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"Heal the sick": Health status and caregiving during the 17th–18th century in Northern Italy (St. Biagio cemetery, Ravenna)

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Abstract

Objective: The study of health-related care provision in archeology gives important indications on the culture and community organization of past populations. This study aims to assess the health status of the skeletal assemblage recovered from the burial site of St. Biagio (Ravenna, 17th–18th Centuries); next, we identified likely instances of need for and receipt of caregiving in response to the condition, to examine evidence of community attitudes toward disease and disability.

Materials and Methods: The skeletal assemblage is composed of 133 individuals in a generally good state of preservation. Sex and age-at-death were estimated through classical anthropological methods. Health status was inferred through the biological index of frailty (BIF) and paleopathological analysis was performed through macroscopic and radiographic investigations. The "bioarcheology of care" approach was applied to individuals who showed evidence of impairment and disability.

Results: The skeletal assemblage of St. Biagio was equally represented by males and females (50% males), with a higher percentage of adults (83.4%) than subadults (10.5%), and this is reflected in the high life expectancy at birth (40.3 years). No significant differences in health status emerged between age groups and sexes, with a generally high percentage of joint diseases, antemortem trauma, and infectious diseases. Evidence of care and compassion was found in some individuals with a high degree of impairment or disability, as in the case of probable Angelman syndrome.

Discussion: This study provided important insights into the biological and social aspects of an Early Modern population in Northern Italy, showing that people with functional and/or visible abnormalities were probably cared for in life and were presumably considered full members of the society.

KEYWORDS

bioarcheology of care, disability, health status, Italy, paleopathology

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1 | INTRODUCTION

In recent years, there has been growing interest in the so-called "bioarcheology of care" (BoC) approach, which uses a combination of mortuary archeology, osteological, and paleopathological data in an attempt to reconstruct past societies' attitudes toward illness and disabilities (Bohling et al., 2022; Stodder & Byrnes, 2019; Tilley, 2015). The skeletal assemblage found in the St. Biagio cemetery, dating back to the 17th–18th centuries, represents an excellent case for the application of this approach.

Besides historical sources, skeletal remains represent the main archive that can provide information on the living conditions of the deceased. The evaluation of health status and frailty in individuals and populations of the past is a crucial aspect of bioanthropology. Frailty has previously been described as the state of physiological stress that an individual experienced during his or her lifetime, which may have contributed to his or her susceptibility to disease and death (DeWitte & Bekvalac, 2010; Zedda et al., 2021).

The assessment of frailty and health in past individuals can only be based on the signs left on the skeleton by physiological stress; however, biomarkers of stress (van Schaik et al., 2014) are still good proxies for assessing health conditions in past individuals (Reitsema & McIlvaine, 2014).

Usually, the reconstruction of health and frailty is performed using single stress biomarkers (i.e., DeWitte & Bekvalac, 2010; Rinaldo et al., 2019; Ritzman et al., 2008; Rothschild, 2012; Walker et al., 2009). Although each biomarker separately can provide important information, it is also fundamental to assess the overall health of individuals and populations by analyzing several biomarkers together. Recently, two indices that combine several stress biomarkers have been proposed for a quantitative evaluation of frailty: the skeletal frailty index (SFI) by Marklein et al. (Marklein et al., 2016; Marklein & Crews, 2017) and the biological index of frailty (BIF) by Zedda and colleagues (Zedda et al., 2021), which combines 13 and 12 stress biomarkers, respectively. The main difference is that the SFI requires the skeleton to be complete or nearly complete for the estimation of frailty, whereas the BIF offers the possibility to have a good estimate of the individual's frailty even with partial skeletal remains, applying a different weight to each biomarker in the final evaluation.

Bioarcheological contexts ascribable to populations with poor living conditions often exhibit an extensive and multifaceted paleopathological record. In addition to the classical paleopathological analysis, when reconstructing past societies, it is relevant to consider and evaluate the social behaviors related to illness and disability. In this light, the BoC approach focuses on the analysis of caregiving patterns in past populations. This rather recent field of research was first officially defined in the last decade by L. Tilley and her research group (Tilley, 2012, 2015; Tilley & Oxenham, 2011), with further contributions in recent years by other authors (Shaw & Sykes, 2018; Vlok et al., 2017). One of the major inputs to the field was published by Tilley and colleagues, who developed a specific web-based methodology—the index of care—to assess the level of care potentially provided to individuals whose skeletons were found in an archeological context (Tilley & Cameron, 2014). Specifically, following the guidelines of the index of care, individuals assessed as disabled or physically impaired would be further analyzed to determine their survival time/disease duration and to identify their level of self-sufficiency in the activities of daily living (Tilley & Cameron, 2014). Therefore, the main purpose of BoC is to provide an interpretation of how people with disabilities or impairments were treated in the past (Tilley, 2015; Tilley & Cameron, 2014; Tilley & Oxenham, 2011). The length of the survival period of individuals with limiting conditions may provide an interpretation of attitudes toward disabled people and their social role in ancient human groups (Vlok et al., 2017). Studies focusing on BoC aim to assess how past societies reacted to people with physical and social limitations in one or more aspects of their everyday lives (i.e., social and economic life, and basic living activities such as eating or auto-sufficiency) (Tilley, 2012; Vlok et al., 2017). Indeed, caring for injured, sick, or disabled persons implies a desire to keep them alive as long as possible, regardless of the costs in terms of time and resources. The analysis of caregiving behaviors can thus provide important cultural insights into a population: social rules, cultural system, economic and political organization, and more (Tilley, 2015). Moreover, in a recent paper, Bohling et al. (2022) proposed a novel population-scale approach (bioarcheology of disability [BoD]), to identify widespread social attitudes toward disability based on consistent patterns in mortuary treatment. This approach, which investigates and combines paleopathological, archeological, and theoretical analyses at the population level, provides a comprehensive and multi-integrated understanding of past societies.

Population-based studies are still scarce and different approaches have been used, mainly based on the aggregation of individual cases (Bohling et al., 2022; Fedorina et al., 2022; Schrenk, 2019; Tilley & Cave, 2023; Tremblay Critcher, 2017). In this study, we applied the BoC approach to the archeological site of St. Biagio, located in the Italian city of Ravenna. Given its extensive archeological record, the cemetery of the St. Biagio church represents an important anthropological site, counting 133 graves and covering a period from the 17th to the 18th century. The large number of individuals with various pathologies makes this archeological site particularly suitable for the application of a population-scale approach to BoC. In addition to archeological and anthropological analysis, knowledge of its historical and geographical context (including religious beliefs) is crucial in revealing how individuals perceive impairment and the reasons behind their social behavior.

Ravenna is the largest city in Romagna (North-eastern Italy), located in the Po valley and best known as the capital of the Byzantine kingdom (fifth to sixth century) (Caravita, 2008). Between the 17th and 18th centuries, the city and its surroundings were affected by climatic adversities and epidemics (Caravita, 2008; Montanari Cipriani, 1996). From the end of the 16th century, multiple episodes of famine and frosts are documented, while several floods occurred between 1646 and 1715 (Caravita, 2008). In addition to catastrophic events, the poor hygienic conditions of the population often facilitated the spread of diseases. Several authors report that a large proportion of the population died from epidemics, especially during

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1594–1596, 1603, and 1631–1632 (the second plague pandemic) (Caravita, 2008; Montanari Cipriani, 1996). Historical sources also document the scarcity of potable water during the 17th and 18th centuries and repeatedly report of the nauseating quality of the water in comparison to the deliciousness of the wine produced in the area (Beltrami, 1833; Caravita, 2008). Moreover, most of the population was employed in heavy work with generally poor living conditions. Historical sources also report the high number of laborers of both sexes in the mid-19th century and emphasize the high number of disabled, crippled, impaired, and even alcoholics living in the district of St. Biagio (Montanari Cipriani, 1996).

