example to examine if the bone is human or non-human [27, 29, 30]. Other cases in forensic anthropology include analysing footage provided as evidence against a perpetrator for distinct vein patterns

[31]; applying gait and stride analysis with CCTV images [32], using facial recognition software with two- and three-dimensional images to identify suspects [33] and assessing pornographic images to determine the age of non-adults from photographic material [34, 35]. Other examples include assessment of human remains, which are on sale via social media [36].

4. ONLINE OPEN-SOURCE INFORMATION AND INTERNATIONAL CRIMINAL JUSTICE.

The value of digital open-source information is increasingly being accepted within legal processes [20]. Tallgren [37] argues that images are fundamentally important for international criminal justice. Traditionally international courts have been reliant on eyewitness and survivor accounts, however, more recently, open-source images and footage have been used in various ways as legal evidence for trials [21]. For example, in 2016, digital content published on Facebook and Twitter was used in a legal case in Sweden to prosecute a former Syrian dissident who kidnapped and killed Syrian soldiers [7]. Also, the International Criminal Court (ICC) began incorporating digital and scientific evidence after the watershed *Al-Mahdi* case [38] where digital open-source footage was used as evidence of cultural heritage destruction in Mali [39]. However, there remains a conflicted understanding of how best to handle open-source material in judicial processes.

5. MATERIALS AND METHODS.

This study was primarily aimed at forensic anthropologists. To examine what could be interpreted from open-source images, a selection of 10 digital open-source images were assessed by professionals with varying expertise in forensic anthropology to assess the following: 1) Types of forensic anthropological methods and techniques that can be applied; 2) What information can be assessed, interpreted, and concluded; 3) Levels of confidence in providing opinions; 4) Perceived evidentiary value; and 5) What is needed to improve analysis. The survey questions were developed in line with the research aims.

Elements of previous empirical studies using visual analysis techniques with images were useful for the survey design [40, 41, 24, 35].

5.1. Materials.

Ten online images were chosen for the survey based on their visual representation of skeletal remains, biological profile variations, differing taphonomic alterations and preservation, commingling, and trauma (Table 1).

Image #	Categories visually represented	Contextual information provided
1	• Human vs. non-human	*These skeletal remains were reported in open-source mass media. They were allegedly found at the site of a mass grave from a massacre in North Afica.*
2	• Human vs. non-human • Biological profiling (age)	*This image was shown in open-source mass media. Forensic anthropologists were consulted about whether or not the bone show in the image is human.*
3	• Preservation/decomposition • Identifying skeletal features • MNI • Archaeological or forensic?	*The following image is from a social media post supposedly shows a mass grave from a conflict in recent years (unverified).*
4	• PMI • Archaeological or forensic?	*An open-source media news site alleged that this image depicks skeletal remaisn that have been found in a mass grave site in the Middle East.*
5	• Biological profiling (sex) • Skeletal features • Preservation/decomposition	*•The following image was posted on social media with an image of female skeletal remains from the Spanisch civil war.*
6	• Archaeological or forensic? • Trauma analysis	*This image that uploadede on a social media platform. The contextual information associated with the image is not verified.*
7	• Archaeological context • Preservation/decomposition	*The following image was posted on a social media platform allegedly showing a mass grave in Sierra Leone.*
8	• Human vs. non-human • Skeletal features	*The following image was posted on a social media platform. It was uploaded to see whther the remains depicted in the image were human. You are asked to comment as a forensic anthropologist.*
9	• Context manipulation	*• This is a screen shot taken from footage from a current conflict. The image depicts a body in a vehicle following an alleged explosion. It was sent by a reputable open-source investigative team for comment.*
10	• Evidentiary value	*• The following image is from footage from the documentary Africa Addio which contained a sequence about massacres that allegedly occurred during the Zanzibar revolution of 1964.*

Table 1 Categorisation of the 10 images

Images were individually selected from open-source social media platforms and online websites and were not modified or manipulated. While meta-data is usually removed by default on certain social media platforms (such as Facebook), the images were obtained with a screenshot to reduce privacy risks and file size. Two images that had aroused online suspicion regarding their origin and authenticity were also selected. Reverse image searches were conducted on each of the images using the built-in feature on the Google Chrome browser and entering the image URL in images.google.com. This was done to verify the visual content and check whether the image had been used previously [42].

5.2.Survey.

