



Identification success rates in the post-Spanish Civil War mass graves located in the cemetery of Paterna, Spain: Meta-research on 15 mass graves with 933 subjects

Juan A. Sanchis-Gimeno^{a,*}, Javier Iglesias-Bexiga^{a,b}, Marisol E. Schwab^{a,b}, Gema López-García^b, Eloy Ariza^b, Alejandro Calpe^b, Miguel Mezquida^b, Shahed Nalla^{a,c}, Ilker Ercan^d

^a GIAVAL Research Group, Department of Anatomy and Human Embryology, University of Valencia, Faculty of Medicine, Valencia, Spain

^b ArqueoAntro Scientific Association, Spain

^c Department of Human Anatomy and Physiology, Faculty of Health Sciences, University of Johannesburg, Johannesburg, South Africa

^d Department of Biostatistics, Faculty of Medicine, Bursa Uludağ University, Bursa, Türkiye

ARTICLE INFO

Keywords:

Identification

Mass graves

Cemetery

Repression

Dictatorship

Spanish Civil War

ABSTRACT

Spain suffered a Civil War between 1936 and 1939 that ended with the victory of the National Forces led by General Franco. Once the Spanish Civil War ended, 2238 subjects were executed and buried in several mass graves in the Cemetery of Paterna, one of Spain's largest mass grave sites. Efforts to locate and identify all the victims of the mass graves of the Paterna cemetery are ongoing, but the actual data of the percentage of DNA identifications remains uncertain. Following this, we conducted a meta-research study including 15 mass graves and 933 subjects to determine the DNA identification rates in the mass graves of the Paterna cemetery. We found that the total proportion of identified subjects in the mass graves was 15.9 % (95 % CI: 10.0–22.9). Moreover, we found that the model between the identification success rate (ISR) and the number of relatives that donated DNA (NRTDD) in the mass graves of the cemetery of Paterna was $ISR = NRTDD^{-0.424}$. Results obtained about the proportion of identified subjects and the model between the ISR and the NRTDD imply the need for a scientific reflection between all the research groups involved in the identification tasks to modify deficiencies and update identification protocols to obtain better future results.

1. Introduction

Every war has symbols of destruction, death, and civilian massacres, as witnessed after Russia invaded Ukraine. Once the war ends, the remains of thousands of soldiers and civilians of both Ukrainians and Russians must be identified before being returned to their families for proper burial. Similarly, this is currently happening in Spain, related to the remains of those killed during and after the Spanish Civil War.

Between 1936 and 1939, just before World War II, Spain suffered a dreadful Civil War. The Civil War started in 1936 with a military coup led by General Franco against the Republican Government and ended with the victory of the National Forces of Franco in 1939. As a result of the National Forces' victory, Franco led a dictatorship from 1939 until his demise in 1975.

During the Spanish Civil War, different massacres of civilians were

reported to be carried out by both the Republican and National forces (i. e. massacres in Paracuellos del Jarama, massacres in Badajoz, etc.) [1]. Those names are currently related in Spain to the horror lived during the three years that the Civil War lasted.

During the past few years, some researchers have analyzed the mass graves related to the Spanish Civil War and posterior repression [2–6], and as noted by Rios et al., [3] “along the Spanish Civil War (1936–1939) and the first years of the dictatorship that followed at least 175,000 persons were victims of extrajudicial executions and death sentences from court-martials and popular tribunals”.

Nevertheless, there is a lack of information regarding the mass graves related to the Spanish Civil War and posterior repression that are the mass graves of the cemetery of Paterna.

Paterna, a town near Valencia, Spain's third most populous city, was controlled by the Republican forces during the Civil War. Although

* Correspondence to: GIAVAL Research Group, Department of Anatomy and Human Embryology, Faculty of Medicine, University of Valencia, Avda. Blasco Ibañez, 15, Valencia E46010, Spain.

E-mail address: juan.sanchis@uv.es (J.A. Sanchis-Gimeno).

<https://doi.org/10.1016/j.forensiint.2024.112122>

Received 31 May 2023; Received in revised form 21 March 2024; Accepted 24 June 2024

Available online 25 June 2024

0379-0738/© 2024 The Authors. Published by Elsevier B.V. This is an open access article under the CC BY-NC-ND license (<http://creativecommons.org/licenses/by-nc-nd/4.0/>).

during the Civil War, the Republican Forces executed political opponents in Paterna [7], the name of Paterna has been linked with the post-Civil War horror because. After the victory of the national forces of Franco, 2238 subjects were executed in Paterna [8].

The 2238 individuals executed after the war ended were linked to the Republican Forces, political opponents (i.e., communists, trade unionists, etc.), intellectuals and academics linked to the Republican government, and other citizens accused of crimes against the National forces of Franco and their civilian supporters [8].

The remains were buried in several mass graves in the Paterna cemetery, which is currently known to be one of Spain's largest mass grave sites [8]. All these factors have contributed to considering the Paterna cemetery as a symbol of the post-Spanish Civil War repression [9].

The remains of the executed individuals lay for decades in the mass graves of the Paterna cemetery without being exhumed. However, after being approved in 2007 by the "Law of Historical Memory" [10], several exhumations have been carried out to identify the subjects executed (Fig. 1). This law established measures in favor of those who suffered persecution and/or violence during the Civil War and the subsequent dictatorship and repression. This law also promoted the preservation and maintenance of the memory of the victims of the Civil War and the Franco dictatorship through knowledge of the truth and reparation. It, therefore, considers the search, location, exhumation and identification of missing persons during that period to be a priority and urgent matter. In sum, the law gave the victims of the Republican forces and their civilian supporters the same right to be identified and have a proper and dignified burial as had the victims of the National forces of Franco and their civilian supporters when the Civil War ended.