The aims of this study were: (i) to provide a comprehensive overview of the health status of the skeletal assemblage recovered from the St. Biagio cemetery; (ii) to analyze in detail individuals that exhibited signs of impairment and diminished functional capacity to identify probable instances of caregiving in response to pathology; we also examined evidence of community attitudes toward disease and disability through the analysis of nonnormative funerary treatments.

2 | MATERIALS AND METHODS

2.1 | Sample

In this study, we analyzed a sample of skeletonized individuals, discovered in the burial areas of the St. Biagio church (Ravenna, Northeastern Italy), dating back from the 17th to the 18th centuries. The archeological excavation took place in 2013 in the area adjacent to the church of St. Biagio (Scianò, 2015). The sample consists of 133 individuals generally in a good state of preservation: 111 adults, 14 subadults, and 8 individuals represented only by scattered fragments. All these skeletons are currently stored at the Laboratory of Archaeoantropology and Forensic Anthropology of the University of Ferrara.

2.2 | Biological profile analysis

Sex and age-at-death of the individuals were estimated according to classical morphometric methods (Acsádi & Nemeskéri, 1970; Brooks & Suchey, 1990; Brothwell, 1981; Ferembach et al., 1980; Lovejoy et al., 1985). The diagnosis of sex was only carried out for individuals older than 15 years through morphological traits of the skull and pelvis, or metric analysis if these skeletal districts were not available (Bass, 1995; France, 1998). Adults' age-at-death was estimated based on degenerative changes of the skeletons, in particular the pubic symphysis (Brooks & Suchey, 1990; Todd, 1920, 1921), the auricular surface (Lovejoy et al., 1985), dental wear (Brothwell, 1981; Lovejoy, 1985), ectocranial suture obliteration (Meindl & Lovejoy, 1985), and the sternal end of the third and fourth ribs (İşcan et al., 1984). Age-at-death of subadults was estimated mainly through the diaphyseal length of the long bones (Ubelaker, 1989), the eruption and formation of teeth (Ubelaker, 1989), and the degree of formation and fusion of the ossification centers (Scheuer & Black, 2004).

The total sample was divided into the six age categories proposed by Buikstra and Ubelaker (Buikstra & Ubelaker, 1994): fetus (F, prenatal), infant (I, 0–3 years), child (C, 3–12 years), adolescent (A, 12–20 years), young adult (YA, 20–35 years), middle adult (MA, 35–50 years) and older adult (OA, 50+ years).

Historical data suggest that this cemetery was not used during pandemics. Therefore, life expectancy at birth was calculated using the life table for attritional cemeteries proposed by Halley (Chamberlain, 2006; Mallegni & Lippi, 2009).

Stature was calculated using the regression equations proposed by Pearson (Pearson & Henrici, 1997) applied to the maximum left-side length of the femur, tibia, humerus, and radius.

The body mass (BM) of the individuals were estimated using the regression equations proposed by Ruff et al. (1991), McHenry (1992), and Grine et al. (1995) for adults. In addition, the method proposed by De Groote & Humphrey, (2011) to derive the diameter of the femoral head from the measurement of the first metatarsal was used for seven individuals. It was not possible to estimate the BM for all subadults. Body mass index (BMI) was calculated as the ratio of BM to the square of stature (kg/m^2) and used to classify individuals into the following four categories of weight status (WS): underweight (<18.49), normal weight (18.5–24.9), overweight (≥25), and obese (≥30) (Keys et al., 2014).

2.3 | Health status, paleopathological analysis, and bioarcheology of care and compassion

As a proxy for the general health status of the population of Ravenna, when possible, we calculated for each individual the BIF proposed by Zedda et al. (2021). To apply this method, individuals must have at least three observable biomarkers and be older than 12 years at the time of death. Each biomarker was assigned a weight (as reported by Zedda et al., 2021) and the score was one if present and zero if absent. The BIF was calculated using the following formula:

$$\mathrm{BIF} = \left(\sum(\mathrm{weight} \times \mathrm{score})\right) / \left(\sum(\mathrm{weight})\right) \times 100$$

The BIF values were then divided into three categories of frailty: low frailty (0–21), medium frailty (21–53), and high frailty (53–100) (Zedda et al., 2021).

The absolute and relative frequencies of each biomarker were also evaluated and reported separately. The list of the biomarkers included: short stature, low BM, linear enamel hypoplasia (LEH), cribra orbitalia (CO), porotic hyperostosis (PH), rickets, periodontitis, periostitis, joint disease, vertebral disease, trauma, and osteoporosis. For a detailed description of each biomarker see Zedda et al. (2021). Information on CO and PH was collected through the BOPLE evaluation forms (Rinaldo et al., 2019). The presence of osteoporosis was evaluated through a Quantitative Ultrasonometry device (DBM Sonic Bone Profiler 1200, IGEA, Carpi; Pasini et al., 2023; Rinaldo et al., 2018).

The palaeopathological analysis was conducted based on a macroscopic observation of each individual and a radiographic analysis of

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selected individuals. Radiographs were taken at the hospital of Santa Maria Maddalena (Rovigo, Italy), using a Carestream Health DRX-1 system. Differential diagnosis was performed for each individual, following the recommendation of Buikstra and colleagues (Buikstra et al., 2017).

To determine the presence of coxa valga (Cvl) and coxa vara (Cvr), the femoral collo-diaphyseal angle was measured on both the right and left femur, where possible, with a digital osteogoniometer (Gualdi-Russo & Russo, 1995). A femoral collo-diaphyseal angle greater than 140° was determined as Cvl, while an angle less than 120° as Cvr (Coskun Benlidayi et al., 2015).

Evidence of trauma was collected and evaluated following the recommendations from the scientific literature (Lovell, 1997; Ortner, 2003; Scianò et al., 2020).

Pathologies were divided into six macro-areas: infections, neoplasms, metabolic disorders, joint diseases, antemortem traumas, and congenital diseases. In this classification, nonspecific stress markers (such as LEH, CO, and PH) were excluded.

For the analysis of care and compassion in St. Biagio, we considered and evaluated various pathologies that could have given limitations and impact on various functions in one or more aspects of daily living, such as neoplasms, craniosynostosis, significant evidence of coxarthrosis and osteoarthrosis, rheumatoid arthritis and antemortem trauma. For the purposes of this study, only antemortem traumas (traumas showing signs of healing) were considered. For the assessment of pathologies that could have led to disability and physical impairment, we adapted the protocol of the biological index of care published by Tilley and Cameron (2014) and we applied it to the overall skeletal assemblage. Further, we incorporated the BoD population-scale approach to contextualizing and interpreting consistent patterns of funerary and burial treatments of community members who lived with impairment and disabilities into our analysis (Bohling et al., 2022). For the description of the funerary context, we followed the recommendation published by Bohling (2020).