An online survey was developed using Qualtrics software as it enabled real-time analysis of the results during the survey distribution phase. Qualtrics also allowed data to be downloaded for use in other software packages, which was useful for broader statistical and qualitative analysis undertaken. The survey included 18 questions (c. 25 minutes). Most questions required multiple-choice responses. Some questions included scales that allowed for responses to be controlled. Open text boxes were offered for some questions to enhance the potential for differing interpretations. The participants received identical surveys in terms of layout and appearance.

The sequence of the images and questions was structured to enable the results to be measurable and to minimise the influence on participant decision-making. The first section (Q1 – Q5) focused on the background of the participants. Participants were asked to give information on their area of expertise (forensic anthropology, bioarchaeology, forensic archaeology, forensic other, and non-forensic other), level of education (BSc, MSc, Ph.D., equivalent experience), and years of experience (0-4 years, 5-10 years or 10+ years).

Questions Q6 to Q15 related to the 10 images and included sub-questions. For some questions, the information given with the images was purposely vague and had been amended from its source. The intention was to create ambiguity to examine how the participants responded [25]. The final section (Q16-Q18) aimed to gather information regarding the usefulness of analysing images, the participant's confidence in their analysis, and the perceived value of open-source images for further investigative work and legal processes.

5.3.Participants.

An anonymous survey link was sent to peers to be shared with other participants and/or networks in forensic anthropology. Known distribution channels included the Cranfield Forensic Institute Facebook page; lecturers at Cranfield University; Cranfield MSc in Forensic Anthropology and Archaeology 2021/22 cohort; Spanish Association of Forensic Anthropology and Odontology (AEAOF); and the British Association for Biological Anthropology and Osteoarchaeology (BABAO).

5.4.Ethics and risks.

Before commencing the research, ethical approval was granted. The research purpose was explained in a participant information sheet and consent form. All participants provided data anonymously, following standard data protection protocols of Cranfield University. Additional risks, such as a warning that images would depict human remains, were identified for participants at the start of the survey. Participants were given the option to skip questions associated with images.

5.5.Data collection and analysis.

The survey ran between 26th July and 8th August 2022. Participants with responses in progress after the closing date were permitted to finish in the timeframe specified (two weeks). A results report was produced using Qualtrics visualising survey results and options were customised for further interpretation. The survey's raw response data (including answers to the survey, additional metadata such as dates and duration of participant's responses and embedded data, etc.) was also exported into Microsoft Excel for additional analysis outside of Qualtrics [43]. The results were then quantitatively and qualitatively analysed using visualisations generated in the online results report. Most questions contained numerical outputs to allow for statistical analysis.

5.6.Limitations.

The following limitations were identified during the data collection and analysis process:

- As a global network of forensic specialists was accessed, it was necessary to acknowledge the varying profiles of forensic anthropology. In hindsight, it may have been useful to have included questions related to country/residence.

- To minimise the possibility that images may negatively impact participants, the option was given for participants

to skip questions and images. This may have hampered the comprehensive analysis of the results as not all questions were answered.

- The images differed in terms of quality and contextual detail.

- The survey did not differentiate whether participants had academic or practitioner experience.

6. RESULTS.

A total of 141 survey responses were recorded. Of this total, 124 consented to proceed with the survey, however not all 124 answered every question. 83 (67%) fully completed the survey. Below is a summary of the results of questions 1-5 in the survey, which provide detail on the background of the participants.

- Q.1: Please select your main area of expertise: The participants had a mix of disciplinary expertise; distributions were forensic anthropology (36%), bioarchaeology (30%), forensic archaeology (17%), forensic other (11%), and non-forensic other (6%).

- Q.2: Please select your highest level of qualification: Of the participants that answered this question, 4 (4%) had a BSc, 53 (46%) had a MSc (including current and graduated), 49 (44%) had a PhD, and 7 (6%) did not have these qualifications but self-assessed themselves to have equivalent experience up to PhD level.

- Q. 3: How many years of experience do you have working with human remains in forensic, humanitarian, or archaeological contexts? The survey divided the participants into three groups: 0-4 years of experience (28%); 5-10 years (28%) and more than 10 years (44%). The largest number of participants that identified themselves to have expertise in forensic anthropology also had more than ten years of experience. Most participants with more than ten years of experience also had PhDs (63%).

- Q.4: Have you ever given evidence as an expert witness in court? Almost a quarter (24%) of participants had direct experience of providing expert testimony in court. As expected, a greater proportion of participants with 10+ years of experience (20 out of 48 respondents) had given evidence as an expert witness.

- Q.5: Any other relevant background you would like to share? (e.g., police, humanitarian, international aid, human rights work): Other relevant background was shared by 50 participants (43%). A large proportion of participants had humanitarian and/or human rights experience.