Approximately 1000 subjects have been exhumed from the Paterna cemetery mass graves [11], and efforts to locate and identify all the victims of the mass graves of the Paterna cemetery are ongoing using DNA techniques. Still, the actual data on the percentage of DNA identifications remains uncertain.

Following this, we aimed to determine the DNA identification success rate (ISR) in the mass graves of the Paterna cemetery, and we also aimed to determine the relationship between the ISR and the number of relatives that donated DNA (NRTDD) for identification of the executed that lay in the mass graves.

2. Methods

2.1. Search strategy

To determine the current identification rate of human remains in the mass graves of the Paterna cemetery, a search following the Preferred Reporting Items for Systematic Reviews and Meta-Analyses guidelines [12] was carried out between January and March 2023 in the databases of the Web of Science, Scopus, PubMed, ScienceDirect, Embase and Google Scholar as well as in the institutional webpages of the Regional Government of the Valencia Community (Diputación de Valencia and Conselleria de Participación, Transparencia, Cooperación y Calidad Democrática). We aimed to identify studies, reports, and web pages that reported information on the identification rates of subjects in the mass graves of the cemetery of Paterna. No language or time restrictions were applied. The search terms used were "Paterna cemetery", "Paterna mass graves", "identification mass graves Paterna", "Paterna cemetery identification", and "exhumations of mass graves in Paterna". In addition, once we analyzed the reports, and because the identifications are ongoing using DNA techniques, we contacted the research groups that carried out the identifications to confirm to data to April 2023 the number of subjects found, the number of subjects identified in each mass grave and the NRTDD for identification of the executed. Arqueoantropo and Fisabio research groups answered our questions about the current identification rates of the mass graves they analyzed and the NRTDD. For the other mass graves analyzed by other research groups, we used data extracted from institutional webpages of the Regional Government of the Valencia Community (Diputación de Valencia and Conselleria de Participación, Transparencia, Cooperación y Calidad Democrática).

2.2. Eligibility assessment

Two independent reviewers performed an eligibility assessment. The following exclusion criteria were employed: (1) reports that presented results of mass graves with less than ten subjects; (2) reports that presented results of mass graves located outside the Paterna cemetery; (3) reports that did not report results of subjects identified in the mass grave; (4) reviews; (5) letters to editors; (6) essays; (7) studies that reported information that was not clear enough or was inconsistent, incomplete, or contradictory. In case of disagreements during eligibility



Fig. 1. Exhumation work in the mass graves of the Paterna cemetery.

assessment, all decisions were made by a consensus among all the authors.

2.3. Data extraction

Two researchers conducted the data extraction. The following data were extracted: the name of the mass grave, the year when the remains were exhumed, the number of subjects found in the mass grave, the number of subjects of the mass grave identified and the NRTDD.

2.4. Statistical analysis

For the meta-analysis, the reporting bias was examined by using Begg's and Egger's tests. Cochran's Q test evaluated the heterogeneity of the reports; equation I^2 statistic was performed to determine heterogeneity, as well. Due to the heterogeneity, the random effect model DerSimonian-Laird method was performed. The meta-analysis took a Type-I error rate of $\alpha=0.10$ for the heterogeneity and publication bias tests. MedCalc version 19.6.1 software was used for analysis.

The Spearman rank correlation coefficient examined the relationship between ISR and NRTDD. The ISR was determined as the (number of

subjects identified)/(number of subjects to identify).

The relationship between ISR and NRTDD was modelled with the power model, which gives the highest coefficient of determination in the tried models. P values less than 0.05 were considered to be statistically significant. Statistical analysis was performed by using SPSS v25 package software.

3. Results

A total of 15 reports involving 933 subjects presented data on the identification rates of the mass graves of the Paterna cemetery. The subjects of these mass graves were executed between 1939 and 1941. Table 1 presents the flow diagram of the search carried out.

As a result of Egger's test ($p = 0.827$) and Begg's test ($p = 0.656$), it was determined that there was no publication bias. Cochran's Q test revealed heterogeneity ($p<0.0001$; $I^2= 85.54\%$, 95 % CI for I^2 : 77.66–90.64).

The total proportion of identified subjects from remains found in the mass graves was 15.9 % (95 % CI: 10.0–22.9). The results of the meta-analysis to examine the total proportion of the identified subjects in the mass graves are given in Table 2. The forest graph is presented in

Table 1
Flow chart showing the identification, screening, and inclusion of reports in the meta-analysis.