2.4 | Statistics

Descriptive statistics were calculated, as means and SDs for continuous variables (including BIF) and mean and absolute frequencies for categorical variables.

According to the distribution of the data, the *t* test, ANOVA, and analysis of covariance (ANCOVA) adjusted for age was used to evaluate differences in BIF values between sexes and between age classes. The χ^2 test was used to calculate differences between frequencies.

A *p*-value ≤0.05 was considered statistically significant. Statistics were performed with the statistical software MedCalc version 14.8.1 (MedCalc Software bvba, Ostend, Belgium).

3 | RESULTS

The total sample consisted of 133 archeological skeletons. Biological sex was estimated for 112 individuals (56 females and 56 males) (Table 1), while for 21 individuals the assessment was not possible because they were represented only by scattered fragments, or because their age-at-death was fewer than 15 years. All age classes were represented except for fetuses, but for eight individuals the age-at-death remained undetermined (Table 1). The number of subadults was low compared to the number of adults (12% vs. 88%), and individuals between 35 and 50 years old (MA) were the most represented.

According to the life table, the life expectancy at birth of the individuals from Ravenna was 40.3 years (Table S1).

BM and BMI were calculated only for adults. As expected, the mean BM of males (68.1 ± 7.3 kg) was significantly higher than that of females (59.5 ± 7.2 kg) ($p < 0.001$); the same trend was observed for height, with a mean value of 163.4 ± 4.8 cm in males and 153.8 ± 3.7 cm in females ($p < 0.001$). Conversely, the mean BMI values were similar in males and females (25.33 ± 2.5 kg/m^2 and 25.1 ± 2.4 kg/m^2 respectively; $p = 0.702$), with the majority of individuals falling into the category of normal weight (48.3%) or overweight (50.6%). Only one female was obese (1.1%) and none in the underweight category.

It was possible to estimate frailty using the BIF for 106 individuals aged 12 years or older (Table 2). More than half of the individuals had a medium level of frailty, almost a third a high level of frailty, and less than 20% had a low level of frailty. ANOVA between age classes was not significant for frailty values, but an increasing trend in mean frailty values can be observed from young adults, with a mean value of 37, to the elderly, with a mean value of 44. Adolescents diverted from

TABLE 1 Distribution of individuals recovered from St. Biagio (Ravenna) by age and sex.

	Males	Females	ND sex	Total	%
Infants (0–3 years)	0	0	2	2	1.5
Children (3–12 years)	0	0	4	4	3.0
Adolescents (12–20 years)	4	1	3	8	6.0
Young adults (20–35 years)	15	19	1	35	26.3
Middle adults (35–50 years)	23	21	1	45	33.8
Old adults (>50 years)	14	15	2	31	23.3
ND subadults	0	0	2	2	1.5
ND adults	0	0	6	6	4.5
Total	56	56	21	133	100

Abbreviation: ND, not determinable.

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this trend, presenting a higher mean value of frailty than young adults, yet, with a high SD, due to the low number of individuals in this age class. Regarding sex, although females presented a higher mean value of frailty than males, the difference is not statistically significant.

Figure S1 shows the frequencies of each biomarker that has been considered for the evaluation of frailty. The highest percentage of biomarkers were joint and vertebral diseases, found in more than half of the individuals. Antemortem traumas, periodontitis, and periostitis were found in about one-third of the individuals, while osteoporosis and rickets were present in only 6% and 1% of the sample, respectively (Figure S1).

TABLE 2 Comparisons between mean values and categories of BIF

	N	Mean of BIF (SD)	*p*
Total	**106**	40.77 (20.9)	
Females	52	41.92 (21.9)	0.314[a]
Males	52	38.93 (18.3)	
12–17	5	39.00 (36.5)	0.531[b]
18–34	31	36.99 (19.7)	
35–50	41	41.23 (19.5)	
50+	29	44.47 (21.3)	
Categories of BIF			***N* (%)**
Low (0–21)			19 (17.9%)
Medium (21–53)			58 (54.7%)
High (53–100)			29 (27.4%)

Note: The total value included individuals for whom sex and/or adult age category could not be determined.
Abbreviation: BIF, biological index of frailty.
[a]ANCOVA test.
[b]ANOVA test.

The palaeopathological analyses identified two relevant cases of metabolic diseases in two male adolescents, one with a probable case of scurvy (Figure 1a) and the other with characteristic malformations on the lower limbs caused by rickets. Concerning neoplasms, only one case has been found, metastatic carcinoma in an elderly man.

Osteoarthrosis was very frequent in these skeletons, both in the vertebral column (82%) and in the other joints (86.7%). Of these, 62 out of 82 had both osteoarthrosis in the vertebral column and in the other joints, except for 6 individuals who had only osteoarthrosis in the vertebral column and eight only in other joints. Males and females were equally affected and lesions were present in all adult age classes, and even in young adults with 11 young individuals with osteoarthrosis in the vertebral column (12.4%) and 23 young adults with osteoarthrosis in other joints (25.8%). Although pain, swelling, and reduced range of motion in the affected area are common consequences of this degenerative disease, individuals with osteoarthritis rarely require direct support. Rather, there is a progressive adjustment of performance expectations by the individuals themselves and those who lived and worked with them (Tilley & Cave, 2023).

We observed 39 antemortem trauma affecting 33 individuals, in both males and females (Table 3, Figure S2), with the highest frequencies on the femur (12.1%) (Figure 1b), sternum, ribs (33.3%) and vertebral column (54.5%). Other traumatic evidence has been found in the skull, scapula, radius, and humerus. Finally, five relevant cases of congenital diseases were detected, mainly among males.

The distribution of diseases was similar between the two sexes, apart from metabolic disorders, congenital diseases, and neoplasms that were only found in males. Regarding the distribution among age-at-death classes, no pathologies were found in infants and children,