6.1 Results of survey responses on open-source images.

- Q.6. (Image 1): Based on your observation of the skeletal remains in the image, please select one of the following: They are human; They are animal (non-human) ; They are a mix of human and non-human; I can't say: The first image depicted skeletal remains. Participants were asked to observe the skeletal features in the image and respond based on their professional opinion. Only one selection was permitted. For this question, 95% of the respondents demonstrated their abilities to differentiate between human, non-human, and provide an opinion. 62% correctly answered that image 1 presented a mix of both human and non-human bone. Only 5% of respondents indicated that they couldn't say anything based on the image (Figure 1).

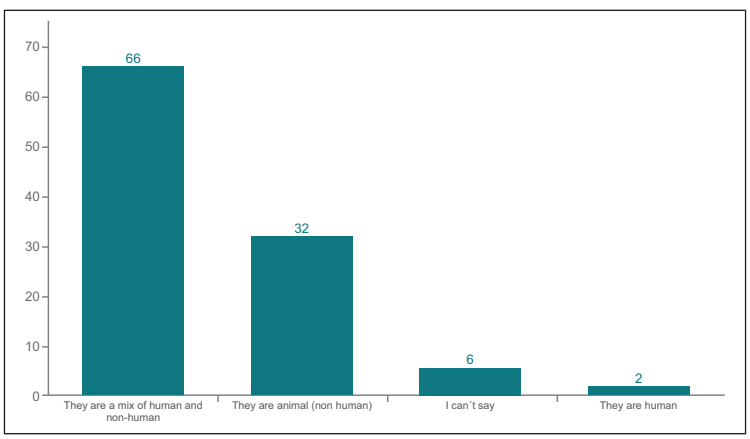

Figure 1 – Image 1: distribution of observations of human vs. non-human.

- Q.7 (Image 2) - (a) To what extent would you agree that this is human bone? Using a 0 to10-point measurement scale (0 - strongly disagree to 10 - strongly agree), almost half of respondents (48%) agreed to some extent (selecting 6-10 on the scale) and a quarter (25%) somewhat disagreed (selecting 0-4 on the scale). 27% selected point 5 on the scale (unsure) (Figure 2).

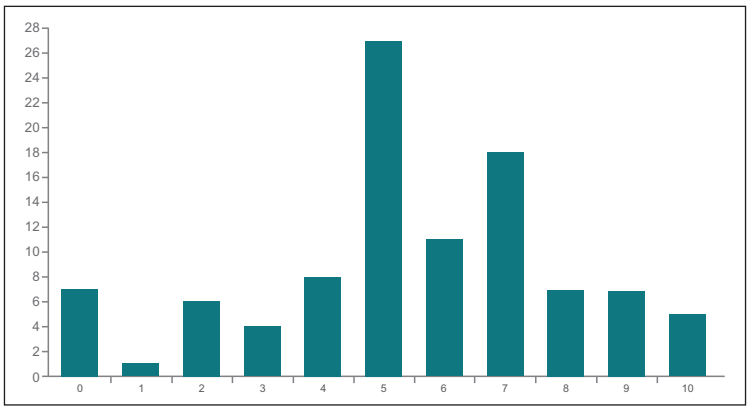

Figure 2 - Image 2: Distribution *of responses for differentiating human from non-human bone.*

- Q.7.(b) - If human, could you comment on age (e.g., adult vs. non-adult)? Based on the skeletal features present in image 2, 86% of participants were able to give an opinion on the possible age-at-death (adult vs. non-adult). Most participants selected yes (i.e. they could make an informed judgment) regardless of their years of experience, however, the largest proportion (94%) had 10+ years of experience.

- Q.8 (Image 3) - (a) To what extent do you agree that this is a mass grave as a result of violent conflict? Image 3 was taken from a social media post and showed an alleged mass grave containing human remains from a recent violent conflict. Options used were a 0 to 10-point measurable scale (ranging from strongly disagree to strongly agree). 30% of participants agreed to some extent (selecting between 6-10 on the scale); just over half (52%) were unsure (based on selecting point 5), and 18% disagreed to some degree by selecting between 0-4 on the scale. The results showed no significant differences in response based on qualification or years of experience.