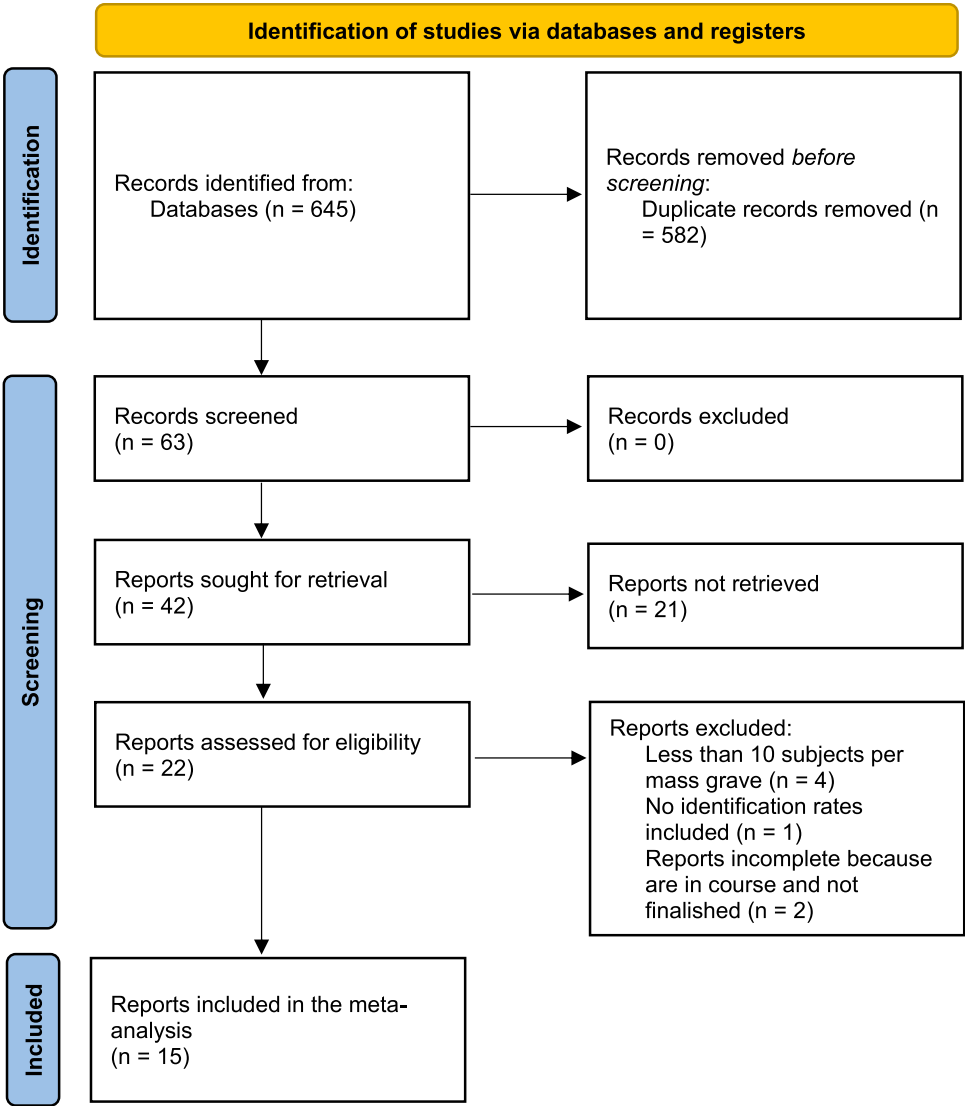


Table 2

Results of the meta-analysis carried out to examine the total proportion of the subjects identified in the mass graves.

Name of the mass grave / year of exhumation)	Sample size	Proportion (%)	95 % CI	Weight (%)
Mass Grave 113 / 2017 [13]	50	22.000	11.527–35.961	7.04
Niches 54–55 / 2017 [14]	42	0.000	0.000–8.408	6.82
Mass Grave 22 / 2018 [15]	33	39.394	22.907–57.861	6.49
Mass Grave 94 / 2018 [16]	39	38.462	23.364–55.381	6.73
Mass Grave 112 / 2018 [17,18]	98	30.612	21.698–40.735	7.66
Mass Grave 128 / 2018 [19]	107	12.150	6.630–19.880	7.72
Niches 43–44 / 2018 [20]	38	0.000	0.000–9.251	6.69
Mass Grave 100 / 2019 [21]	22	22.727	7.821–45.370	5.85
Mass Grave 115 / 2019 [22]	144	21.528	15.120–29.143	7.89
Mass Grave 127 / 2019 [23]	143	11.888	7.080–18.351	7.89
Mass Graves 13–14–15 / 2020 [24]	21	0.000	0.000–16.110	5.77
Mass Graves 57–73B / 2020 [25]	13	0.000	0.000–24.705	4.88
Mass Grave 111 / 2020 [26]	150	14.000	8.880–20.601	7.91
Mass Grave 120 / 2020 [27]	17	41.176	18.444–67.075	5.39
Mass Grave 21 / 2021 [28]	16	18.750	4.047–45.646	5.28
Total (random effects)	933	15.891	9.951–22.911	100.00

Fig. 2.

Table 3 reflects the data about the number of subjects to identify, the number of subjects identified, the NRTDD and the ISR. This data was obtained from 10 mass grave reports from the 15 mass graves included in the research.

A negative correlation was found between ISR and NRTDD ($r=-0.624$, $p=0.054$). The correlation coefficient was interpreted as marginal significant because it was impossible to increase the sample size. Subsequently, the relationship between ISR and NRTDD was modelled with the power model, which gives the highest coefficient of determination ($R^2=0.949$) in the tried models. The model between the ISR and the NRTDD was: $ISR = NRTDD^{-0.424}$ (Model: $p<0.001$) (Fig. 3).

Table 3

Relationship between the number of subjects to identify, the number of relatives that donated DNA and the number of subjects identified.