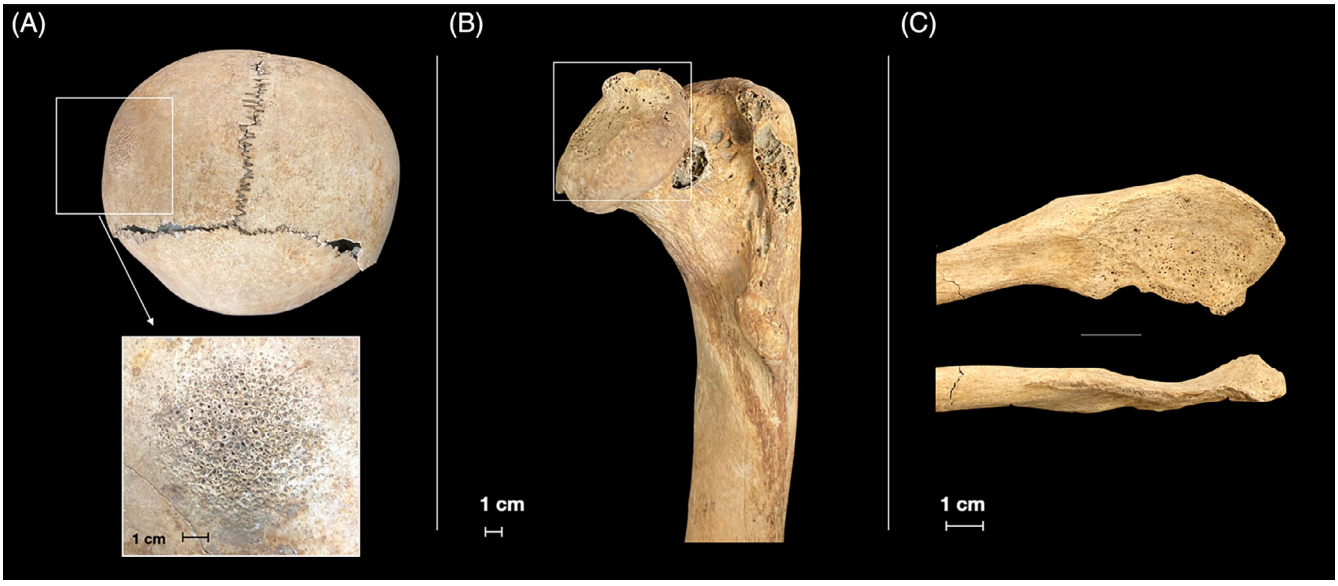

FIGURE 1 Cases of impairing pathologies from St. Biagio. (a) Skull of Sk 144, diagnosed with probable scurvy, exhibiting large porosity on the right parietal region; (b) femoral head fracture of Sk 162, with crushing and signs of malunion; (c) fracture and severe thinning on the clavicula of Sk 231, diagnosed with rheumatoid arthritis.

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TABLE 3 Pathologies distribution in St. Biagio's sample.

	Infections *N*/tot (%)	Neoplasms *N*/tot (%)	Metabolic disorders *N*/tot (%)	Joint diseases *N*/tot (%)	Antemortem trauma *N*/tot (%)	Congenital diseases *N*/tot (%)
Total	31/133 (23.3)	1/133 (3.0)	2/133 (1.5)	85/133 (63.9)	33/133 (24.8)	5/133 (3.8)
Males	15/56 (26.8)	1/56 (1.8)	2/56 (3.6)	40/56 (80.3)	18/56 (32.1)	3/56 (5.4)
Females	14/56 (25.0)	0/56 (0.0)	0/56 (0.0)	45/56 (88.2)	15/56 (26.8)	0/56 (0.0)
ND sex	1/21 (4.8)	0/21 (0.0)	0/21 (0.0)	0/21 (0.0)	0/21 (0.0)	2/21 (9.5)
Subadults	0/8 (0.0)	0/8 (0.0)	0/8 (0.0)	–	–	1/8 (12.5)
Adolescents	1/8 (12.5)	0/8 (0.0)	2/8 (25.0)	0/8 (0.0)	1/8 (12.5)	1/8 (12.5)
Adults	30/117 (20.6)	1/117 (0.8)	0/117 (0.0)	85/117 (72.6)	32/177 (27.3)	3/117 (2.5)

whereas one case of infection, one of antemortem trauma, and two cases of metabolic disorders were found in adolescents.

3.1 | Care and compassion

This study identified 26 individuals with physical impairment and various pathologies that might require care for a period or until the death of the individual (Table 4). We found one case of gout that may lead to limitations in activities of daily living, especially in mobility and neuro-skeletal function. A case of DISH in an elderly man may have caused dysfunctions of the musculoskeletal and nervous systems and limited mobility. In Ravenna's sample, we identified two individuals with metabolic disorders (scurvy and rickets) that may have resulted in limited mobility in instrumental activities of daily living and possible dysfunctions of the neuromuscular-skeletal, sensory-nervous, digestive, and metabolic endocrine systems. It is also noteworthy to observe that two individuals over the age of 50 had multiple pathologies. A man over the age of 50 years (Sk 180) had evidence of metastatic carcinoma, Cvl, and an antemortem trauma to the left radius with evidence of healing; an elderly woman (Sk 231) presented evidence of rheumatoid arthritis and a healed antemortem trauma localized to the scapula. Four cases of craniosynostosis have been identified: two individuals with sagittal synostosis, one individual with bilateral lambdoid synostosis, and one individual with syndromic craniosynostosis (Figure S3). Finally, Sk 207 is a young individual who presented signs of a neurodevelopmental disorder that may be compatible with a diagnosis of a neuro-motor disorder, probably Angelman Syndrome (for the differential diagnosis see Data S2). Concerning evidence of Cvr and Cvl, of the seven affected individuals, six were males, and only one case of Cvr affected a female. Among the individuals with antemortem trauma, physical impairment was found in 15 cases.

3.2 | Funerary treatments

The majority of burials, that can be classified as "normative burial treatments," are characterized by an orientation of the head toward the north, with individuals buried supine, extended, with upright facing. There is no uniform pattern in the arms' position, which may be extended or bent at different levels of the body; the legs are generally extended. Of 26 individuals with physical impairment or disability, 18 (69.2%) had a normative funerary treatment. A total of 16 individuals out of 133 (12.1%) had a nonnormative funerary treatment, of whom 8 (50%) had a presumed physical impairment, whereas 8 (50%) had no osteological evidence of disability or impairment. Only one individual (Sk 151), with evidence of craniosynostosis and other abnormal features, was buried with an opposite orientation, with the head to the south. Six individuals were found with isolated skulls positioned on or near the body, but only Sk 207 showed evidence of impairment; all of these individuals were adults in different age categories and of both sexes. Two individuals of both sexes (Sk 105 and Sk 136), both with a healed fracture of the sternum, were found with a brick in place of the skull; one OA female with evidence of rheumatoid arthritis and fracture of the scapula/acromion (Sk 231) was discovered with a roof tile over the skull. Two females of different ages (Sk 162 and Sk 115) were buried in a marginalized position with respect to the other individuals. The positions of their bodies were also unusual in comparison to the other individuals: Sk 162 was an OA female with a fracture of the femoral head, buried with her arms crossed over her chest and her injured leg and pelvis vertically misaligned in relation to the other leg, whereas Sk 115 was a YA female with perimortem trauma in one rib, buried at the edge of the cemetery with her feet crossed over each other. A YA female without evidence of impairment was buried with arms and legs crossed, whereas an adolescent was found with a brick under the skull. Although no signs of disability were found in this individual, we must stress that the skeleton was poorly preserved and therefore we cannot exclude the presence of pathologies. The last case is a poorly preserved OA male with evidence of Cvl, found with a skull above the leg.

4 | DISCUSSION

The aim of this study was twofold: first, we aimed to assess the health status of the skeletal assemblage recovered from the 17th–18th century cemetery of St. Biagio in Ravenna (Italy). Second, we applied the BoC approach at a population scale to attempt a reconstruction of

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TABLE 4 Summary of individuals with signs of physical impairment from St. Biagio sample.

