The Problem of Assessing Intervertebral Disc Disease as Impairment and Disability in Bioarchaeology. The Case of a Male Individual from the Late Medieval and Early Modern Period in Łekno, Poland

Magdalena D. Matczak, Jane E. Buikstra, Andrzej M. Wyrwa and Jessica Pearson

Zitiervorschlag
Magdalena D. Matczak, Jane E. Buikstra, Andrzej M. Wyrwa and Jessica Pearson. 2022. The Problem of Assessing Intervertebral Disc Disease as Impairment and Disability in Bioarchaeology. The Case of a Male Individual from the Late Medieval and Early Modern Period in Łekno, Poland. Forum Kritische Archäologie 11:167–194.

URL https://www.kritischearchaeologie.de

DOI http://dx.doi.org/10.17169/refubium-37540

ISSN 2194-346X

The Problem of Assessing Intervertebral Disc Disease as Impairment and Disability in Bioarchaeology. The Case of a Male Individual from the Late Medieval and Early Modern Period in Łekno, Poland

Magdalena D. Matczak (corresponding author)

Department of Archaeology, Classics, and Egyptology, University of Liverpool, 12–14 Abercromby Square, Liverpool, L69 7WZ, UK; Center for Bioarchaeological Research, Arizona State University, 900 S. Cady Mall, Tempe, AZ 85281, USA; m.matczak@liverpool.ac.uk

Jane E. Buikstra

Center for Bioarchaeological Research, Arizona State University, 900 S. Cady Mall, Tempe, AZ 85281, USA

Andrzej M. Wyrwa

Faculty of History, Adam Mickiewicz University, ul. Uniwersytetu Poznańskiego 7, 61-614 Poznań, Poland

Jessica Pearson

Department of Archaeology, Classics, and Egyptology, University of Liverpool, 12–14 Abercromby Square, Liverpool, L69 7WZ, UK

Abstract

Joint disease is one of the most common bone changes identified in skeletal populations. This paper presents a methodological discussion of the medical and bioarchaeological grading systems for describing intervertebral disc disease (IDD). A comparison of the bioarchaeological and medical grading systems helps to estimate the impact of IDD in the spine on the functioning of an individual and potential disability. The case study is focused on a male from the 14th to 16th centuries CE (late medieval and early modern period) who was buried in Łekno, Poland. The cemetery in the Łekno settlement complex consists of approximately 400 burials of Cistercian monks and local people. The individual was buried in the same body position and orientation as contemporaries. Analysis of the lesions in specimen indicate mild, moderate and severe IDD, classified as grades 1 to 3 on the Bioarchaeological Intervertebral Disc Disease Grading System. Moreover, the analysis indicated osteoarthritis, possibly early stage of DISH and healed and stable fracture of the left clavicle. Archaeological context and texts were used to evaluate the possibility that this individual was disabled. The spinal disease might have caused limitations of flexibility and temporal and chronic pain. This would become more evident as the age of the individual progressed. The individual could be regarded as sick and temporarily unable to work, thus needing help and healing. Due to his challenging conditions, it seems that he was cared for and supported by family, other people from the village and/or the Cistercian Order.

Keywords

spinal disease, disability, palaeopathology, history, Cistercian Order

Zusammenfassung

Gelenkerkrankungen sind eine der häufigsten Knochenveränderungen, die in Skelettpopulationen festgestellt werden. In diesem Beitrag wird eine methodische Diskussion der medizinischen und bioarchäologischen Klassifizierungssysteme zur Beschreibung von Bandscheibenerkrankungen (*Intervertebral Disc Disease* – IDD) vorgestellt. Ein Vergleich der bioarchäologischen und medizinischen Einstufungssysteme hilft, die Auswirkungen von IDD in der Wirbelsäule auf die Funktionsfähigkeit einer Person und eine mögliche Behinderung abzuschätzen. Die Fallstudie konzentriert sich auf einen Mann aus dem 14. bis 16. Jahrhundert u. Z. (Spätmittelalter und frühe Neuzeit), der in Łekno, Polen, bestattet wurde. Der Friedhof im Siedlungskomplex von Łekno besteht aus etwa 400 Gräbern von Zisterziensermönchen und Einheimischen. Das Individuum wurde in der gleichen Körperposition und -ausrichtung wie seine Zeitgenossen bestattet. Die Analyse der Läsionen in der Probe deutet auf eine leichte, mittelschwere und schwere Bandscheibenerkrankung hin, die nach dem bioarchäologischen Klassifizierungssystem für Bandscheibenerkrankungen als Grad 1 bis 3 eingestuft werden. Darüber hinaus deutet die Analyse auf Arthrose, möglicherweise ein frühes Stadium von diffuser idiopathischer Skeletthyperostose (DISH) und eine verheilte und stabile Fraktur des linken Schlüsselbeins hin. Zur Beurteilung der Möglichkeit einer Behinderung wurden archäologische und schriftliche Quellen herangezogen. Die Wirbelsäulenerkrankung könnte zu Einschränkungen der Beweglichkeit und zu vorübergehenden und chronischen Schmerzen geführt haben. Dies würde mit zunehmendem Alter des Individuums deutlicher werden. Die Person könnte als krank und vorübergehend arbeitsunfähig betrachtet werden, so dass sie Hilfe und Heilung benötigte. Aufgrund ihres schwierigen Zustands wurde sie anscheinend von der Familie, anderen Personen aus dem Dorf und/oder dem Zisterzienserorden gepflegt und unterstützt.

Schlagwörter

Wirbelsäulenerkrankung, Behinderung, Paläopathologie, Geschichte, Zisterzienserorden

Introduction

Many definitions and three main models of disability were developed over the past decades. The medical model recognizes that it is physical or mental limitations that cause disability (Barnes and Mercer 2010). On the other hand, the social model recognizes that there are social expectations of the “able-bodied” in society that affect the lifestyle of an individual. The “able-bodied” members of a society create social, cultural, legal, or political barriers that prevent people with impairments from fully participating in society. It is these barriers that cause disability. In turn, the multifactorial or mixed model reconciles medical and social dimensions of disability (Beaudry 2020). It indicates that disability is the result of many factors (individual and environmental) and covers different dimensions of disability under one definition. A well-known example of a multifactorial model is the WHO biopsychosocial model, in which “disability and functioning are viewed as outcomes of interactions between health conditions (diseases, disorders and injuries) and contextual factors (environment and personal factors)” (WHO 2002: 10).

Bioarchaeological studies reflect these models. In the early years, the medical model anchored bioarchaeological studies that assessed disability based only on pathological changes visible on bone (e.g., Trinkaus 1983; Spoor et al. 1998; Murphy 2000). Some recent research continues to adopt this approach (e.g., Conlogue et al. 2017). In the last years, however, researchers have been moving towards a socio-cultural definition of disability and considerations of identity (e.g., Boutin 2016; Lovell 2016; Cormier and Buikstra 2017). It is emphasized that disability is a socio-biological condition resulting from the attitude of society towards a person with impairment (e.g., Dettwyler 1991; Finlay 1999; Zakrzewski 2014; Tilley 2015; Boutin 2016). Bioarchaeologists agree that the recognition of disability depends on cultural contexts and social norms. The Bioarchaeology of Care paradigm fits into the multifactorial model of disability and defines disabled as individuals having significant physical impairments that prevented them from meeting social demands fully and therefore needed care to survive (Tilley 2015; Tilley and Schrenk 2017). We agree that, especially in bioarchaeology, which examines the physical dimension of impairment, the biological factor of disability is essential. The archaeological context and the attitudes of contemporary people must be considered as well in the (re)construction of the disability experience. Therefore, the multifactorial model seems to be the most appropriate for bioarchaeological research because it considers physical impairment relative to social expectations in the past.