	NSTI	NRTDD	NSI	ISR
Mass Grave 113 [13]	50	12	11	0.22
Mass Grave 22 [15]	33	22	13	0.39
Mass Grave 94 [16]	39	18	15	0.38
Mass Grave 112 [17,18]	98	44	30	0.31
Mass Grave 128 [19]	107	44	13	0.12
Mass Grave 100 [21]	22	18	5	0.23
Mass Grave 115 [22]	144	63	31	0.22
Mass Grave 111 [26]	150	46	21	0.14
Mass Grave 120 [27]	17	12	7	0.41
Mass Grave 21 [28]	16	60	3	0.19

NSTI = number of subjects to identify; NRTDD = number of relatives that donated DNA; NSI = number of subjects identified; ISR = identification success rate

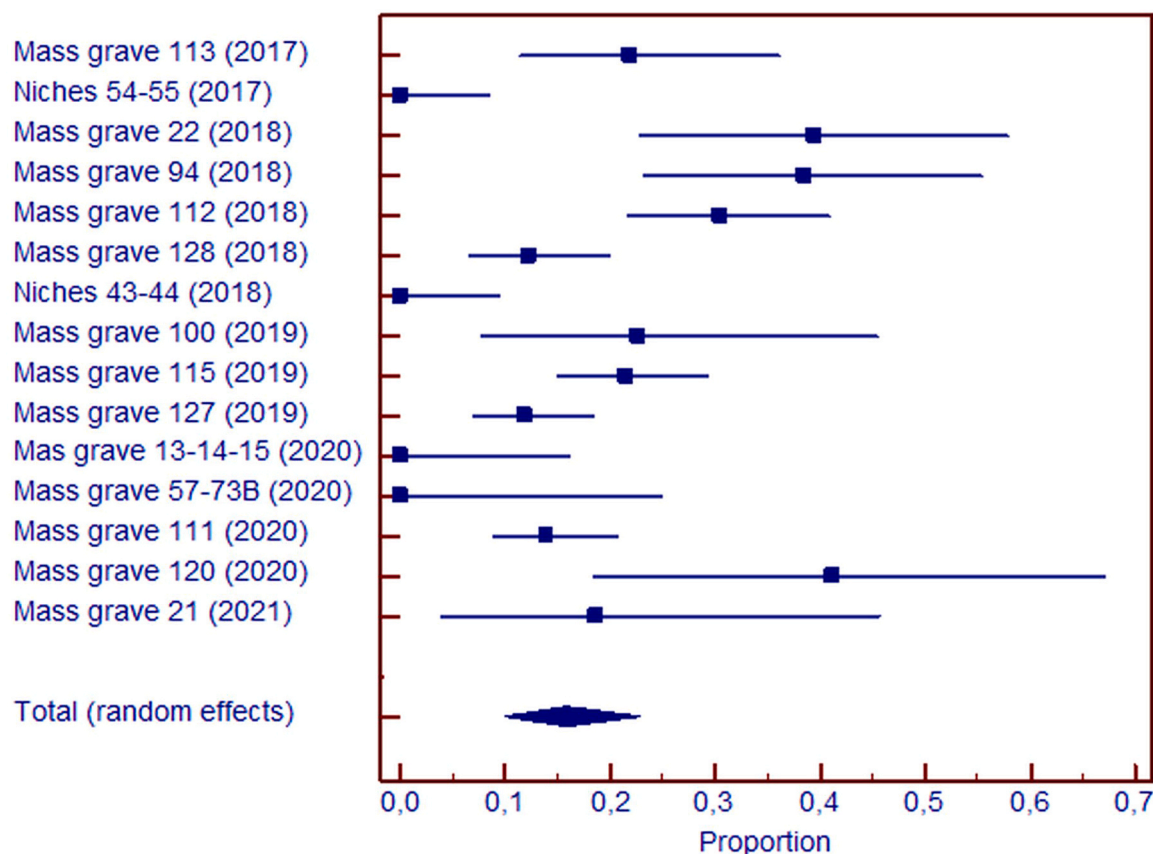


Fig. 2. Forest graph showing the current proportion of subjects identified in the mass graves of the Paterna cemetery—names of the Mass Graves (year of exhumation).

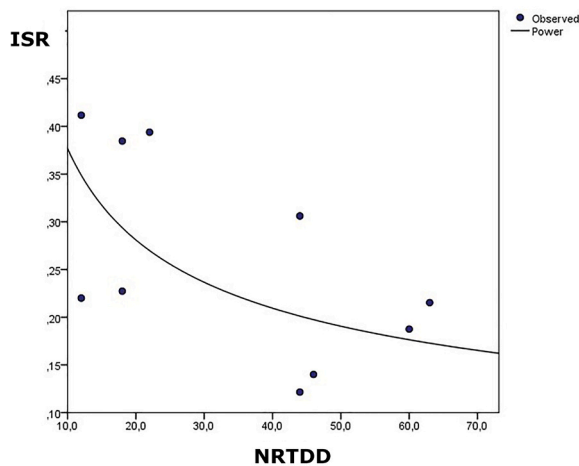


Fig. 3. The model was obtained by comparing the identification success rate (ISR) with the number of relatives that donated DNA (NRTDD).

4. Discussion

We have analyzed and presented the current DNA identification rates in the Paterna Cemetery mass graves. Results revealed that in April 2023, the total proportion of identified subjects from remains found in the mass graves was a low 15.9 % (95 % CI: 10.0–22.9). During exhumations, clothing, dentures, prostheses, watches, and other items, were recovered, which may guide a possible identification of the subject. However, the identifications were only matched as positive if a DNA analysis confirmed them. That is, all subjects were identified solely utilizing DNA analysis.