Individual			Pathology		Functional impact			
Sk	Sex	Age-at-death	Pathology	Duration	Body function/system	Essential activities and daily living	Essential activities	References
126	M	35–50	Gout	Acquired: medium to long term	Musculoskeletal (probable), sensory-nervous (probable), genitourinary (possible)	Restricted in Instrumental activities of daily living, especially for mobility	Limited mobility	Roddy and Doherty (2010) and Giuffra et al. (2017)
114	M	45–55	DISH	Acquired: medium to long term	Musculoskeletal (probable), sensory-nervous (probable)	Restricted in Instrumental activities of daily living, especially for mobility.	Limited mobility	Holgate and Steyn (2016)
144	M	12–15	Scurvy	Acquired: medium to long term	Musculoskelet (probable), sensory-nervous (probable), hematological (probable), cardiovascular (possible)	Restricted in Instrumental activities of daily living, especially for mobility and economics	Limited mobility	Snoddy et al. (2018) and Magiorkinis et al. (2011)
180	M	OA	Metastatic Carcinoma	End of life	Neuromusculoskeletal (probable), sensory-nervous (probable), digestive-metabolic-endocrine (probable)	Restricted in Instrumental activities of daily living, especially for mobility, eat/drink (for almost total dental loss) and economics	Limited mobility and eat/drink	Lieverse et al. (2014) and Marks and Hamilton (2007)
232	M	15–18	Rickets	Acquired: definitely long	Respiratory (probable), cardiovascular (possible), digestive (probable), musculoskeletal (probable)	Restricted in Instrumental activities of daily living, especially for mobility	Limited mobility	Carpenter et al. (2017) and Vlok et al. (2023)
207	M	20–35	Angelman syndrome	Congenital	Neurologic, cognitive/mental, sensory, musculoskeletal dysfunctions	Severely restricted (essential, instrumental)	Restricted self-sufficiency in all essential activities	Margolis et al. (2015), Buiting et al. (2016), and Larson et al. (2015)
231	F	50+	Rheumatoid arthritis	Acquired: medium to long term	Muscolo-skeletal, respiratory, cardiac dysfunctions	Fully applicable (essential, instrumental)	Limited mobility	Wasserman (2011) and Cutolo et al. (2014)
151	ND	10–15	Bilateral lambdoid and sagittal synostosis	Congenital	Sensory, musculoskeletal, respiratory, mental/cognitive dysfunctions	Fully applicable (essential), restricted (instrumental)	Limited mobility	Kabbani and Raghuveer (2004), Pillai et al. (2013), and Ahmad et al. (2008)
98A	M	30–45	Sagittal synostosis	Congenital	Neuromusculoskeletal, sensory-nervous (probable)	Restricted in Instrumental activities of daily living	Limited mobility	Duncan and Stojanowski (2008)
131	M	40–50						
104		8	Bilateral lambdoid synostosis	Congenital	Neuromusculoskeletal, sensory-nervous (probable)	Restricted in Instrumental activities of daily	Limited mobility	
221	M	OA	Coxa valga	Congenital/acquired: definitely long	Neuromusculoskeletal	Essential activities of daily living, but restricted in "Instrumental activities of daily living"	Limited mobility	Clohisy et al. (2009) and Coskun Benlidayi et al. (2015)
228	M	40–50						
229	M	40–50						
175	M	OA						
180	M	OA						
134A	F	35–40	Coxa vara	Congenital/acquired: definitely long	Neuromusculoskeletal	Essential activities of daily living, but restricted in "Instrumental activities of daily living"	Limited mobility	
131	M	40–50						

(Continues)

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TABLE 4 (Continued)

Individual			Pathology		Functional impact			
Sk	Sex	Age-at-death	Pathology	Duration	Body function/system	Essential activities and daily living	Essential activities	References
162	F	50+	Hip fracture (femoral head), crush	Acquired: medium to long term	Musculoskeletal dysfunctions	Restricted (essential, instrumental)	Limited mobility caused by wrong welding	Lovell (1997), Kimmerle and Baraybar (2008), Sauer (1984), and Scianò et al. (2020)
180	M	50+	Fracture (radius)	Acquired: medium to long term	Musculoskeletal dysfunctions	Restricted (essential, instrumental)	Restricted instrumental abilities (before healing)	
231	F	50+	Fracture (acromion, scapula)	Acquired: medium to long term	Musculoskeletal dysfunctions	Restricted (essential, instrumental)	Restricted instrumental abilities (before healing)	
98A	M	30–45	Fracture (manubrium, sternum)	Acquired: medium to long term	Musculoskeletal dysfunctions	Restricted (essential, instrumental)	Restricted instrumental abilities (before healing)	
105	F	25–35	Fracture (manubrium, sternum)	Acquired: medium to long term	Musculoskeletal dysfunctions	Restricted (essential, instrumental)	Restricted instrumental abilities	
107	F	45–55	Fracture (acromion, scapula)	Acquired: medium to long term	Musculoskeletal dysfunctions	Restricted (essential, instrumental)	Restricted instrumental abilities (before healing)	
112	F	25–30	Fracture (manubrium, sternum)	Acquired: medium to long term	Musculoskeletal dysfunctions	Restricted (essential, instrumental)	Restricted instrumental abilities	
114	M	45–55	Fracture (skull), impact/slash	Acquired: medium to long term	Neuro-skeletal dysfunctions	Restricted (essential, instrumental)	Restricted abilities	
116	M	45–55	Fracture (manubrium, sternum)	Acquired: medium to long term	Musculoskeletal dysfunctions	Restricted (essential, instrumental)	Restricted instrumental abilities	
120	F	25–35	Fracture (manubrium)	Acquired: medium to long term	Musculoskeletal dysfunctions	Restricted (essential, instrumental)	Restricted instrumental abilities	
130	M	50+	Fracture (sternum)	Acquired: medium to long term	Musculoskeletal dysfunctions	Restricted (essential, instrumental)	Restricted instrumental abilities (before healing)	
131	M	50+	Fracture (femural distal)	Acquired: medium to long term	Musculoskeletal dysfunctions	Restricted (essential, instrumental)	Restricted instrumental abilities	
136	M	50+	Fracture (sternum)	Acquired: medium to long term	Musculoskeletal dysfunctions	Restricted (essential, instrumental)	Restricted instrumental abilities (before healing)	
159	F	50+	Fracture (manubrium, sternum)	Acquired: medium to long term	Musculoskeletal dysfunctions	Restricted (essential, instrumental)	Restricted instrumental abilities (before healing)	
186	M	25–30	Fracture (femoral distal midshaft, incomplete)	Acquired: medium to long term	Musculoskeletal dysfunctions	Restricted (essential, instrumental)	Restricted instrumental abilities (before healing)	

Note: Description of duration categories (modified by Bohling et al., 2022). Congenital: conditions present at birth. Acquired: medium to long term: conditions acquired probably during adulthood or evidence of healing and remodeling indicative that the individual has lived with this condition with a limited period of time. Acquired: definitely long: conditions typically arisen during childhood and which have been likely present most of the individual's life. End of life: conditions that probably affected the individuals toward the end of their life and/or that probably caused the death of the individual in a short period of time.

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how disability and impairment were viewed and treated in this community.