- Q.8.(b) - What features can you observe enabling you to provide an opinion? For the second part of the question, participants were asked what features they observed enabling them to provide an opinion. Options were: a) body positioning and orientation; b) trauma; c) dismemberment; d) taphonomy/body decomposition; e) funerary context. The respondents applied multiple observational features to aid their analysis. Most participants observed body positioning and orientation (46%), followed by funerary context (20%), taphonomy/body decomposition (15%), dismemberment (10%), and trauma (9%). Comparing responses with years of experience; just over half (54%) with 0-4 years of experience chose body positioning and orientation, compared with just less than half with 5-10 years and 10+ years of experience (43% and 44% respectively). Those with more than 5 years of experience observed *taphonomy and body decomposition* slightly more frequently than those with less than 5 years of experience. Participants with 10+ years of experience observed *funerary context* more than the group with 0-4 years of experience (Figure 3).

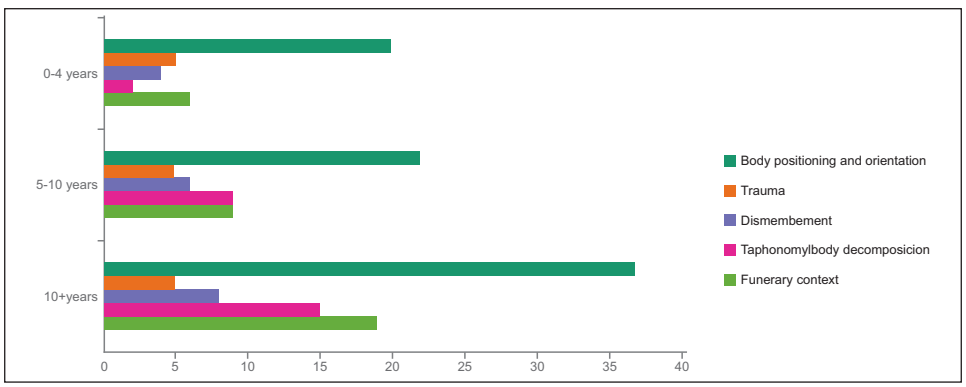

Figure 3 – Image 3: distributions of observations per feature compared with years of experience.

- Q.8. (c) – Can an observation be made about the minimum number of individuals (MNI)? In response, 61% said *yes*, and 39% said *no*. There were no significant differences based on years of experience and the highest level of qualification.

- Q.8. (d) – Could you say that the preservation of the human remains is consistent with being from four decades ago? The results showed that 72% of participants said they were *unsure/can't tell*, 15% said *yes* and 13% said *no*. Based on years of experience, there were no significant differences.

- Q.9. (Image 4) – (a). To what extent would you agree that the human remains in this image correspond with a violent conflict event? This image was taken from a social media site showing skeletal remains that had allegedly been found in a mass grave site in the Middle East. When asked the extent to which the state of human remains corresponded with a violent conflict, just over half answered *can't say* (52%). However, more respondents *agreed* (6-10 on the scale) to some extent (31%), than *disagreed* (17%) (0-4 on the scale).

- Q.9 – (b) Could this image be consistent with a 1940s burial site? 71% said they *couldn't say*, while 23% said *yes* and 6% said *no*. Responses were proportionately similar compared with years of experience. In the 10+ years most were unsure, but 9 said *yes* and 4 said *no*.

- Q.9c. Why? When asked *why;* participants that said *yes* indicated that their observations were based on environmental, historical decomposition, and taphonomic factors, as well as artifacts and body positioning. Those that said *no* reportedly did so due to a lack of observable taphonomic factors, burial context, preservation of remains, and artefacts visible from the image. Participants that *couldn't say* cited the need to have more contextual information on location, environment, taphonomic effects, assemblage, local funerary practices; multiple and better-quality images; and/or radiocarbon dating. Some participants asserted that they would never consider providing an opinion via image or that it was not possible to comment from photographic evidence alone.

- Q.10 (Image 5) – (a) From the image do you think you would be able to identify the biological sex? This image was taken from social media. The largest proportion of respondents (42%) said *no* to being able to estimate biological sex from the image of the skeletal remians, 37% said *yes,* and 21% were *unsure*. Those with up to 10 years of experience said *yes* more than participants with 10+ years suggesting a more cautious response.

- Q.10 – (b) If yes, what skeletal features did you look at? Most participants observed pelvic features (56%) followed by the cranium (38%). The long bones were observed less (4%) along with other features (2%), such as the mandible.

- Q.10 – (c) If *no*, what would you require in the image? The largest proportion of respondents (22%) recommended close-ups of skeletal features, different angles, and analyses supported by physical examinations. Some participants said they couldn't tell from the images.