Interdisciplinary teams performed exhumations in the mass graves of the cemetery of Paterna under the supervision of forensic practitioners. Those teams followed the protocol for action in exhumations of victims of the Civil War and the dictatorship [29], which recommends carrying out exhumations by teams with previous experience in these types of work, composed of specialists from different areas: historians, archaeologists, restorers, forensic specialists, such as forensic anthropologists, and a forensic doctor. However, the first thing that may be noted is that in Spain, there are no official homogeneous standards for the exhumations of mass graves [30]. That is a problem because every scientific research group that analyses the mass graves uses their protocols based on its expertise, which may be a possible reason for the differences in the percentage of identification between them. For example, the mass graves we included in the research were exhumed by the scientific research groups *Paleolab* (mass graves 13–14–15, mass grave 127, niches 43–44, niches 54–55) and *Arqueantro* (mass grave 21, mass grave 22, mass grave 57–73B, mass grave 94, mass grave 100, mass grave 111, mass grave 112, mass grave 113, mass grave 115, mass grave 120, mass grave 128) with their protocols. Additionally, the bone remains obtained from the mass graves have been analyzed by different DNA laboratories such as Biomixs (Mass Grave 22, Mass Grave 94, Mass Grave 100), Cefegen (Mass Grave 13–14–15, Mass Grave 127, Niches 43–44, Niches 54–55), Citogen/Fisabio (Mass Grave 21; Mass Grave 22, Mass Grave 112), Genomics (Mass Grave 22, Mass Grave 57–73B, Mass Grave 94, Mass Grave 100, Mass Grave 111, Mass Grave 112, Mass Grave 113, Mass Grave 115, Mass Grave 120, Mass Grave 128), using the different DNA techniques available [31] over the years. These factors may contribute to the marked differences in the identification results obtained in mass graves in the same cemetery. In addition, one thing that may be useful in interpreting the outcomes is the bone chosen for DNA typing, although it always depends on the specific case. In this context, the collection of bone samples was carried out in accordance with the "Recommendations on genetic identification studies of victims of the Spanish Civil War of the Commission for the Forensic Use of DNA" [32],

which suggests taking two or more teeth that have not undergone dental interventions or decomposition processes - such as cavities -, in the following order of preference: molar, premolar, canine, incisor and a sample of bone tissue compact of the diaphysis of a long bone, preferably femur. The analysis of the percentage of subjects identified by using teeth and long bones from mass graves 21, 22, 57–73B, 94, 100, 111, 112, 113, 115, 120 and 128 [13,15–19,21,22,25–28] revealed that from a total amount of 149 (100 %) subjects identified in those mass graves, 145 (97.3 %) subjects were identified by using teeth. In contrast, only other 4 (2.7 %) were identified using long bones.

Nevertheless, people can only prevent DNA identifications depending on factors such as the availability of DNA samples from living relatives, the condition of the remains, and the availability of historical records and other evidence.

Logically, obtaining DNA samples from living relatives of all subjects executed between 1939 and 1941 is difficult or impossible. That implies that it is impossible to identify those executed whose families did not provide their DNA because the identification process implies the collection of DNA samples from the remains and the comparison of these samples with DNA samples provided by the victims' families [33,34]. The focus must be applied in institutional politics of searching the maximum number of living relatives of the executed because it is the basis for future identifications. Moreover, no one can ignore that as the executions were carried out between 1939 and 1941, under a military dictatorship that followed the Civil War, and the executed were linked to enemies of the dictatorship, it is understandable that a "family code of silence" to avoid more retaliations. This fact has the current undesirable effect that many of the descendants of those executed ignore that they have relatives in the mass graves of the cemetery of Paterna. In this context, we believe that a greater institutional effort is necessary to disseminate the history of the mass graves of Paterna to search for more relatives of those executed, as their DNA is needed for the identification tasks. Nevertheless, related to the previous, in theory, when more relatives of the executed donor have their DNA, the number of identifications may be higher. However, we found an unexpected inverse relationship between the ISR and the NRTDD (NRTDD decreases while ISR increases.) that may relate to the paradoxical results obtained in some mass graves. For example, we found a disproportion between mass grave results being Mass Grave 21 and the mass grave with the worst ratio ISR/NRTDD. Focusing on the paradoxical results of Mass Grave 21, the main difference between Mass Grave 21 and the other mass graves of Paterna is that the identification of NRTDD has been led by a top-recognized Sequencing and Bioinformatics Service of Fisabio and not by forensic anthropologists as happened with the other mass graves analyzed. The scientific approach of the Fisabio Sequencing and Bioinformatics Service Team to the identification tasks applied in Mass Grave 21 is based on collecting the maximum amount of genetic information of both relatives and bone remains that will serve for current identifications and also to be added to a DNA Data Bank for future analysis and reanalysis. On the other hand, the forensics anthropologist team approach is based on searching and selecting the best relatives that may donate DNA among the total possible relatives that could donate DNA [11]. However, it implies collecting less genetic information.