4.1 | Paleodemography and health status of the St. Biagio's cemetery

Considering the paleodemographic data of the St. Biagio's cemetery, our results showed an equal distribution between the two sexes and the adults' age-at-death classes, with one-third of the total sample represented by MA. Subadults were underrepresented (12% of the total sample), with no fetuses and only three adolescents. We compared our results with those of the cemetery of Imola "Osservanza" (BO), a catastrophic cemetery for plague victims, of the same geographical region and historical period. The site of Imola "Osservanza" showed a greater presence of children, adolescents, and YA than St. Biagio, probably due to the intrinsic characteristics of catastrophic assemblages that mirror the living population (Margerison & Knüsel, 2002). Nevertheless, also in Imola, there was a small assemblage of infants, which could be due to the possible existence of a burial area reserved for infants outside the city walls (Guellil et al., 2021). The separation of children and adults in different burial areas could also be the cause of the low number of subadults in Ravenna, as well as the lower mortality rate in infants and children. However, these results can be biased by the lower preservation rate of subadults' bones due to diagenetic issues (Guy et al., 1997).

This phenomenon is also reflected in the life expectancy at birth. Ravenna had a life expectancy of 40.3 years, much higher than that of Imola (19.9 years) (Rinaldo, 2012). However, these results are influenced by the small number of subadults found in St. Biagio.

The WS of the individuals from St. Biagio showed interesting results, as most of them fall into the overweight (50.6%) and normal weight (48.3%) categories. This outcome could be partially explained by the various historical sources that report a high consumption of wine among the inhabitants of Ravenna. This is related to the poor sanitation conditions that affected the Emilia-Romagna region during the 17th century (Caravita, 2008), which included poor quality and low quantity of drinking water (similar to other European cities) (Ferreira et al., 2014; Mara et al., 2010). As reported by Caravita (2008), for these reasons the inhabitants of Ravenna preferred to drink the wine that they produced rather than water. Popular sayings such as: "The water you drink is bad but the wine is good (1681)" or "The water is very bad and you drink the water from heaven contained in cisterns (1700)" reinforce the hypothesis that excessive alcohol consumption could be among the causes of overweight for the individuals examined in this study.

As regard the general health status, most of the individuals from Ravenna fall into the medium frail category, with no differences between sexes and, as expected, with an increasing trend with increasing age. The evaluation and quantification of frailty have been extensively used in recent studies to evaluate the susceptibility to death of some individuals (Wood et al., 1992), especially in relation to epidemics, such as plague (Zedda et al., 2022), and influenza (Wissler, 2021). However, when inferring the health status of a population, especially when analyzing an attritional cemetery, the osteological paradox should be considered, as the evidence of frailty could be either an indicator of actual frailty or, conversely, of resilience, depending on age (McFadden & Oxenham, 2020; Wood et al., 1992). Furthermore, several pathologies, such as arthropathies and osteoporosis, are strongly influenced by the age and sex distribution of the population (Zuckerman et al., 2023). While several approaches to the evaluation of frailty have been proposed (van Schaik et al., 2014), an integrated approach involving several biomarkers, sex and age distribution of the population, and the state of the lesions (active or healed) should be always considered (DeWitte & Stojanowski, 2015; Marklein & Crews, 2017; Sołtysiak, 2015; Zedda et al., 2021).

Zedda et al. (2022) in their article compared the overall frailty score of a sample of plague victims and the more ancient subsample of Ravenna's skeletal assemblage (1600–1700 CE), reporting a greater heterogeneity in the frailty score of plague victims. In our study, which included the entire skeletal assemblage from the St. Biagio cemetery, we found a higher number of "low frail" individuals and a generally lower frequency of frailty biomarkers, suggesting that in the more recent subsample (1700–1800 CE), the individuals were less frail than in previous centuries, especially males. However, mean frailty scores are high and comparable to those of two monastic cemeteries in medieval London (Marklein & Crews, 2017; Zedda et al., 2021). This evidence, in addition to the small number of subadults, could suggest a possible case of selectivity of the individuals buried in St. Biagio cemetery.

The individuals from Ravenna suffered from a high number of infectious diseases (more than a third of the population), joint diseases (more than 80%), and antemortem trauma (almost 50%). All these pathologies are equally distributed between the sexes. The high number of joint diseases is probably linked to the high mean age-at-death of the St. Biagio skeletal assemblage, as well as to the high number of antemortem trauma interpreted as osteoporotic fractures (femoral head and Colles' fractures). There are also several cases of cumulative healed fractures (Sk 98A, Sk 227, and Sk 159) that indicate injury recidivism and could be linked to both working conditions and violence (Mant & Holland, 2019). Yet, the high number of joint diseases in the youngest individuals could represent a work-related condition, supporting the hypothesis of a labor-based lifestyle of the Ravenna population.

4.2 | Bioarcheology of care at the St. Biagio cemetery

BoC reconstructs social paradigms such as marginalization and care provision through cross-analysis between skeletal and archeological evidence (Byrnes & Muller, 2017). The main task of BoC is to assess whether potentially disabled and impaired individuals were considered effective members of society. Thus, to understand attitudes toward disability in past human groups, it is of primary relevance to investigate the approaches of populations to care and assistance of impaired people. Indeed, the cemetery of St. Biagio houses several individuals presenting skeletal evidence of possible healthcare needs and can be

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used as an illustrative case of BoC applied to a skeletal sample. First of all, it is important to define the terms "care provision" and "marginalization." The term "marginalization" is defined both as a condition and as a process that prevents individuals and groups from being included in most of society's life, at the social, economic, and political level (Mant & Holland, 2019). In archaeo-anthropological studies, social marginalization could be inferred through the analysis of burial treatment, which might mirror social inclusion or marginalization in life (Bohling et al., 2022), although this is not always the case. On the other hand, healthcare provision involves planning, implementation, and assessment of care for people suffering from health conditions, and in an archeological context, it could be assumed from the evidence in the skeleton that the individual lived for some time despite his or her disability (Tilley & Cave, 2023). Even if healthcare provision might also include social inclusion, it does not necessarily imply it, therefore caution is needed in interpreting burial and anthropological data.

4.3 | Healthcare provisions in acquired pathologies

Individuals presenting evidence of disabling trauma (Figure 1b,c) revealed a diversified approach to care provision at St. Biagio. Several fractures exhibited signs of malunion, which may result from a lack of or insufficient immobilization during the healing phase of the trauma (Lovell, 1997). This evidence may suggest carelessness in the treatment of the injury, and that the injured persons did not interrupt their work activities for a sufficient time. Moreover, malunion is also associated with delayed healing caused by skeletal frailty or nutritional distress (Grauer & Roberts, 1996; Lovell, 1997). These considerations are consistent with the unwealthy and labor-based lifestyle of the population, which is also testified by historical sources (Caravita, 2008).

On the other hand, other cases of acquired impairing pathologies testify that caregiving was provided for some individuals, such as Sk 231 diagnosed with rheumatoid arthritis (Figure 1c), or Sk 114 diagnosed with DISH. In addition, Sk 114 presented evidence of multiple traumas on the skull and the mandible. Given the high impairment caused by skull fractures (Li et al., 2021), this case represents another finding of consistent care at St. Biagio, other than interpersonal violence. It is difficult to assess whether assistance was provided on an asset basis since we are not informed of the social status of everyone. However, the presence of skeletal evidence suggesting functional limitations might imply that the person was assisted for a prolonged period and that someone was committed to his survival (Matczak & Kozłowski, 2017; Tilley & Oxenham, 2011; Wesp, 2016).