There are currently between one billion people (~ 15%) with disabilities worldwide (The World Bank 2021a), which is a significant part of the society. Lower back pain (LBP) due to spinal diseases is one of the most common forms of disability in Western society with a high economic burden (e.g., loss of income, medical costs) and a major impact on wellbeing (i.e. decreased quality of life) (Raastad et al. 2015; see also Candotti et al. 2015; Plomp 2017). Only after World War Two was LBP recognized as a disability, and today it is a global scale problem (Allan and Waddell 1989). However, its history is much longer, going back to ancient times. LBP was recognized in ancient Egypt, as evidenced by the Edwin Smith papyrus (ca. 1500 BC, Allan and Waddell 1989). Galen of Pergamon (ca. 150 AD) and his disciples defined back pain as symptomatic of many illnesses and also as one of the pains that affected joints and muscles. In later times, however, infectious diseases, plagues, malnutrition, and high mortality were bigger health problems for short-lived societies than LBP (Allan and Waddell 1989). It was only during the construction of the railroad and during the industrial revolution in the 19th century that heavy physical work caused the LBP to grow on a massive scale. The first compensation and lawsuits for work injuries appeared at that time (Allan and Waddell 1989). The main cause of LBP from the 19th century is unknown, but it might be assumed that one of the reasons was spinal joint disease.

Spinal joint diseases such as osteoarthritis and spondylosis are frequently observed in archaeological populations (Rogers and Waldron 1995; Waldron 2012; Yustos et al. 2021). Spondylosis, degenerative or intervertebral disc disease, also known as intervertebral osteochondrosis and vertebral osteophytosis, is a degenerative condition of the disc and vertebral bodies (Plomp 2017; Kinkopf et al. 2021). The intervertebral disc is a component of a spinal "motion segment" that includes the facet joints. Intervertebral disc disease (IDD) is a distinct but functionally related condition to facet joints osteoarthritis (Gellhorn, Katz and Suri 2013). IDD is characterized by marginal osteophytes of the vertebral bodies, coarse pitting, and new bone growth on the superior and inferior surfaces of the vertebral bodies (Waldron 2009; Burt et al. 2013). IDD is most frequently found in lower cervical, upper thoracic and lower lumbar sections of the spine. Schmorl's nodes are frequently associated with IDD and are recognized as depressions on the upper or lower surfaces of the vertebral bodies (Rogers 2000). They are most common in the lower thoracic and lumbar regions (Waldron 2009).

Archaeological studies focus on the description of joint disease prevalence in the past populations, e.g., spondylosis in the cervical spine in individuals from medieval Germany (Weber et al. 2003). Some studies present methodological approaches to degenerative joint disease (DJD); for example, Yustos et al. (2021) analysed DJD in spines including IDD from comingled remains. There are also studies that focus on biocultural approaches to DJD. For instance, Sofaer Derevenski (2000) discussed whether gendered division of labour had an impact on sex differences in the distribution of osteophytosis of the vertebral bodies and vertebral DJD in medieval Wharram Percy (England) and modern Ensay (Scotland). Kinkopf et al. (2021) investigated whether economic access influenced vertebral osteophytosis and vertebral osteoarthritis at rural late medieval Villamagna in Italy. Plomp (2017) adopted a theoretical approach in discussing how pathological changes causing back pain may have led to disability without, however, presenting case studies. There is a need to take the next step forward and move beyond the description of DJD and IDD of the spine to investigating the problem of its impact on disability and quality of life. Domett et al. (2017) presented the impact of osteoarthritis in peripheral joints on quality of life and disability using materials from prehistoric Thailand. However, there is a need to conduct such studies for spinal DJD including IDD. This article aims to (re)construct the impact of spinal disease with special emphasis on IDD on the quality of life and possible impairment or disability of an individual from medieval and early modern Poland.

There are bioarchaeological grading systems for osteophytosis of vertebral bodies (Sofaer Derevenski 2000; Weber et al. 2003; Kinkopf et al. 2021; Yustos et al. 2021), but none have been compared to medical grading systems in assessing the impact of lesions on quality of life and disability. Medical studies link grades of spinal disc disease to chronic pain and disability. If we compare the bioarchaeological grading system for disc disease of the spine with the medical grading system, we gain insights into which disc disease grades visible on the bones may have led to pain and contributed towards disability in the past.

This article has several goals: 1) a methodological discussion of the medical and bioarchaeological grading systems for describing IDD in the spine; 2) a comparison of the bioarchaeological and medical grading systems to estimate the impact of IDD in the spine on the functioning of an individual and potential disability; 3) presentation of how IDD in the spine could have an impact on the life of an individual from the late medieval and early modern periods in Poland; 4) addressing through contemporary medieval and early modern Polish literature whether back pain was recognized as an impairment or disability in Poland at that time. This article is deeply grounded in palaeopathological, medical, archaeological and historical research, and thus has both an interdisciplinary and biohumanistic dimension. This study has value for archaeological research because it moves beyond palaeopathological description and facilitates an understanding of its potential impact on past human lives from the perspective of those societies in which individuals lived rather than imposing modern perceptions of what constituted disability in the past.

Methods

Age and Sex Estimation, Stature

Biological sex was estimated by examining the morphological characteristics of the pelvis and cranial morphology (Phenice 1969; Buikstra and Ubelaker 1994; Klales et al. 2012). Age-at-death was estimated by assessing morphology of the pubic symphysis, auricular surface and cranial sutures using Transition Analysis 2 (Boldsen et al. 2002). Palaeopathological analysis followed Buikstra and Ubelaker (1994). Stature was estimated using the Breitinger method (1937).

The Bioarchaeological Intervertebral Disc Disease Grading System

In the case of the spine, degenerative changes include both the diarthrodial and the amphiarthrodial joints. The last-mentioned involves intervertebral disc degeneration, which is characterized radiologically by the presence of osteophytes, endplate sclerosis, and disc space narrowing. In clinical studies disc space narrowing is the most frequently investigated radiographic feature, while osteophytes and end plate sclerosis are least often studied (Raastad et al. 2015). In archaeological investigations osteophytes and pitting on the inferior or superior surface of the vertebral bodies are most commonly examined to assess IDD (Waldron 2009). Disc space narrowing cannot be observed in osteological material, and thus it cannot be investigated in archaeology. This presents a disadvantage in a palaeopathological study.

Osteophytes are formation of bony spurs of initial horizontal orientation extending from vertebral bodies. Horizontally oriented osteophytes develop on the anterior margin of the vertebral body to stabilize the compromised disc joint. The development of vertebral osteophytes is related to age, sex and physical activity. Intervertebral disc degeneration involves changes in “disc composition and biochemistry, as well as accumulated tissue damage due to multiple age progressive stressors, including avascularity resulting in oxidative injure, high magnitude mechanical compression at high frequencies or for prolonged duration, and depleted cellular waste disposal due to acidic, hypertonic, and/or oxidative joint microenvironment” (Kinkopf et al. 2021: 501). Research suggests “there is a complex series of cellular mechanisms central to a cycle of phenotypic change in the disc and centra, affecting and affected by the amplification of inflammatory pathways and sensitization via neutrophils and other inflammatory mediators […]. The initiation of degenerative changes in the spine likely occurs due to a combination of these stressors and progresses in a positive feedback system” (Kinkopf et al. 2021: 501). Severe cases are marked by vertically oriented osteophytes, which may articulate or fuse to form a bony bridge with adjacent disc. Osteophytosis “tends to produce ‘shelf-like’ protrusions and irregular or undulating fusion” (Buikstra and Ubelaker 1994: 121).

Clinically, many classifications and grading systems have been developed that define the advancement of degenerative changes, depending on the deformation of the anatomical structures of the affected joint. Among all available grading systems based on macroscopic anatomy, plain radiography, histology, magnetic resonance, discography imaging, those concerning plain radiography and magnetic resonance imaging

(MRI) are the most useful for bioarchaeologists because they estimate the size of osteophytes, as in bioarchaeological grading systems. Because clinicians investigate living people and do not have direct access to bones, the grading systems used in medicine have been designed to assess X-ray images, while the grading systems used in palaeopathology are oriented to a greater extent for direct examination. Currently, a frequently used grading system in medicine is the one proposed by Pfirrmann et al. (see Kettler and Wilke 2006); however, it is based on MRI signal intensity, disc structure, distinction between the nucleus and anulus, and disc height. Since soft tissues do not preserve, it is impossible to observe them in osteological materials and therefore it cannot be used accurately in bioarchaeological research.