- Q.11. (Image 6) – (a) From observing this image would you agree that it depicts a victim of a recent conflict? Image 6 depicted an image of a skull that had been uploaded on social media. Participants were informed that the contextual information associated with the image had not been verified and details were not provided. When asked to select whether the image depicted a victim of a recent conflict, 52% of respondents were *unsure*, 37% said *no* and 4% said *yes*. Participants with 0-4 years and 10+ years provided a similar patterned response, with the majority being *unsure*. Participants with 5-10 years provided a higher proportion of *no* responses.

- Q.11 - (b) If you had to provide an opinion about the trauma inflicted, which of the following would you choose? Just over half (53%) selected *post-mortem* trauma, 28% for *perimortem* trauma, 13% for *both perimortem and post-mortem trauma*, and 6% for *antemortem*. Comparing these responses with years of experience; the highest proportionate response (around 50%) selected across all three experience groups was *post-mortem* trauma. A higher proportion of respondents (38%) with 0-4 years of experience selected perimortem trauma compared with the other groups. A diagnosis of antemortem trauma was more prevalent in the group with 5-10 years and in 10+ years. Antemortem trauma was not selected by anyone with 0-4 years of experience.

- Q.11 – (c) If you checked perimortem, what type of trauma would you diagnose? Of the categories presented, 82% observed *blunt force* trauma, 11% *ballistic* trauma, and 7% *sharp force* trauma. When comparing responses according to years of experience, the highest proportion in each group selected blunt force trauma. Only participants with more than 5 years of experience considered ballistic trauma as a possibility.

- Q.12 (Image 7) - (a) What does the positioning of the bodies tell you about the event? Image 7 was posted on social media and allegedly showed a mass grave in an African country. The survey participants were asked if the positioning of the bodies revealed anything about the

event. While 22% of participants said that they were *unable to provide an opinion on the image*, none (0%) said that they could tell *nothing*. Of the participants who chose to provide an opinion, 35% chose the possibility that the *bodies were likely thrown in by the perpetrator(s)*; 19% said that *it was likely the killing site*, while 17% said *it was unlikely to be killing site* and 7% observed that the *bodies were placed in, possibly by non-perpetrator(s)*. Comparing the responses with years of experience, respondents within all three groups observed the most likely scenario to be that the *bodies were likely thrown in by the perpetrator(s)*. Considering participants with expert witness experience, 79% provided an opinion based on the body positioning from the image (compared with the 21% that were unable to provide any opinion).

- Q.12. – (b) Do you think analysing this image is within the remit of a forensic anthropologist? The response was closely divided with a slightly higher proportion of participants saying *no* (54%). Various comments were provided by participants when asked *why*. The most prevalent response from respondents who said *yes* was due to a need to have knowledge on taphonomy, body positioning, trauma, and burial contexts. Participants that responded *no* mostly did so because the bodies were not skeletonised and a forensic pathologist would be required. Comparing the responses with years of experience, a higher proportion of respondents with 10+ years of experience (59%) considered the analysis of image to *not be* within the remit of a forensic anthropologist compared with 0-4 years that indicated yes (56%). The opinion of participants with 5-10 years of experience was more closely divided (Yes – 48%, No – 52%).

- Q.13 (Image 8) - (a) Does the image show human bones? Of the participants that responded, 58% said they were *unsure*, 34% said *yes*, and 8% said *no*. Comparing responses with the different areas of expertise, respondents with expertise in *forensic anthropology and bioarchaeology* (6% and 16% respectively) indicated *no* compared with respondents with forensic archaeology and other forensic expertise who either said *yes* or *unsure*. A higher proportion of respondents with 10+ years (65%) selected *unsure* compared to those with fewer years of experience.

- Q.13. (b) - What skeletal elements can you see? Open-text comments were recorded. Responses ranged from the ulna and radius, the femur, tibia, and/or fibula, to long bones. Participants also speculated on the morphology of the observable skeletal elements and commented on the quality of the image affecting the visual analysis.

- Q.14 (Image 9) – (a) To what extent do you agree that this image may have been staged? Most respondents (68%) *agreed* to some extent (6-10 on the scale). The largest proportional response (33%) *strongly agreed* (scale point 10). When asked *why*, most responses referred to the autopsied condition of the skull, signs of a craniotomy; and the colour/pattern of burning evidenced that burning took place after those dissection. Comparing responses with years of experience, just over half (52%) with 10+ years opted for point 9 or 10 on the scale compared to 22% with 5-10 years and 29% of 0-4 years. Interestingly, 80% of participants that selected point 9 and 69% that selected point 10 had 10+ years of experience. This suggested a higher level of confidence compared with those with fewer years of experience.