Regarding these two approaches, in Paterna, the leadership of the identification tasks was assigned to expert forensics/forensic anthropologists until 2021, when the leadership was assigned to the geneticist team of Fisabio. It is to say that until 2021, forensic anthropologists were responsible for selecting and obtaining DNA of the best relatives and obtaining bone remains from the mass graves for DNA analysis. The function of the geneticists was limited to analyzing and comparing the DNA of the relatives and the skeletal remains. Since 2021, geneticists have been responsible for selecting the best relatives for DNA donation, obtaining the DNA of the best relatives and comparing the DNA of the relatives and the skeletal remains. In this new approach, forensic anthropologists are under the supervision of the geneticists. Their function is to obtain human remains from the mass graves and have no

participation in selecting the best relatives for DNA donation. Nevertheless, whether the geneticists' team approach or the forensics/forensic anthropologist approach may be the best choice for the identification process will be seen with the analysis of the results of the mass graves that are currently undergoing under the leading of the geneticists and with the posterior comparison with the results of the mass graves which identification tasks have been led by forensic anthropologists.

However, despite having DNA from the relatives, the degree of kinship with the victim is also influenced. The importance of having samples of direct descendants is evidenced in the study by Moreno-Martín et al. [11] that presented the results of mass grave 112 where 80 % of samples taken at first-degree relatives (son/daughter) allowed identification, while the percentage of identifications dropped to 22 % when samples were taken from second-, third-, or fourth-degree relatives. However, a severe problem in the genetic identification processes of the victims of the Paterna mass graves is that many of their direct descendants (daughters/sons) have already died before starting the current identification processes. Hence, there are no biological samples of them to compare with the remains present in the graves. This primary factor may explain the low identification rate in Paterna's mass graves. Additionally, Carbo-Ramírez et al. [18], in their official report on the reanalysis of Mass Grave 112, noted that the main limiting factor for their DNA analysis was the availability of obtaining family samples. Nevertheless, Carbo-Ramírez et al. [18] added the identification of another eight subjects in the Mass Grave 112. However, in this case, all the identifications were obtained by comparing the DNA of the remains with the DNA of relatives of the second and third degree.

Another factor linked with the above is the discrepancy between historical and archaeological information regarding the number of victims expected and the actual number of victims found in the mass graves because it is a primary limiting factor in the identification rates [18,28].

However, the success of DNA identification depends on the quality and quantity of DNA available from the mass grave bone remains. The post-mortem interval is the most remarkable factor associated with DNA degradation [35]. It is known that dental samples' DNA concentration drops drastically from 10 days to 8 months postmortem [35–37], with promising dental DNA obtained from corpses with a short post-mortem interval [35]. Thus, obtaining a DNA identification in the Paterna mass graves analysed represents a unique challenge because the post-mortem interval ranges from 82 to 84 years.

Mansour et al. [35] noted that dental DNA yield in corpses found in dry indoor conditions is superior to that of other surrounding environments. In contrast, they noted that sparse dental DNA could be expected from cases buried in the ground and forensically skeletonized after a long post-mortem interval. This may explain the lower identifications of the remains in the Paterna cemetery mass graves. In addition, the DNA identification implies the generation of a DNA profile from long bones and teeth that it is also positive or negative influence by different factors that include [38]: cooler temperatures that will favor DNA preservation, the presence of moisture in the depositional environment that can impact biological decomposition, the presence of groundwater that contributes to bone degradation and contributes to DNA loss, oxygen rich environments that will lead to more significant DNA degradation, endogenous and exogenous greater microbial presence that results in more significant DNA degradation, soil solutes such as tannins and humic acids that may co-purify with the DNA during the extraction process and inhibit specific subsequent genetic analyses, the acidic and alkaline environments with DNA being less prone to damage in neutral or near neutral environments, or using the dense cortical portions of lower limb bones and the more complex tissues of teeth that tend to be consistently reliable in generating DNA profiles and tends to yield more significant amounts of DNA than spongy bone. All the above factors have also been vital during decades in Paterna Cemetery, explaining the lower DNA identifications.

At this point, knowing the current low rates of identifications and that it will never be possible to identify all the subjects, it could be

interesting to define the success or failure in the identification of mass graves. For the general population and the victims' relatives, success is achieved through the positive DNA identification of the victim. Nevertheless, genetic information was obtained from half of the markers analyzed in 37 % and 74 % of the analyzed bone samples of Mass Grave 21 and Mass Grave 112, respectively [18,28]. Still, the ISR was 26.7 % (Mass Grave 112) and 50 % (Mass Grave 21) of remains for which sufficient genetic information was obtained. Thus, we believe the success could be in obtaining enough genetic information to be added to a DNA Data Bank for future reanalysis and serve as a memorial to the victims.

In sum, we have observed that the total proportion of identified subjects from remains found in the mass graves of the Paterna cemetery is a low 15.9 % and that the relationship between the ISR and the NRTDD is $ISR = NRTDD^{-0.424}$. This low rate may be related to the difficulty of obtaining DNA samples of living relatives of the individuals executed between 1939 and 1941. Additionally, the elapsed post-mortem interval associated with a higher DNA degradation cannot be eluded when carrying out the DNA identifications of the remains of the Paterna cemetery. It is also needed in the mass graves of Paterna, the best selection of living relatives, to identify the bone remains of the mass graves due to the inverse relationship between the ISR and the NRTDD we found. Nevertheless, unified protocols are necessary during the exhumations to minimize bone contamination. This will allow for obtaining better quality and quantity of DNA from the bone, which must remain for subsequent identification analysis.