4.4 | Healthcare provisions in congenital pathologies

In this study, we found four cases of craniosynostosis: two cases of sagittal synostosis, one case of bilateral lambdoid synostosis, and one case of multiple synostosis (Figure S3). The main evidence of craniosynostosis is the development of an abnormally shaped skull that can cause intracranial pressure and sensory, respiratory, and neurological dysfunction. Primary craniosynostosis is caused by a defect in primary ossification, whereas secondary craniosynostosis is the result of systemic diseases such as hematological, congenital, infective, and metabolic dysfunctions (e.g., rickets). Craniosynostosis can also be classified into syndromic (such as Apert, Crouzon, and Angelman, among others) and non-syndromic (Derderian & Seaward, 2012). In archeological contexts, it is rare to find this type of evidence (Cohen & MacLean, 2000). In general, males are more affected, as confirmed in this study. Multiple synostoses or bilateral coronal synostosis are the most uncommon (Bennett, 1967; Cohen & MacLean, 2000; Oostra et al., 2005), but in most cases, the latter usually involves half of the coronal suture or multiple sutures (Duncan & Stojanowski, 2008; Giuffra et al., 2011). In this study, cases of craniosynostosis were found in both adults and subadults. An interesting case is Sk 151, an adolescent with multiple craniosynostoses but also other skeletal malformations and anatomical anomalies such as midface hypoplasia and crowding of teeth resulting in malocclusion, torus palatinus, spondylolysis with vertebral deformities and bifid rib. Sk 151 was also deposed with nonnormative burial; in fact, this is the only case in the cemetery of St. Biagio of an individual positioned with an opposite orientation to the other individuals and close to the side of the cemetery. Marginal burial might have been reserved for those who were not allowed to be buried near the church (e.g., because a physical disability could impair the capability to participate in economic activities) or for those from a lower social class (Craig-Atkins, 2014; Hadley, 2009).

In the St. Biagio cemetery, we found eight cases of Cvl and Cvr, five males with Cvl and one female, and one male with Cvr. This type of pathology can be acquired or congenital (Clohisy et al., 2009). Congenital Cvr is caused by an embryonic limb bud abnormality, while acquired Cvr can be caused by an underlying condition such as rickets, traumatic closure of the proximal femoral epiphyseal plate, and fibrous dysplasia (DiFazio et al., 2003). In anthropological studies, it is difficult to discriminate between congenital and acquired cases. Cvl and Cvr could be linked to coxarthrosis and are often evidence of hip dysplasia, which now accounts for 40% of cases of coxarthrosis. These pathologies may cause reduced range of motion, muscular hypotrophy of the quadriceps muscles, and shortening of the leg, resulting in limited musculoskeletal functions and mobility. Even though Cvl is one of the most common congenital deformities of the musculoskeletal system (6 children per 1000 newborns, Veklich and Veklich, 2022), there is little literature currently available in the bioarcheological field, except for Boutin (2016) who reported a case of Cvl from the Cornwall collection (Bahrain, 2050–2800 BCE). This lack of reported cases in archeological contexts could be due to the methodological difficulties in diagnosing Cvl and Cvr.

4.5 | Case study: A putative case of Angelman syndrome

Among the wide skeletal assemblage from St. Biagio, Sk 207 stands out both for its paleopathological condition and for the nonnormative

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FIGURE 2 Grave of Sk 207. The intentional deposition of several skulls on the pelvic girdle is observable.

burial treatment. Sk 207 (Figure S1) represents an interesting case for the application of BoC, as it has been diagnosed as a possible case of Angelman syndrome, a rare congenital neurogenetic disorder primarily causing mental impairment and presumed low autonomy (Buiting et al., 2016; Margolis et al., 2015) (see Data S2 for differential diagnosis). The incidence of Angelman Syndrome ranges from 1 in 20,000 to 1 in 12,000 live births (Madaan and Mendez, 2023). People with this condition are affected by severe cognitive delay, seizures, and motor impairment (Larson et al., 2015). Mental disability is hard to diagnose from archeological remains, mainly due to the rarity of syndromes and disorders involving the skeletal system. However, cases of possible cognitive disability are reported in the scientific literature (Li et al., 2021; Matczak & Kozłowski, 2017; Tornberg & Jacobsson, 2018), although Sk 207 seems to be unique in the archeological record to date.

The age at death of this individual (20–35 years), who reached adult life despite his condition, suggests that he was cared for and assisted from childhood, despite his probable inability to work or engage in any other social activity, including communication. Based on the archeological and anthropological evidence, it is impossible to define whether he was assisted by his family, a religious or medical institution. Given his condition, it seems highly unlikely that this individual lived to adulthood alone or cared for only by his family, and the support of the entire community was probably indispensable. It is likely that Sk 207 also required a great deal of attention and help with basic self-care activities, such as dressing, eating, and bathing, although a semi-independent life could be possible as the clinical manifestation varies. Another important aspect is that Sk 207 required essentially constant supervision, as people affected by this pathology have no sense of danger (Clayton-Smith & Laan, 2003). As mentioned above, this individual is also associated with a peculiar burial context that can be interpreted as a possible case of deviant burial (i.e., a grave distinct from the rest of the site due to an atypical context or arrangement) (Murphy, 2008; Saracino et al., 2014; Saracino et al., 2017). Although Sk 207 position was similar to other burials, his grave (Figure 2) was characterized by the intentional deposition of several skulls arranged around the pelvic girdle of the deceased. Although isolated skulls were also found in other graves, only Sk 207 shows obvious signs of intentionality. This evidence may point to a deliberate funerary behavior toward this specific individual, although it is not possible to empirically verify a potential link with his disability or the specific circumstances of this action. In addition to functional and mental impairments, visible abnormalities should be considered in this context, as Angelman syndrome is also characterized by atypical facial features. It is known that many societies reserved nonconventional burial treatments for those who were considered outcasts or socially excluded (Perego, 2014; Saracino et al., 2017). His burial, however, reflects a particular treatment aimed specifically at this man. This "deviancy" may thus be considered as a form of funerary consideration toward a well-known member of a community. Although a denigratory or sophomoric meaning specifically directed at this man and perhaps to his diverse condition may be assumed, the age at death of Sk 207 suggests that he lived in a nonhostile environment, and similar cases are reported by other research (Tilley & Cave, 2023). Apart from these assumptions, a ritual significance would be hard to explain in this cultural context and finds no coeval comparisons.

4.6 | Care, funerary treatments, and general considerations

Sk 207 is a relevant example of the advantage of integrating biological analysis of skeletal evidence with archeological findings and burial practices for better contextualization, as suggested by Bohling and colleagues (Bohling et al., 2022); indeed, funerary behaviors are symbolic representations of social paradigms, other than religious constructs. Other cases of funerary deviancy characterizing graves of individuals with mental or physical disabilities are known in the literature (Bohling et al., 2022; Matczak & Kozłowski, 2017; Saracino et al., 2014).

As previously reported, there were other cases of nonconventional burial treatments in the St. Biagio cemetery. Examples are Sk 151, the only individual buried with an opposite orientation, and Sk 231, found with a roof tile placed over the skull. However, no pattern can be discerned in the funerary treatments, as nonconventional burials seem to be reserved for both physically impaired and apparently healthy individuals of both sexes and of different age-at-death

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classes. Remarkably both individuals found with a brick replacing the skull (Sk 105 and Sk 136) had a healed fracture of the sternum, but not all the individuals with the same fracture had a nonconventional burial. There are other similar cases in the literature, for example, individual 5074 described by Bohling et al. (2022). Another interesting case is Sk 162, a woman with a healed femoral head fracture who was buried with a misaligned position of the lower limb that might simulate difficult walking while alive. When analyzing burial treatments, we must remember that some taphonomic changes could be misinterpreted as deliberate treatments and that we can only see osteological evidence of impairment and disability in sometimes poorly preserved skeletal remains.