Kettler and Wilke (2006) described 42 medical grading systems for the description of degenerative changes in the cervical and lumbar spine. They argue that the grading system proposed by Kellgren et al. (1963), which is based on radiography, is regarded as the best for assessing cervical disc degeneration because it has interobserver reliability as indicated by the Kappa Coefficient 0.71 (Kettler and Wilke 2006). It includes four grades of osteophytes, disc space narrowing and sclerosis expression (Table 1). We developed the Bioarchaeological Intervertebral Disc Disease Grading System (Table 1) and compared it with the medical grading system to estimate the degree of expression of IDD and its impact on the functioning of an individual. The Bioarchaeological Intervertebral Disc Disease Grading System (BIDDGS) elaborates on the grading system for osteophyte expression from the *Standards* by Buikstra and Ubelaker (1994). The osteophytes in the *Standards* (1994) have four degrees of expression: barely discernible, elevated ring, curved spicules and fusion present. The BIDDGS, which is used to describe the cervical vertebrae section of the spine, has five grades (grade 0 to 4) of osteophyte expression (Table 1; Fig. 1). In each case, we record the location of each lesion. The medical grading system by Kellgren et al. (1963) and the BIDDGS correspond as follows (Table 1). Kellgren et al. (1963) do not grade lack of lesions (grade 0 in BIDDGS). Grade 1 in both grading systems is comparable. Grades 2 and 3 for osteophytes according to Kellgren et al. (1963) may correspond to BIDDGS grade 2. Grade 4 according to Kellgren et al. (1963) corresponds to BIDDGS grade 3. Kellgren et al. (1963) do not distinguish ankylosis (BIDDGS grade 4). For a better comparability of the evaluation of the degree of osteophytosis, we defined grade 1 as a mild form, grade 2 as a moderate form and grades 3 and 4 as severe forms.

Kellgren et al. (1963) grading system		**Bioarchaeological Intervertebral Disc Disease Grading System (BIDDGS)**		
Grades	**Lesions**	**Grades**	**Osteophyte degree**	
		0	None	None
1	Minimal anterior osteophytosis	1	Barely discernible	Mild
2	Definite anterior osteophytosis with possible narrowing of the disc space and some sclerosis of vertebral plates	1	Sharp ridge, slight spicules extending horizontally	Moderate
3	Moderate narrowing of the disc space with definite sclerosis of vertebral plates and osteophytosis			
4	Severe narrowing of the disc space with sclerosis of vertebral plates and multiple large osteophytes	3	Extensive spicular formation	Severe
		4	Ankylosis	Severe

Table 1. Comparison of Kellgren et al. (1963) grading system with the Bioarchaeological Intervertebral Disc Disease Grading System (BIDDGS) for the cervical vertebrae.

Osteophytes are the most frequently observed radiological lumbar disc degenerative feature (de Schepper et al. 2010; Raastad et al. 2015). The medical grading system for describing thoracic and lumbar vertebral disc degeneration follows Lane et al. (1993; see Kettler and Wilke 2006). It is the most recommended among clinical grading systems because the only material needed are radiographs and it has a clear structure that can be very easily applied (Kettler and Wilke 2006). This grading provides a method for assessing the presence and severity of radiographic features (Table 2). Joint space narrowing, anterior and posterior osteophyte formation, and subchondral sclerosis should be assessed individually. Then, an overall grading is given from 0 to 2 (see Kettler and Wilke 2006):

Grade 0 = Normal joint (0 for osteophytes and narrowing)

Grade 1 = Mild (1) narrowing or mild (1) osteophytes

Grade 2 = Moderate-severe (2–3) narrowing and/or moderate-severe (2–3) osteophytes

The BIDDGS has the same grades for the thoracic and lumbar regions of the spine as for the cervical region. For the thoracic and lumbar regions, the medical grading system by Lane et al. (1993) and the BIDDGS compare as follows (Table 2). Grades 0 to 3 for osteophytes by Lane et al. (1993) correspond with BIDDGS grades 0 to 3 for osteophytes. The BIDDGS grade 4 describes ankylosis, which is identified in osteological material. The grading system by Lane et al. (1993) does not include ankylosis. For a better comparability of the evaluation of the degree of osteophytosis, we defined grade 1 as a mild form, grade 2 as a moderate form and grades 3 and 4 as severe forms (Fig. 1). It is impossible to investigate disc space narrowing in osteological material. For this reason, here, as in the cervical spine, the BIDDGS does not record joint space narrowing. This is contrary to medical grading system by Lane et al. (1993) that assesses disc space narrowing based on radiography.

Lane et al. (1993) grading system				**Bioarchaeological Intervertebral Disc Disease Grading System (BIDDGS)**		
Grades	**Joint space narrowing**	**Osteophytes anterior and posterior**	**Sclerosis**	**Grades**	**Osteophyte degree**	
0	None	None	None	0	None	None
1	Definite (mild) narrowing	Small	Present	1	Barely discernible	Mild
2	Moderate	Moderate	-	2	Sharp ridge, slight spicules extending horizontally	Moderate
3	Severe (complete loss of joint space)	Large	-	3	Extensive spicular formation	Severe
				4	Ankylosis	Severe

Table 2. The comparison of the Lane et al. (1993) grading system with the Bioarchaeological Intervertebral Disc Disease Grading System (BIDDGS) for the thoracic and lumbar vertebrae.

The BIDDGS has a compatible grading system with the medical grading system for thoracic and lumbar sections of the spine (Lane et al. 1993). The Kellgren et al. (1963) grading system for the cervical section of the spine is less in line with the BIDDGS in terms of described degrees of degenerative changes.

There is a less detailed, three-grade scale (Weber et al. 2003) for IDD than the BIDDGS. Sofaer Derevenski (2000) uses five-graded scale for IDD. Yustos et al. (2021) distinguish five degrees of osteophytes: 0 – not present, 1 – slight, 2 – moderate, 3 – bony spurs, 4 – ankylosis, that are similar to those from the BIDDGS, because they also refer to the *Standards* (Buikstra and Ubelaker 1994). Kinkopf et al. (2021) have presented an elaborated scale with seven scores. However, for the purpose of statistical analyses, the seven scores were combined into “low severity” and “high severity”. The BIDDGS presents a moderate number of degrees of lesion expression which is feasible for qualitative and quantitative (statistical) analyses. Moreover, the advantage of the BIDDGS is that it corresponds with the clinical medical grading system (Lane et al. 1993) for the assessment of thoracic and lumbar IDD, which allows easy comparison and assessment of the impact of lesions on the experience of pain and quality of life of an individual. We discuss this issue below.