- Q.15 (Image 10) – (a) To what extent do you agree that this image could be reliable evidence of mass killing? This image was a still taken from open-source footage from the documentary Africa Addio. There has been speculation on whether the footage taken of alleged massacres that occurred in Zanzibar in 1969 was staged. The survey participants were asked the extent to which they agreed that the image could be reliable evidence of mass killing. A total of 44% respondents said they were *unsure*, 29% somewhat *disagreed*, choosing between 0-4 on the scale, and over a quarter (27%) *agreed* to some extent, choosing between 6-10 on the scale. The highest proportion of respondents with expert witness experience (35%) was mostly *unsure*.

- Q.15 – (b) Do you think this image provides evidence for court purposes? 54% of respondents said *maybe*, 42% said *no* and 3% said *yes*. When asked *why*, most respondents commented on the quality of the image, the need for additional supporting evidence, and speculated on what was depicted in the image (unclear whether bodies were deceased, may not be related to conflict – pandemic, disease, etc.).

- Q.16, Q.17, and Q18. Assessing the utility of visual anthropological analysis with images from open sources: The final three survey questions contained no images. The intention was to assess the perceived value of open-source images for evidentiary purposes. Question 16 asked the survey participants to grade how much confidence they have in their analysis of the 10 images using a 10-point scale ranging from 0 – completely unconfident, to 5 – neutral, to 10 – completely confident. Most respondents (20%) chose a *neutral* response. A slightly higher proportion of participants (46%) chose a lower confidence level on the scale (between 0-4) compared with 34% that opted for a higher confidence level between 6-10 (Figure 5).

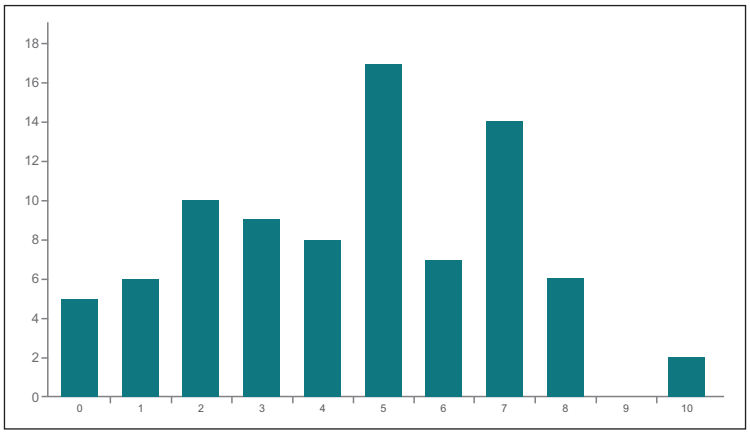

Figure 5 distribution of responses to Q16. The X-axis denotes a 0 to10-point scale, Y-axis denotes the number of respondents.

Comparing the responses with years of experience, respondents with 0-4 years of experience were more confident with their analysis than participants with more experience (5-10 years and 10+ years). Participants were then asked (Question 17) what additional features could have improved their diagnosis based on the images and the most common recommendation was the need for higher resolution and quality images, multiple angles and close-ups of skeletal elements.

The final question (Q.18) asked the participants to assess the extent to which anthropological methods are useful when analysing images from open sources. Overall, most respondents considered that there methods could be used to varying degrees. The largest proportion chose *slightly useful* (37%), followed by *moderately useful* (35%) and *very useful* (20%). Only 5 participants (6%) considered it *not useful at all*. The least favoured option was *extremely useful* which was chosen by 2% of participants. Most of the respondents that had experience as expert witnesses considered the application of forensic anthropology methods to be useful. However, more participants without expert witness experience considered open-source images to be *very useful*.

7. DISCUSSION.

The results of this study revealed that with relevant expertise, qualifications and experience in forensic anthropology, scientific deductions and expert opinions could be formulated when analysing the images presented in the survey. The participants applied well-known anthropological methods. However, while 95% of participants regarded this type of analysis as useful, feedback asserted that further physical examination (of the context and/or the remains) was needed to mitigate any uncertainty with images. Overall, the survey results demonstrated that professionals with knowledge and understanding of forensic anthropology could provide a valid opinion from images, which helped to build a picture of what is present and/or what may have happened.