A double perception emerges in funerary treatments at St. Biagio: while some of them suggest attention and regard toward the deceased, others may be perceived as mocking gestures. Indeed, some aspects of these burials suggest an inclusive attitude toward the deceased (e.g., being buried in the community area, adopting the same orientation/positioning of the body as other non-pathological individuals, and a prolonged and more elaborate funerary process). Nevertheless, all these cases emphasize an implicit sense of diversity perception, either with a nonhostile or a hostile attitude.

With the obvious exception of Sk 207, St. Biagio appears overall as a typical, undifferentiated Italian Catholic cemetery. The presence of both disabled and non-impaired subjects suggests a lack of marginalization of physical abnormality. It is thus reasonable to hypothesize that impaired subjects were potentially considered part of society and not socially excluded, as stated in other research (Bohling et al., 2022; Fedorina et al., 2022). Nevertheless, this perception may be misleading. As pointed out by Bohling et al. (2022), disabled people may have been marginalized during their lives and then buried more inclusively due to moral and religious duties. Indeed, modern European society is characterized by the prevalence of Catholic culture and its concept of compassion and charity. In the 18th century, caregiving and healthcare were still the competence of religious bodies, such as orphanages, hospitals, and similar institutions, despite the establishment of secular hospitals and medicine following the influence of the enlightenment (Wesp, 2016). Despite the Catholic moral imposition and the rising of Illuminism and its conception of medicine (Pestilli, 2007; Wesp, 2016), the marginalization of disability or diversity was likely an actual component of the cultural substrate in small Italian communities (Pestilli, 2016).

In light of all the elements considered, the St. Biagio cemetery seems to reflect a society in which generally impaired and disabled individuals were integrated and not marginalized. Care practice at St. Biagio seems heterogeneous and depends on the characteristics of the disease, rather than on social conditions. This situation finds similarities with the Rus' cemetery (Fedorina et al., 2022), where bioarcheological findings suggested a perceived inclusive attitude toward the sick and the disabled.

The age at death of these individuals testifies that significant efforts were made to keep them alive despite their incapacity to work or participate in other aspects of sociality. In contrast, the fractures that showed evidence of malunion suggest that the time or conditions allowed for recovery were insufficient in most cases and the hypothesis of labor-related reasons seems the most reasonable. Similar findings were observed in another study on the working classes (Dittmar et al., 2023). In both St. Biagio and Cambridge cemeteries, trauma care was actually provided, although in most cases adverse consequences occurred due to poor recovery (Dittmar et al., 2023).

4.7 | Strengths and limitations of the study

The major strength of this study is the application of the BoC approach on a population scale, which represents a new frontier in this field of study. Only in a few cases this approach could be applicable, and the cemetery of St. Biagio, with its rare panorama of paleopathological cases, is one of them. In this respect, bioarcheology provides an interpretation of social evidence through the multi-integrated analysis of biological findings (Byrnes & Muller, 2017). Applying BoC to a human group and not just to a single case, provides a broader understanding of societies' heterogeneous response to diversity. Indeed, a society that takes care of those who cannot be economically employed and represents a loss of resources may be interpreted as inclusive and responsive to diversity.

Nevertheless, a population-based approach implies several limitations, mainly concerning the risk of generalizing and methodological scarcity. First, to our knowledge, published BoC methodologies only provide applications to single cases or specific pathologies (Byrnes & Muller, 2017; Tilley & Cameron, 2014; Vlok et al., 2017). Only a few studies have attempted to apply the BoC approach at a population level, but their approach mainly relied on the aggregation of single cases (Schrenk, 2019; Tilley & Cave, 2023; Tremblay Critcher, 2017). Thus, a standardized, empirical approach is currently difficult to apply on a population scale, even if recent studies have suggested interesting implementations (Bohling et al., 2022; Dittmar et al., 2023; Fedorina et al., 2022). Another limitation is that this kind of study considers a skeletal assemblage as a perfect representation of a population, but this may be misleading (DeWitte & Stojanowski, 2015). Indeed, skeletal remains from a cemetery represent only a deceased portion of a human group over a limited period specifically, the reconstruction of the health status of a population based on deceased individuals can lead to interpretative bias (DeWitte & Stojanowski, 2015). These theoretical statements should always be kept in mind in order not to fall into misinterpretation or over-generalizations. Like all archeological contexts, the cemetery of St. Biagio provided only a small sample of the actual population, thus, we are unable to provide a comprehensive interpretation of the real society. Moreover, survival timing or conditions of wealth and health can only be estimated and partially interpreted, as can specific considerations concerning social inclusivity or healthcare. Indeed, it is of paramount importance to avoid any form of over-interpretation and not to fall into simplistic assumptions.

5 | CONCLUSIONS

This study reconstructed the health status of a 17th–18th centuries Italian population and its approach to disability and impairment.

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The level of frailty of the individuals is high but in line with other similar sites; moreover, this skeletal assemblage presents a high number of paleopathological cases, especially traumatic lesions, and joint and infectious diseases. These findings are consistent with a predominantly poor, labor-based society, as also reported in historical sources.

In this research, a population-based BoC approach was applied for the first time on an Italian skeletal assemblage. Although antemortem impairing fractures were mostly untreated, individuals with a high degree of impairment or disability—such as Sk 207 or Sk 231—were undoubtedly cared for throughout their lives. These findings may suggest that people with functional and/or visible abnormalities were presumably cared for and considered full members of society, despite their inability to be active members.

Concluding, this study has provided important insights into the biological and social aspects of a population of the past. By shedding light on the complex social dynamics and care practices of the past, this research has important implications for our understanding of human societies and the evolution of care practices.

AUTHOR CONTRIBUTIONS

Federica De Luca: Data curation (equal); formal analysis (equal); investigation (equal); writing – original draft (equal); writing – review and editing (equal). **Alba Pasini:** Conceptualization (equal); investigation (equal); methodology (equal); writing – original draft (equal); writing – review and editing (equal). **Filippo Scianò:** Formal analysis (equal); investigation (equal); writing – review and editing (equal). **Nicoletta Zedda:** Data curation (equal); formal analysis (equal); investigation (equal); methodology (equal); writing – review and editing (equal). **Chiara Guarnieri:** Resources (equal); visualization (equal); writing – review and editing (equal). **Sabrina Masotti:** Data curation (equal); investigation (equal); writing – review and editing (equal). **Barbara Bramanti:** Resources (equal); visualization (supporting); writing – review and editing (equal). **Emanuela Gualdi-Russo:** Data curation (equal); resources (equal); supervision (equal); writing – review and editing (equal). **Natascia Rinaldo:** Conceptualization (equal); project administration (equal); supervision (equal); writing – original draft (equal); writing – review and editing (equal).

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DATA AVAILABILITY STATEMENT

Data available on request from the authors.

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