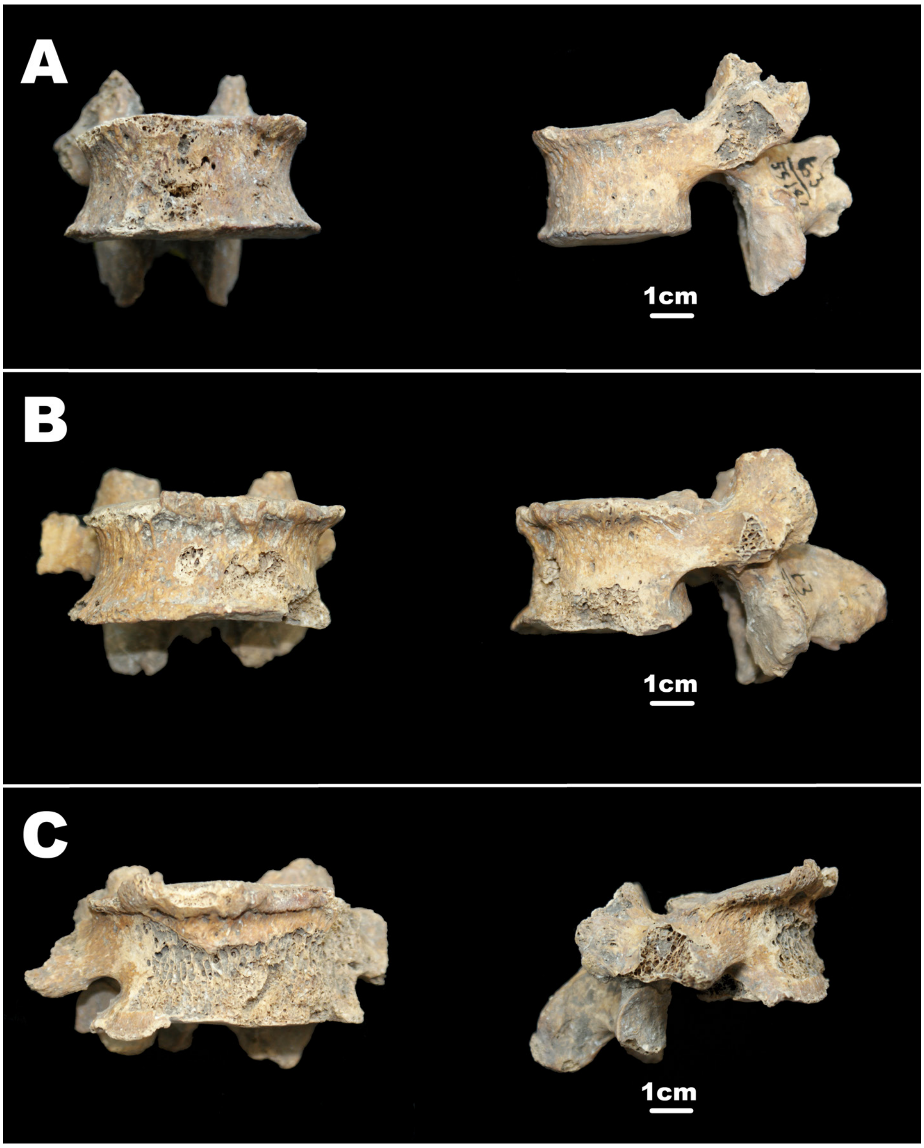

Fig. 1. Intervertebral disc disease grades based on the Bioarchaeological Intervertebral Disc Disease Grading System (BIDDGS). A – barely discernible osteophytes observed in a lumbar vertebra (grade 1). B – sharp ridge, slight spicules of osteophytes extending horizontally on the anterior and left superior aspect of the body of a lumbar vertebra (grade 2). C – extensive spicular osteophyte formation observed on the right superior and the inferior aspects of the body of a lumbar vertebra (grade 3) (photo by M. D. Matczak).

Functional Impact of Intervertebral Disc Disease

Clinical studies show that disc space narrowing in the lumbar section of the spine according to the Lane et al. (1993) grading system causes LBP and leads to disability (de Schepper et al. 2010). Moderate and severe grades (grade 2 and 3) of osteophytes in the lumbar section of the spine have been shown according to Lane et al. (1993) to lead to temporary and chronic LBP (de Schepper et al. 2010). Other studies indicate that osteophytes, end plate sclerosis, and facet joint osteoarthritis have a weak or non-significant association with LBP (Raastad et al. 2015). Thus, studies show contrary results regarding an impact of osteophytes: association between them and LBP or no association (de Schepper et al. 2010). For this reason, osteophytes are problematic features to assess IDD impact on the functioning of an individual. Disc space narrowing, which is a reliable feature to assess pain, cannot be identified in osteological material. However, the fact that clinical studies show that the presence of large osteophytes is associated with disc depression, which results in pain (Fujiwara et al. 1999; Pye et al. 2007) might suggest that osteophytes might be still used for assessment of pain. In addition, if a person had osteophytes on at least one vertebra, other vertebrae also had osteophytes (Weiler et al. 2012). This helps bioarchaeologists to assess the impact of IDD on the function of an individual by observing osteophytes especially in cases when only a few vertebrae are preserved. Increasing severity of each radiographic feature of lumbar IDD (osteophytes, end-plate sclerosis, disc space narrowing) is associated with increasing severity of those mentioned features. In sum, grades 2 and 3 by Lane et al. (1993) are the same as grades 2 and 3 of the BIDDGS (Table 2). Thus, grades 2 and 3 of the BIDDGS may be characterized by temporary and chronic back pain in the lumbar section. Grade 3 – extensive osteophyte formation on vertebral body – can cause chronic pain. However, medical clinical research does not show that grades 2 and 3 of osteophytes lead to disability (de Schepper et al. 2010). Grade 4 (joint fusion) can result in an inability to move or bend the affected spine section. Ankylosis can have a significant impact on the development of disability. Thus, grade 4 on the BIDDGS may indicate a disability in the modern sense. Medical grading systems also assess facet joint degeneration (Kettler and Wilke 2006). IDD and facet joints osteoarthritis are interdependent; lesions that affect the disc tend to have an effect on the facet joints, "and trauma or instability of the posterior structures may in turn affect the disc" (Gellhorn, Katz and Suri 2013: 4). Ankylosis between the facet joints also leads to immobilization of the joints and together with ankylosis of the vertebral bodies may lead to disability.

Smaller gaps between vertebrae, osteophytes and abnormal spine curvature might cause pinching of nerve structures (e.g., spinal roots that give rise to peripheral nerves), which is manifested by pain in the areas innervated by the compressed structures. Regardless of the location of the degenerative process, pain is the leading symptom, and its intensity increases with the development of the disease, which gradually reduces the joint function and leads to progressive disability. Many publications from orthopaedics and rheumatology (e.g., studies by the Australian Institute of Health and Welfare) indicate that degenerative changes in the spine are often associated with severe pain and reduced fitness of the patient. They lead to localised pain that intensifies initially after exercise and then reappears with any movement and during rest. The pain is caused by the compression of the roots of the sensory spinal nerves. The development of the degenerative process within the spine leads in most cases to the reduction of the space available for the nervous structures and the increasing pressure on these structures. This causes both local pain, the starting point of which is the affected anatomical structures of the spine, and also the pain coming from the compressed nerve roots. The other type of ailment is pain radiating along the area innervated by the compressed root, for example to the limbs or the neck. DJD in the cervical spine might cause headaches (Persson et al. 2007). IDD in the lumbar spine can also cause pain in the hip joint (de Schepper et al. 2013). In more advanced cases, there are so-called "deficient symptoms" (sensory disturbances, tingling, muscle weakness) resulting from the limitation of the functions of the roots as a result of their compression by the surrounding connective tissue structures. Degenerative changes in vertebral discs and back pain are the most common causes of chronic pain, i.e., pain that lasts more than a year (de Schepper et al. 2010). Episodic spinal pain associated with disc degeneration can also be observed (Pye et al. 2007).

The above-mentioned studies show that DJD is a major problem that impacts quality of life, causes chronic pain and leads to disability, with degenerative changes in vertebral joints and back pain being the most common causes of chronic pain. The medical grading system by Lane et al. (1993) was used in a clinical study that assessed how osteophytes in the lumbar section of the spine impact lower back pain (de Schepper et al. 2010). The study by de Schepper et al. (2010) showed a correlation between grade 2 and 3 of osteophytes by Lane et al. (1993) and pain. Since grades 2 and 3 of the BIDDGS are the same as grades 2 and 3 by Lane et al. (1993), they may be characterized by temporary and chronic back pain in the lumbar section, and grade 4 of the BIDDGS may indicate a disability. Other researchers (e.g. Weber et al. 2003; Kinkopf et al. 2021; Yustos et al. 2021) present the bioarchaeological grading systems without presenting how they correspond with medical grading systems. Thus, the advantage of BIDDGS is that it corresponds with the medical grading system by Lane et al. (1993) for a thoracic and lumbar section of the spine, which makes it reliable in the studies about pain, quality of life and disability in the past. For this reason, we named it the Bioarchaeological Intervertebral Disc Disease Grading System.

We now explore whether IDD could have led to impairment and disability in late medieval and early modern Poland through the use of contemporary texts and osteological analysis using the BIDDGS on an individual as case study.

Exploring Disability and Impairment in Late Medieval and Early Modern Poland

Disability and Impairment in Texts

A hagiography of Saint Hedwigis from Wrocław (*Vita Beatae Hedwigis* 1993) from the 14th century states that many people suffered from so-called "cramps" and "stiffness" that made them unable to move or made life extremely difficult. *Vita Beatae Hedwigis* (1993: 101) indicates that a woman from the northern part of Poland:

> "[...] was so unusually distorted by contraction that whenever she had to move, her breasts touched her knees. [...] God added another miracle to this miracle: because the aforementioned woman, having recovered, returned to the places where she was known, and it turned out that she was much more beautiful than before, when she was seen as an invalid" (translated by M. D. Matczak).

It is not known, however, whether this was due to degenerative changes or diseases of the nervous system or another condition. It is worth noting that some of the people were treated well by their families and some of them were rejected. Many people affected by "cramps" were engaged in begging in the streets outside churches (*Vita Beatae Hedwigis* 1993). The loss of body parts as a result of fighting or punishment was regarded as an impairment in the Middle Ages in Poland (Matczak 2020).