CRedit authorship contribution statement

Javier Iglesias-Bexiga: Data curation, Formal analysis, Investigation, Resources, Validation, Writing – review & editing. **Juan A. Sanchis-Gimeno:** Conceptualization, Data curation, Formal analysis, Funding acquisition, Investigation, Methodology, Project administration, Resources, Supervision, Validation, Writing – original draft, Writing – review & editing. **Miguel Mezquida:** Data curation, Resources, Validation, Writing – review & editing. **Alejandro Calpe:** Data curation, Resources, Validation, Writing – review & editing. **Ilker Ercan:** Formal analysis, Investigation, Methodology, Resources, Software, Validation, Writing – review & editing. **Shahed Nalla:** Conceptualization, Formal analysis, Investigation, Methodology, Validation, Writing – review & editing. **Eloy Ariza:** Data curation, Resources, Validation, Writing – review & editing. **Gema López-García:** Data curation, Methodology, Resources, Validation, Writing – review & editing. **Marisol E. Schwab:** Data curation, Formal analysis, Resources, Validation, Writing – review & editing.

Declaration of Competing Interest

Javier Iglesias-Bexiga, Marisol E. Schwab, Alejandro Calpe, Gema López-García, Eloy Ariza, and Miguel Mezquida have participated as members of the ArqueoAntro Scientific Association in the identification tasks of some mass graves of the Paterna Cemetery included in this study, and have also provided the current identification rates reports of that mass graves with complete anonymization of the personal data of the victims.

Acknowledgements

This research was funded by grants numbers OTR2021-21615SUBDI and OTR2022-22719SUBDI from the Specific Agreement of Cooperation between the Generalitat Valenciana, through the Conselleria of Participation, Transparency, Cooperation and Democratic Quality and the University of Valencia.