7.1. Analysing what forensic anthropologists can tell from open-source images.

Scientific literature has acknowledged the importance of images and the demands when assessing biological and osteological characteristics [13]. However, the inherent uncertainties with the use of images in forensic anthropology, and the tendency for forensic experts to be more cautious and critical are well documented [35, 24]. In addition, empirical studies [9, 41, 24, 25, 35, 44] have indicated that experience and qualifications do have an impact on participants' responses and methodological decision-making [41]. Interestingly, the findings of this study revealed that variables such as years of experience and qualifications were not really deciding factors for providing an opinion, and comparative differences were relatively minor [43].

7.2. Differentiating human and non-human bone.

Practicing forensic anthropologists are frequently asked to assess images to see whether bones found are human [29, 30], therefore it was assumed that the experience professionals would be reasonably comfortable providing some level of assessment from images. This was evident in

the results. Almost all participants could differentiate between human or non-human bone presented in the images, with 95% giving an opinion. However, limitations have been highlighted such as the quality and size of the image presented in the survey and the equipment participants used (mobile phone, no scale used, etc.).

7.3. Estimating biological profiling.

Other studies that have applied biological/forensic anthropological methods when assessing images [41, 34] have shown that valuable information can be gathered from diagnostic interpretations to assist with identification. The results of the survey were consistent with this, revealing that participants could judge aspects of biological profiling from the images. Over half (58%) of respondents could give a definitive answer when asked to identify the biological sex of the bone depicted in image 2.

Figure 7: Survey image 2. © Skynews Cheshire, T. (2022). Paving over the dead [photograph]. SkyNews. https://news.sky.com/story/paving-over-the-dead-how-china-is-erasing-the-uighur-peoples-past-12339332. Accessed August 20, 2022.

As 86% of participants could comment on whether the long bone depicted in image 2, in this case a non-adult human femur, was an adult or non-adult (juvenile). Major concerns noted were accuracy and error rates associated with using images alone for analysis.

7.4. Trauma analysis.

The challenges, in accurately determining trauma, whether physically or remotely, are well acknowledged [45, 24, 47] yet the ability of forensic anthropologists to identify trauma is an important contribution in death investigations [47,45]. In the survey, when shown an image of possible trauma (image 6), 69% of participants provided an opinion. Around half of the participants identified the trauma type as post mortem, regardless of their years of experience.

While practical experience and training undoubtedly benefit practitioner's decision-making [9, 46], previous studies have shown that forensic anthropologists with less experience are more likely to interpreted trauma more readily than those with more experience [48, 24, 44]. While this study observed only minimal significant differences and no obvious correlation between trauma interpretation and years of experience, more caution was observed in the responses of experienced forensic practitioners.

7.5. Commenting on preservation/time since death.

Taphonomy/time interval methods are also significant aspects for forensic casework [48, 40]. Participants were less able to assess the preservation of human remains from the images compared with other questions. For questions related to post-mortem interval (PMI), most participants selected *unsure* or *cannot tell*, regardless of years of experience, qualifications, or areas of expertise. The uncertainty observed with responses assessing the preservation of human remains is consistent with scientific literature on the challenges for practitioners due to a lack of accurate methods for quantifying PMI [40, 34].

7.6. Recognising fake/staged images.

A key finding of the study was that the results revealed that open-source images are a good way to identify the need for further investigation. A large proportion of participants with 10+ years of experience strongly agreed that image 9 had been staged, referring their diagnosis to the autopsied state of the skull and evidence of postmortem intervention. Participants also commented on the fracturing patterns and trauma that should have been consistent with an explosion. The responses matched the comments of the forensic anthropologists approached by Bellingcat [17] demonstrating the usefulness of consulting forensic experts on the authenticity of crime scenes. Indeed, organisations specialising in human rights investigations have demonstrated the benefit of seeking expert views on online data for investigative work. For example, open-source information has supported claims of war crimes – such as aerial and satellite imagery to gather evidence of massacres in Guatemala and identifying damage to archaeological sites

in Gaza [49]. Africa Eye [18] also used forensic experts extensively to verify the authenticity of footage showing executions in Cameroon, which had been dismissed by the government as fake.

Figure 8: Survey image 9. Tweet [@glastnostgone]. Twitter. Retrieved August 20, 2022. from https://glasnostgone.org/2022/02/22/in-ukraine-russia-uses-corpses-in-false-flag-attack/

7.7. Providing judgements and opinions from open-source images.

While it was clear from the responses to the survey that participants were willing and able to share their judgements and opinions, most participants graded their own analysis of the survey images as neutral or with lower confidence levels. Interestingly, participants with less experience had slightly more confidence in their analysis than those with more than five years of experience, and overall, those with more experience appeared more judicious in their analysis.