Taking care of the sick and the poor was also the duty of the rulers and the powerful. For example, Jan Długosz (2004: 414) reports that Queen Zofia (1405–1461) was generous towards "unhappy people". Being sick was the reason for seeking healing, as seen above in the example of a woman with contraction, at the tombs of saints or during the lifetime of people later declared saints. For example, Saint John of Capistrano, a famous Catholic priest and preacher, healed many sick, blind, lame, and paralyzed and others suffering from weaknesses upon his visit in 1453 in Kraków (Długosz 2004).

Care for the sick continued into later times. For example, Oskar Kolberg (1890: 35), the eminent Polish ethnographer, states that in the 19th century, almost every village and manor house had "its poor, their louts and cripples unable to work, whom it feeds when mercy commands to support them" (translated by M. D. Matczak). On the other hand, at the turn of the 19th and 20th centuries, rural witch doctors were elderly, often physically impaired people, "thus arousing fear and disgust with their appearance alone" (Jaguś 2002: 55). The abovementioned texts show that the concept of physical difference and impairment associated with back problems was present among people inhabiting Poland in the late medieval and modern periods.

Łekno in Medieval and Early Modern Period

The individual we present as a case study was discovered at a cemetery associated with the Cistercian Order in Łekno. The Cistercians developed from the Benedictines in the 11th century in France and created a new form of monastic life, emphasizing the original monastic principles presented by Saint Benedict of Norcia (Eberl 2007; McGuire 2012; Wyrwa 2017a). They provided spiritual advice, developed gothic architecture and painting, established libraries, and contributed to the development of theology. Cistercians did pioneering work on inhabiting deserted places, cutting down forests, and expanding cultivation. They introduced "more effective agricultural methods and new varieties of plants and animals to improve the yields" (Jamroziak 2012: 66). Despite assigning them the role of "pioneers of the wastelands" or "bearers of Gothicism", they were an Order that skilfully matched the settlement, economic and cultural structures of the countries where they settled (Dobosz and Wyrwa 1999).

The oldest Cistercian abbey in Poland was located in Łekno within the former stronghold by Łekno Lake (Fig. 2). The foundation document of the Cistercian monastery in Łekno, according to which Zbylut from the Pałuk family established the monastery in 1153, is the oldest such surviving record in Poland. Therefore, it was entered on the Polish National List of the UNESCO Memory of the World Program (Wyrwa 2016). Initial stages in founding the abbey lasted from about 1143 to 1153. The first monks came from Altenberg near Cologne in Germany to Łekno around 1150, taking part in the construction of the monastery built for them by the founder (Wyrwa 2002, 2018). The first Cistercian sacred building – the oratory – was erected by 1153 by Zbylut. Initially, the church, in accordance with the rules of the Cistercian Order, was named after the Blessed Virgin Mary, keeping the call of Saint Peter, which belonged to an earlier church that functioned in the stronghold (Wyrwa 2000, 2007). In the mid-13th century, the church was rebuilt, expanded and named after the Blessed Virgin Mary and Saints Peter and Paul. A church surrounded by a cemetery was thus in use from the 13th century. Cistercian monks from Łekno played a central role in spreading Christianity, e.g., they started a Christianization mission in Prussia in 1205 (Wyrwa 2006). An individual from a grave discovered in the presbytery was unequivocally identified as an abbot Herman who was a chaplain, confessor, trustee and collaborator of the 14th century king of Poland, Casimir the Great (Wyrwa 2010; Wyrwa and Miłosz 2006). The abbey in Łekno was one of the richest and fastest developing Cistercian abbeys in Poland in the second half of the 14th century. However, the church experienced engineering and technical problems. The structure was seriously damaged due to a long period of subsidence (Wyrwa 2017b). For this reason, an abbot known as Tylman decided to move the abbey from Łekno to nearby Wągrowiec at the end of the 14th century (around 1396). The process of moving the abbey ended in 1493.

The Cistercians from Łekno and Wągrowiec looked after sick people, as shown in their *Chronicle of Wągrowiec* (*Kronika wągrowiecka* 2004) covering the years 1153–1592. Under the heading for the year 1488, there was a note about the income for the sick, established by the abbot: "Income for the sick is granted, namely the tithe from Moraków and Czerlin, every year three stones from the city's tallow and hemp from the village of Tarnowo. Whoever breaks these arrangements is excommunicated. [Signed]: Jan, abbot of Wagrowiec, and abbots: Jan from Paradyz and commissioner Andrzej, from Bledzewo." (translated by M. D. Matczak). This was according to the Order's rules that focused on charity.

The place of the former monastery in Łekno was still under the patronage of the Łekno-Wągrowiec Cistercians (Wyrwa 2011), and a chapel of unknown name with a cemetery was established on the remains of the old abbey church around 1450 (Wyrwa 2018). The cemetery was used as burial place of the local community from the Tarnowo Pałuckie parish which was located about 800 m away from the church. The cemetery was in use until the end of the 16th century. In 1620 the chapel and cemetery were abandoned, and in the 19th and 20th centuries, it became an agricultural field (Wyrwa 2018).

The excavations of the abbey, church, chapel and cemetery took place between 1982 and 2007 in the framework of the Łekno Archaeological Expedition lead by Andrzej Marek Wyrwa. A cemetery at site 3 (see Fig. 1), which is where individual Ł3/55/82a was found, contained around 400 burials of monks and local people from villages belonging to the Cistercians. The preliminary osteological analyses concerning sex and age estimation, palaeopathology and stature have been carried out (Miłosz 2000). The analyses on 169 adult individuals, including 91 males, 54 females and 24 individuals of unknown sex, indicated that the average stature of males was 173.2 cm and of females 162.7 cm. Pathological lesions included fractures, new bone formation and developmental changes. The preliminary results indicated degenerative disease in 56 (69%) out of 196 individuals, which included osteophytes and Schmorl's nodes on lumbar vertebrae and hypertrophic changes in shoulder joints (Miłosz 2000). Ł3/66/90 individual was distinctive because he had skeletal dysplasias such as achondroplasia and Léri-Weill dyschondrosteosis and ulnar hemimelia (Matczak et al. 2022). Advances in clinical and osteological research over more than 20 years since the preliminary analysis as well as new findings of skeletons at the site since the publication of the preliminary research have stimulated ongoing re-evaluation (e.g. Matczak et al. 2022). Moreover, the comprehensive analysis of the cemetery including archaeological findings have not been conducted so far. Here we present a skeleton analysed as part of a new comprehensive analysis of osteological and archaeological materials and a cemetery.

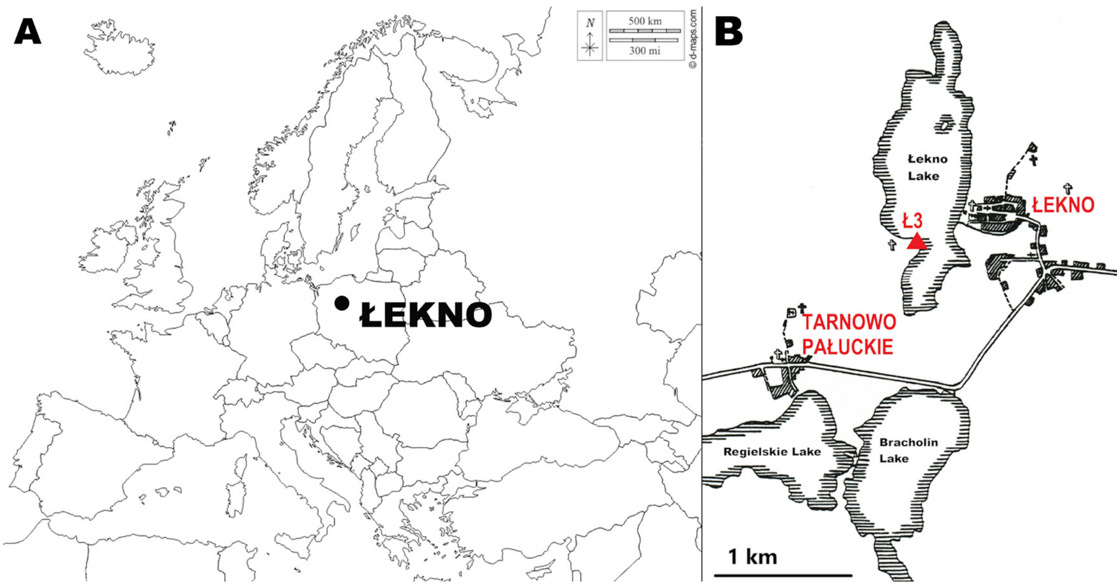

Fig. 2. (a) Location of Łekno in Poland (www.d-maps.com). (b) Location of the Łekno 3 site (Ł3 – Cistercian abbey and cemetery) and Tarnowo Pałuckie (Archive of the Łekno Archaeological Expedition).