References

- [1] P. Preston, *The Spanish Holocaust*, Random House Mondadori SA, Barcelona, 2011.
- [2] L. Ríos, J.I. Ovejero, J.P. Prieto, Identification process in mass graves from the Spanish Civil War I, *Forensic Sci. Int.* 199 (2010) e27–e36, <https://doi.org/10.1016/j.forsciint.2010.02.023>.
- [3] L. Ríos, B. Martínez, A. García-Rubio, L. Herrasti, F. Etxeberria, Marks of autopsy and identification of victims of human rights violations exhumed from cemeteries: the case of the Spanish Civil War (1936–1939), *Int. J. Leg. Med.* 128 (2014) 889–895, <https://doi.org/10.1007/s00414-013-0896-6>.
- [4] M. Baeta, C. Núñez, S. Cardoso, L. Palencia-Madrid, L. Herrasti, F. Etxeberria, M. M. de Pancorbo, Digging up the recent Spanish memory: genetic identification of human remains from mass graves of the Spanish Civil War and posterior dictatorship, *Forensic Sci. Int. Genet.* 19 (2015) 272–279, <https://doi.org/10.1016/j.fsigen.2015.09.001>.
- [5] D. Rubio-Melendi, A. Gonzalez-Quirós, D. Roberts, M.D.C. García-García, A. Caunedo-Domínguez, J.K. Pringle, J.P. Fernández-Álvarez, GPR and ERT detection and characterization of a mass burial, Spanish Civil War, Northern Spain, *Forensic Sci. Int.* 287 (2018) e1–e9, <https://doi.org/10.1016/j.forsciint.2018.03.034>.
- [6] L. Herrasti, N. Márquez-Grant, F. Etxeberria, Spanish Civil War: the recovery and identification of combatants, *Forensic Sci. Int.* 320 (2021) 110706, <https://doi.org/10.1016/j.forsciint.2021.110706>.
- [7] V. Gabarda-Cebellán, *The repression in the Republican rearguard*. Valencia Country, 1936–1939, Edicions Alfons el Magnanim, València, 1996.
- [8] V. Gabarda-Cebellán, *Violence, conceptualization, memory, repression, studies, monumentalization, exhumations*. Valencia, 1936–2020, Ed: Diputación de Valencia, Delegación de Memoria Histórica, 2021.
- [9] M. Mezquida-Fernández, A. Calpe-Vicente, *El Paredón de Paterna: A debt to one of the most significant Memory Spaces in the Valencian Country*, in: V. Gabarda-Cebellán (Ed.), *Violence, conceptualization, memory, repression, studies, monumentalization, exhumations*. Valencia, 1936–2020, Ed: Diputación de Valencia, 2021, Delegación de Memoria Histórica, València, 2021, pp. 213–234.
- [10] Law 52/2007, of December 26, affirms and expands rights and establishes measures in favor of those who suffered persecution or violence during the civil war and the dictatorship, <https://www.boe.es/buscar/act.php?id=BOE-A-2007-22296> (accessed 12 May 2023).
- [11] A. Moreno-Martín, M. Mezquida-Fernández, M.E. Schwab, Exhumaciones de fosas comunes en el País Valenciano: 10 años de intervenciones científicas, *Ebre* 38 (2021) 11.
- [12] M.J. Page, J.E. McKenzie, P.M. Bossuyt, I. Boutron, T.C. Hoffmann, C.D. Mulrow, et al., The PRISMA 2020 statement: an updated guideline for reporting systematic reviews, *BMJ* 372 (2021) n71, <https://doi.org/10.1136/bmj.n71>.
- [13] J. Iglesias-Bexiga, Mass Grave 113 updated report on the identification rate, *ArqueoAntro Scientific Association*, Madrid, 2023.
- [14] Niches 54 and 55 identification report. 2017. <http://memoriahistorica.dival.es/fosa/exhumacion-de-los-nichos-54-y-55-del-cementerio-de-paterna/> 2023 (accessed 30 April 2023).
- [15] J. Iglesias-Bexiga, Mass Grave 22 updated report on the identification rate, *ArqueoAntro Scientific Association*, Madrid, 2023.
- [16] J. Iglesias-Bexiga, Mass Grave 94 updated report on the identification rate, *ArqueoAntro Scientific Association*, Madrid, 2023.
- [17] J. Iglesias-Bexiga, Mass Grave 112 updated report on the identification rate, *ArqueoAntro Scientific Association*, Madrid, 2023.
- [18] S. Carbo-Ramirez, L. Giron-Santamaria, L. Martinez-Priego, F. Gonzalez-Candelas, Genetic analysis report on the bodies recovered from mass grave 112, located in the Paterna Cemetery, Fisabio Foundation Generalitat Valenciana, Valencia, 2022.
- [19] J. Iglesias-Bexiga, Mass Grave 128 updated the report on the identification rate, *ArqueoAntro Scientific Association*, Madrid, 2023.
- [20] Niches 43 and 44 identification report. 2018. <http://memoriahistorica.dival.es/fosa/exhumacion-de-los-nichos-43-y-44-del-cementerio-de-paterna/> 2023 (accessed 30 April 2023).
- [21] J. Iglesias-Bexiga, Mass Grave 100 updated report on the identification rate, *ArqueoAntro Scientific Association*, Madrid, 2023.
- [22] J. Iglesias-Bexiga, Mass Grave 115 updated report on the identification rate, *ArqueoAntro Scientific Association*, Madrid, 2023.
- [23] Mass grave 127 identification report. <http://memoriahistorica.dival.es/fosa/exhumacion-de-la-fosa-127-del-cementerio-de-paterna/> 2023 (accessed 30 April 2023).
- [24] Mass grave 13-14-15 identification report. <http://memoriahistorica.dival.es/fosa/exhumacion-de-la-fosa-15-del-cementerio-de-paterna/> 2023 (accessed 30 April 2023).
- [25] J. Iglesias-Bexiga, Mass grave 57-73B updated report on the identification rate, *ArqueoAntro Scientific Association*, Madrid, 2023.
- [26] J. Iglesias-Bexiga, Mass Grave 111 updated the report on the identification rate, *ArqueoAntro Scientific Association*, Madrid, 2023.
- [27] J. Iglesias-Bexiga, Mass Grave 120 updated report on the identification rate, *ArqueoAntro Scientific Association*, Madrid, 2023.
- [28] S. Carbo-Ramirez, L. Giron-Santamaria, L. Martinez-Priego, F. Gonzalez-Candelas, Genetic analysis report on the bodies recovered from mass grave 21, located in the Paterna Cemetery, Fisabio Foundation Generalitat Valenciana, Valencia, 2022.
- [29] Instruction PRE/2568/2011, of 26 September, Protocol for action in exhumations of victims of the civil war and the dictatorship, <https://www.boe.es/eli/es/o/2011/09/26/pre2568> (accessed 19 October 2023).
- [30] F. Ferrándiz, A Social Autopsy of Mass Grave Exhumations in Spain, *ISEGORÍA* 45 (2011) 525–544.
- [31] B. Bruijns, R. Tiggelaar, H. Gardeniers, Massively parallel sequencing techniques for forensics: a review, *Electrophoresis* 39 (2018) 2642–2654, <https://doi.org/10.1002/elps.201800082>.
- [32] National Commission for the Forensic Use of DNA, *Guide to the Forensic Use of DNA*, Ministry of Justice, Madrid, 2019.
- [33] D. Marjanović, A. Durmić-Pasić, N. Bakal, S. Haverić, B. Kalamujić, L. Kovacević, et al., DNA identification of skeletal remains from the World War II mass graves uncovered in Slovenia, *Croat. Med. J.* 48 (2007) 513–519.
- [34] D. Marjanović, N. Hadžić Metjahić, J. Čakar, M. Džehverović, S. Dogan, E. Ferić, et al., Identification of human remains from the Second World War mass graves uncovered in Bosnia and Herzegovina, *Croat. Med. J.* 56 (2015) 257–262, <https://doi.org/10.3325/cmj.2015.56.257>.
- [35] H. Mansour, O. Krebs, H.O. Pinnschmidt, N. Griem, I. Hammann-Ehrt, K. Püschel, Factors affecting dental DNA in various actual post-mortem conditions, *Int. J. Leg. Med.* 133 (2019) 1751–1759, <https://doi.org/10.1007/s00414-019-02151-9>.
- [36] H. Pfeiffer, J. Huhne, B. Seitz, B. Brinkmann, Influence of soil storage and exposure period on DNA recovery from teeth, *Int. J. Leg. Med.* 112 (1999) 142–144.
- [37] D. Higgins, A.B. Rohrlach, J. Kaidonis, G. Townsend, J.J. Austin, Differential nuclear and mitochondrial DNA preservation in post-mortem teeth with implications for forensic and ancient DNA studies, *PLoS One* 10 (2015) e0126935.
- [38] K.E. Latham, J.J. Miller, DNA recovery and analysis from skeletal material in modern forensic contexts, *Forensic Sci. Res.* 4 (2018) 51–59, <https://doi.org/10.1080/20961790.2018.1515594>.