7.8. Variations in survey responses.

The country of origin and/or work location and education of the participants and different professional standards and practices may have distorted participant's interpretations [50, 15, 51]. As such, this may have distorted responses when asked whether analysing image 7 was *within the remit of a forensic anthropologist*. Participants with experience in forensic anthropology and/or forensic archaeology were divided in their opinion.

7.9. Considering bias.

The biasing effect of contextual information on visual assessments was considered in the development of the survey and the influence of the information given with the images should be acknowledged. The context provided may have influenced respondents and encouraged them to agree with the information provided [25]. The disadvantages of analysing images [52] and the subjectivity of visual analysis [13] could have also been factors influencing survey responses.

7.10. Using digital open-source images for further investigative work and for judicial processes.

Most respondents with experience as an expert witness (24% of participants) considered the application of anthropological methods to the images of human remains to be useful. However, while a higher proportion (44%) opted for *moderately useful,* they were more cautious than respondents without this type of experience.

With the scale of open-source images providing a rich data source for potential use in courts - as seen with social media footage from Facebook and Twitter used as evidence of war crimes, see *Al-Mahdi* [38]; *Al-Werfalli* [53], this paper argues scientific interpretations provided by forensic experts could have a more significant part in legal proceedings. Given issues of security and access to the crime scene by investigators, expert opinions concerning the identification of deceased and/or commenting on traumatic events from open-source images will arguably become more useful. However, for open-source information to be admissible as evidence in court, the authenticity of the image must be established [20]. An expert should first verify the authenticity of the data before a forensic anthropologist is asked to infer anything from an image. This was stressed by several participants of the survey. This study also calls for appropriate standards to be developed for analysing open-source images by forensic anthropologists.

7.11. Recommendations for improvement when analysing images.

Participants were asked to comment on what was needed to improve their diagnosis. The top three recommendations

were: 1) Higher resolution/better quality images, 2) more and multiple angles/360 view, and 3) close-ups/zoomed in and out shots of traumatic injuries and diagnostic features. Oher recommendations included additional background information, multiple images, including scales in the photographs, providing information on the source and location, and examining the remains in the mortuary.

These recommendations could complement existing guidance on methods and procedures for documenting and preserving digital open-source information [3, 20], particularly as that first responders are often better positioned to capture footage and images that can potentially be used as evidence [54][1]. This opinion acknowledges the physical and psychosocial risks facing individuals documenting events [20]. Arguably, ethical considerations for involving non-professionals on the ground in forensic work should be balanced with the perceived utility and value of digital open-source images.

8. CONCLUSION.

The potential of open-source data for investigative work and the increasing requests for forensic anthropologists to remotely assess non-forensic images suggest that this study was necessary. In this paper we have focused on the deceased (human skeletonised remains). Based on the findings, it appears reasonable to conclude that those with relevant expertise, qualifications, and experience in forensic anthropology could help answer investigative questions by analysing images. The results of the survey indicated that experts using open-source images could assist in interpreting events and identifying whether further investigation is needed. Indeed, it demonstrates that there is an opportunity for forensic anthropologists to contribute to open-source investigations. The findings recognise that interpretations generated from open-source material can never replace the value and integrity of physical examinations at a scene or in a laboratory or mortuary setting. Nevertheless, the unprecedented scale that social media platforms are being used to report on global violence and abuse will undoubtedly lead to the call for acceptable standards to aid the involvement of forensic anthropology and those involved in the discipline should strive to develop and evolve practice and research to ensure that the discipline remains relevant in the increasingly digitalised modern world.

9. RECOMMENDATIONS FOR FURTHER WORK.

The following recommendations and points for further research build on the findings and limitations discussed in this paper:

a. Conduct further empirical studies on the potential of forensic anthropological analysis with open-source images. This could be done in partnership with online open-source investigative organisations, by surveying current and relevant open-source material with forensic anthropologists;

b. Examine the biasing impact of contextual information when analysing open-source images;

c. Advocate for appropriate forensic science and forensic anthropology standards and guidelines for the visual analysis of non-forensic images;

d. Forensic anthropologists have only recently recognised ethics issues surrounding the proper treatment and discussion of human remains in public arenas (55, 50). There is a strong case for guidelines linked to technological advances and the forensic interpretations of open-source material (56).

e. Sharing recommendations to improve the potential of images for forensic analysis to assist with improving the usability of open-source images and footage for legal purposes, consider role of artificial intelligence and digital forensics as primary-level analysis;

f. Explore with legal experts the validity of those investigations with open-source images for court proceedings.

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