Ł3/55/82a from Łekno: An Adult Male with Intervertebral Disc Disease

Individual Ł3/55/82a was found in grave 10 at a cemetery in site 3 in Łekno. This individual had moderate and severe IDD in the thoracic and lumbar section of the spine, which might be associated with chronic pain. In the following sections we consider if his ailments were perceived as disability in the past.

Os coxae morphology such as ventral arc, subpubic concavity and ischiopubic ramus ridge as well as cranial morphology such as supra-orbital ridge and mental eminence suggest Ł3/55/82 was a male. Nuchal crest and mastoid process are ambiguous. Supra-orbital margins are more characteristic for female. Os coxae morphology is the most reliable for sex in the human skeleton (Buikstra and Ubelaker 1994), and therefore we conclude that Ł3/55/82a was a male. Due to the fact that aging processes do not progress in the same manner for all individuals, it is difficult to exactly estimate age-at-death for middle and old adults. Transition Analysis 2 (Boldsen et al. 2002) gives interval range and a maximum likely age, and therefore it is one of the best available methods. A maximum age likelihood estimate was 38.6 years at the time of death for Ł3/55/82a (29.3–55.5 years old, 95% interval range). Appendix Table 3 presents stages of morphological changes of Ł3/55/82a estimated within the Transition Analysis 2. Initial bony changes used in the Transition Analysis 2 are of developmental nature: e.g., the ventral rampart at the pubic symphysis. Later changes, such as breakdown of the pubic symphysis, are degenerative. Exostoses on auricular surface of Ł3/55/82a are degenerative in nature and are traits used for age estimation. The stature of Ł3/55/82a was 174 cm (Breitinger 1937), which was an average height for males in Łekno (Miłosz 2000).

Based on the analysis of stratigraphy, the skeleton is dated from the 14th to the end of the 16th century AD. Ł3/55/82a was buried close to the northwest corner of the Cistercian church and a chapel of unknown name. He was interred on the SW-NE axis as were the majority of individuals on the site. The individual was buried in a supine position with the left upper limb positioned along the body (Fig. 3). The hand bones of the left upper limb were located under the pelvis. The hand bones of the right upper limb were not found. There were no grave goods. Traces of wood decay under the skeleton along almost the entire length, an iron nail and a coffin fitting (element connecting the coffin boards) with an iron nail fragment indicate that he was buried in a coffin (Mucha, Piontek and Widelska 1986). At the cemetery, only a minority of individuals were buried in coffins or other grave constructions. Overall, however, grave of individual Ł3/55/82a appears to be a typical according to the ritual of that time. Only four individuals at Łekno 3 site were buried in atypical or so-called anti-vampiric graves (Wyrwa 2008). This suggests Ł3/55/82a was properly commemorated after death according to the burial customs at that time.

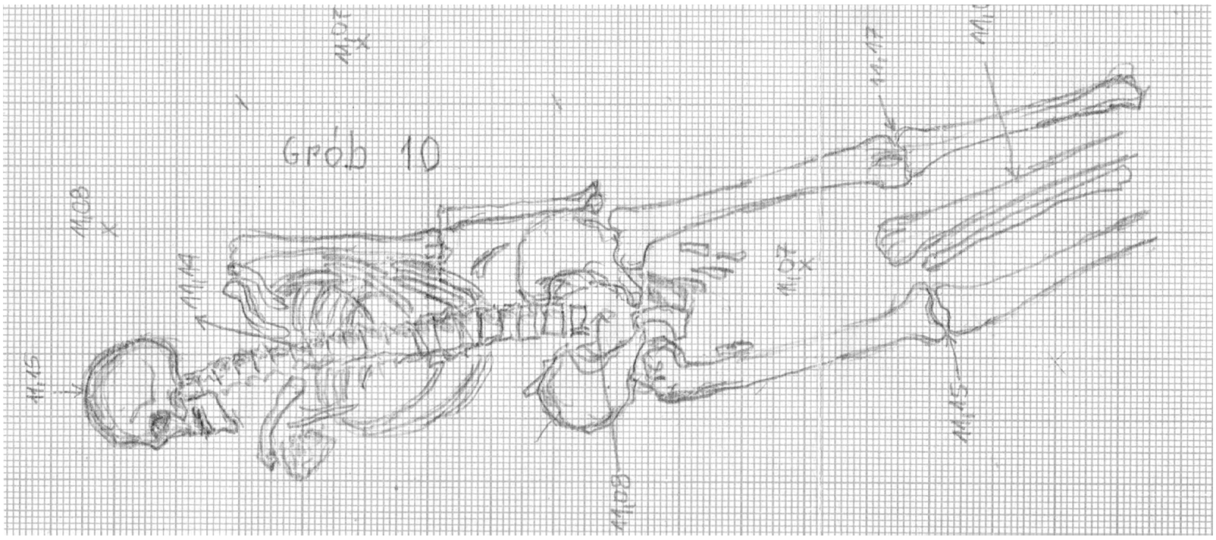

Fig. 3. Grave 10 with Ł3/55/82a individual at site 3 in Łekno, Poland (by L. Fijał, Archive of the Łekno Archaeological Expedition). Note that the drawing does not present all unearthed bones of Ł3/55/82a.

The skeleton displays two abscesses on the right maxilla and a small amount of calculus on the right upper premolars and third molar. Healed porotic hyperostosis is present on the parietal and the frontal bones. Ossification of the costal cartilages of both first ribs is visible. The left clavicle displays an antemortem complete fracture at midshaft, which was healed and stable at the time of death. The bone was misaligned, and the acromial end was rotated for around 90 degrees inferiorly. The rotation together with malunion and new bone formation caused deformity of the clavicle. The left clavicle was 13 mm shorter than the right one. Myositis ossificans of the tibialis posterior muscle is visible on the right tibia on the lateral aspect of the diaphysis, lateral to the nutrient foramen and in the 1/3 of medial diaphysis of the right fibula.

Osteoarthritic changes were observed on proximal and distal ends of both humeri, the heads of both radii, the proximal ends of both ulnae, certain carpals (both scaphoids, lunates, capitates and hamates), the acetabulum of both os coxae, the distal end of the right femur, the distal end of both tibiae, and on the left calcaneus.

Appendix Table 4 and Fig. 4–6 present mild, moderate and severe osteophytic lesions and pitting on vertebral bodies, which indicate IDD, and pathological lesions in the facets and costovertebral joints, which indicate osteoarthritis (Waldron 2009). Schmorl's nodes might be associated with IDD (Rogers 2000). Ethesophytes (T6–T9) on the right anterior aspect of vertebral bodies might indicate other diseases (Fig. 4).[1] Florid ossification into the anterior longitudinal ligament on the right side in the thoracic region or any other region of the spine is characteristic of diffuse idiopathic skeletal hyperostosis (DISH), which has been associated with metabolic disease and diet (Foster et al. 2018; Waldron 2019). Modern clinical diagnosis "requires the presence of four contiguous fused vertebrae with extraspinal enthesophytes" (Waldron 2019: 730). However, palaeopathological cases might not have four continuous fused vertebrae because the condition was not fully developed or due to post-mortem damage. Ł3/52/82a does not have fused vertebrae. However, T9 and T10 show signs of post-mortem damage in locations of extensive spicular formation. Fragile bones might have broken during the excavation, cleaning, and further processing. Therefore, we cannot exclude that they were fused. Foster et al. (2018) indicate that evidence for the anterior longitudinal ligament ossification, vertebral ankylosis or bilateral enthesophytes at the olecranon, patella, tibial tuberosity or posterior calcaneus of at least grade 2 development are markers of possible DISH. DISH is age-related, appears in individuals over 40 years old and is more common in men than women (Foster et al. 2018). Since Ł3/55/82a was male aged probably under 40 at the time of death, had ossification of the anterior

1 Enthesophytes are oriented vertically, form within the anterior and posterior longitudinal ligaments and show a "flowing' pattern" (Buikstra and Ubelaker 1994).

longitudinal ligament on T6–T9 and bilateral enthesophytes, he could possibly have had DISH. However, the preservation of the material and the similarity in the pattern of skeletal changes make it difficult to conclude with certainty. Ankylosing spondylitis, fluorosis, reactive arthropathy and psoriatic arthropathy should be excluded from differential diagnosis because Ł3/55/82a does not display pathognomonic lesions of these conditions (Appendix Table 5). Therefore, we conclude that Ł3/55/82a had IDD, osteoarchritis in the facet and costovertebral joints and possibly early stages of DISH. IDD, DISH and osteoarthritis might coexist (di Girolamo et al. 2001; Rogers and Waldron 2001; Mader et al. 2009). The sacrum of Ł3/55/82a has a sharp ridge of slight spicules of osteophytes extending horizontally on the promontory.

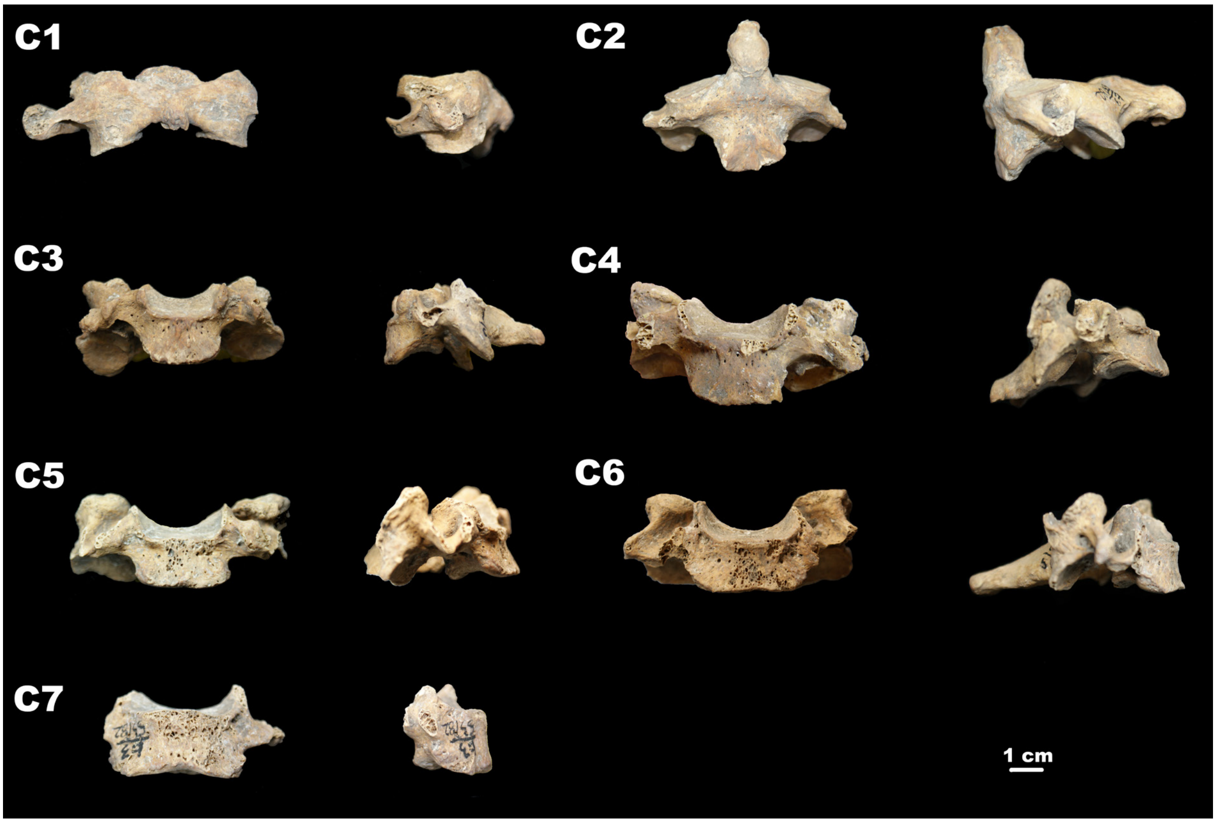

Fig. 4. Pathological lesions observed in the cervical vertebrae of Ł3/55/82a. C1–C3, C5–C7: none osteophytes (grade 0 based on Table 1). C4: mild grade of osteophytes (grade 1 based on Table 1). Fragmented spinous processes and transverse processes were not photographed (photo by M. D. Matczak).

Individual Daily Life, Identity and Social Perception

We do not know whether Ł3/55/82a dates to the 14th–15th century (Late Middle Ages) and therefore was a monk or to the mid-15th–16th century (early modern period), when he would have been a local lay person. However, the analysis of the stratigraphy of the site indicates that he lived in the early modern period. In this case he most likely was a peasant and belonged to a village from Tarnowo Pałuckie parish that was part of the Cistercian property. The life of Cistercian monks, their lay brothers and peasants involved physically hard work.

Peasants were the largest social group – constituting 69.5% of society – and were of the lowest social standing in Poland (Wyczański 1986). Polish villages were diverse and had many types of inhabitants. Polish "kmieć" – a peasant who had a farm – was the most frequent type of villager. The others did not own land and farms. There were also owners of inns, mills, craftsmen, and fishermen, but we do not know which type of peasant Ł3/55/82a was. Children in villages were meant to work from early years, so Ł3/55/82a was probably helping his parents in childhood. The rights of peasants started to be reduced in the 15th and 16th centuries. One of the examples of restricted rights was a ban from leaving a village. Only one peasant could leave a village per year. It is probable that Ł3/55/82a was local or came from a nearby village.

Healed porotic hyperostosis on the parietal and the frontal bones of Ł3/55/82a could be associated with megaloblastic anaemia (Walker et al. 2009). Healed lesions indicate that the condition was not active at the time of death, however, its duration is unknown. Two abscesses on the right maxilla of Ł3/55/82a could have led to severe pain, difficulty in swallowing, facial swelling and even fever (Górski 1983; Roberts and Manchester 2010).

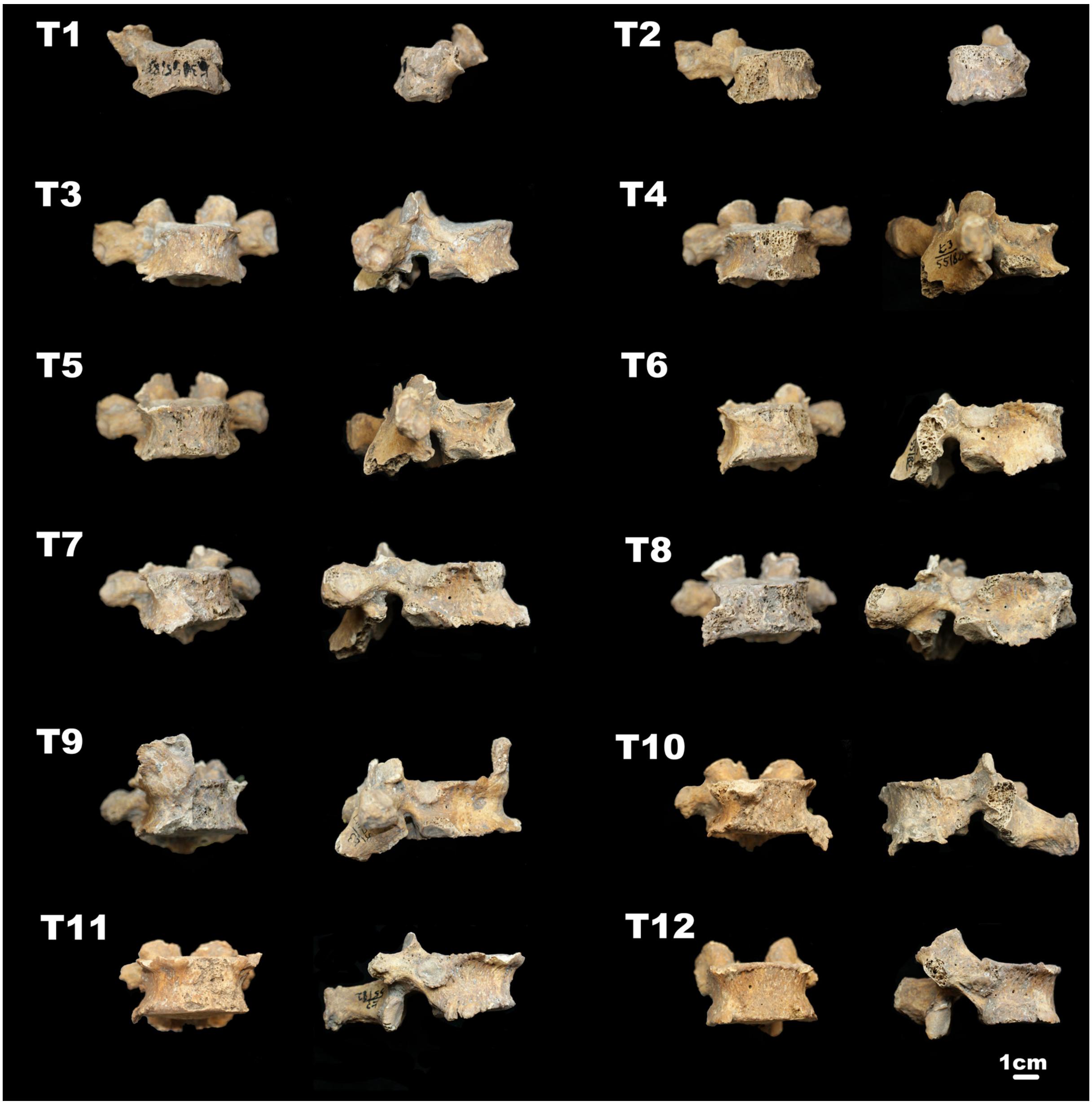

Fig. 5. Pathological lesions observed in the thoracic vertebrae of Ł3/55/82a. T6: none of osteophytes (grade 0 based on Table 2). T1–T2, T4, T7–T10, T12: mild grade of osteophytes (grade 1 based on Table 2). T3–T5, T10, T11: moderate grade of osteophytes (grade 2 based on Table 2). T10: severe grade of osteophytes (grade 3 based on Table 2). T6–T9: enthesophytes. Fragmented spinous processes and transverse processes were not photographed (photo by M. D. Matczak).

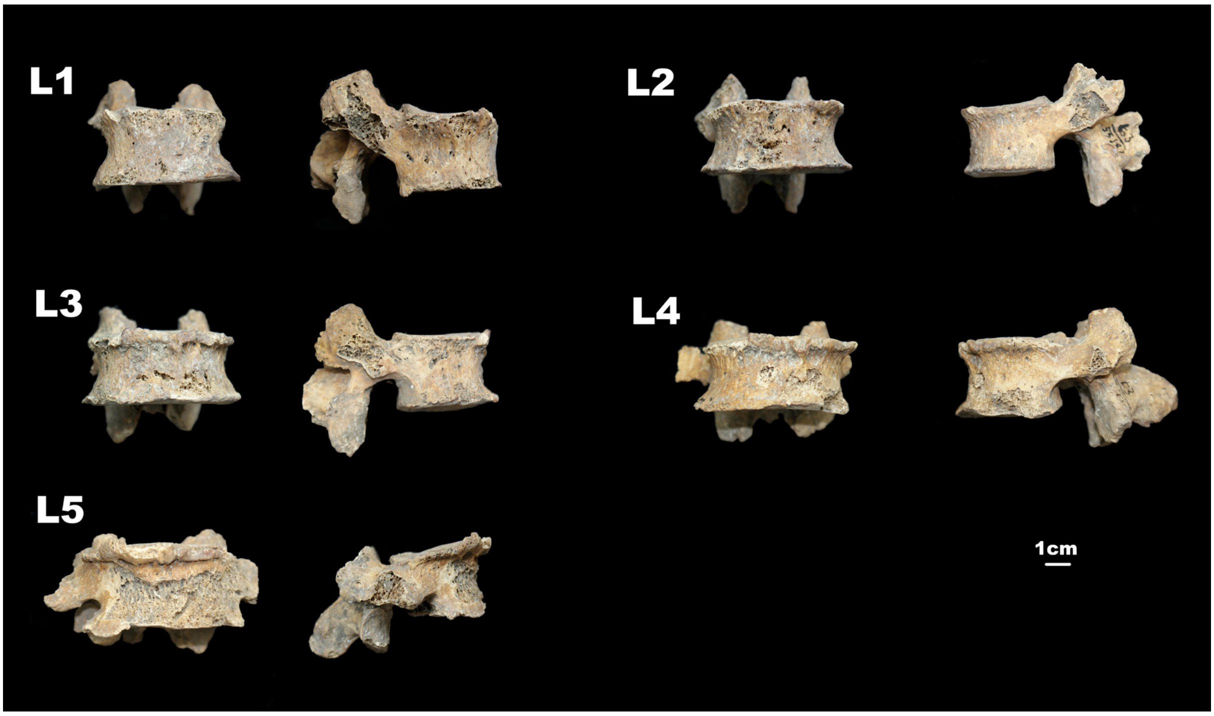

Fig. 6. Pathological lesions observed in the lumbar vertebrae of Ł3/55/82a. L1–L2: mild grade of osteophytes (grade 1 based on Table 2). L3–L4: moderate grade of osteophytes (grade 2 based on Table 2). L5: severe grade of osteophytes (grade 3 based on Table 2) (photo by M. D. Matczak).

Ł3/55/82a could have broken his clavicle as a result of falling onto the shoulder or a horse-riding accident (see Burnham et al. 2016). The fracture was stable and healed. The fractured bone was misaligned, which caused deformity, and it was 13 mm shorter than the right one. According to clinical medical studies malunion may lead to pain, loss of strength, rapid fatigue, paraesthesia of the arm and hand, problems with sleeping on the back, and cosmetic complaints (Hillen et al. 2010). While Ł3/55/82a would have had discomfort initially, it is unknown if he had the aforementioned symptoms. The fracture would probably cause pain and limit his various activities until healing occurred after a couple of months. During his short-term convalescence after breaking his clavicle, if he was a monk, he may have been cared for by monks, as the Order was obliged to be charitable and to care for others (McGuire 2012). If he was a peasant, he could have been cared for by his family. Myositis ossificans of the tibialis posterior muscle in Ł3/55/82a could be a result of trauma to the muscle. According to medical research, it might cause pain and stiffness of the knee joint and some functional limitations (Nieuwenhuizen et al. 2020), however, we do not know if this was the case in this individual.

Degenerative changes could be age-related and develop as a result of physical work. IDD in the thoracic and the lumbar part of the spine could have caused sporadic pain during early stages of the disease. This could have made working difficult although still possible. Osteophytes of grade 2 in the lumbar section may be characterized by temporary and chronic back pain. As time passed, DJD could significantly limit his functioning and performance of duties that required the use of force: e.g., cutting down trees, ploughing fields, growing crops, raising livestock or performing craftsmen's work (for peasants' daily activities, see Markiewicz 2004). He would have had problems engaging in tasks that required a lot of strength. When DJD advanced, extensive spicular formation of osteophyte on T10 and L5 body might have caused chronic, severe pain, however, it is unknown if this would have prevented the individual from performing heavy duties for a significant period of time. Schmorl's nodes cause pain in some individuals, whereas in others they do not (Williams et al. 2007; de Schepper et al. 2010). However, clinical research shows that ≥1 Schmorl's nodes on lumbar vertebrae and ≥2 Schmorl's nodes on thoracic vertebrae can cause pain and stiffness in a particular joint (Williams et al. 2007; Faccia and Williams 2008). Plomp (2017) discusses studies that have shown evidence that Schmorl's nodes cause pain. Thus, we consider the presence of ≥1

Schmorl's nodes on lumbar vertebrae and ≥2 Schmorl's nodes on thoracic vertebrae as indicators of pain, which has an impact on the quality of life of an individual. Ł3/55/82a had Schmorl's nodes on T3–T12 vertebrae which could have contributed to back pain. Cervical and lumbar facet joint osteoarthritis can cause spinal pain that can radiate to neck and limbs (Gellhorn, Katz and Suri 2013). It is possible that facet joint osteoarthritis contributed to back pain in Ł3/55/82a. DISH might be an asymptomatic condition as well as lead to pain, back stiffness, limited range of spinal motion, paraplegia and increased susceptibility to unstable spinal fractures after trivial trauma (Rogers and Waldron 2001; Mader et al. 2009). Since possible DISH was early in Ł3/55/82a, he could have felt some kind of stiffness related to the anterior lateral ligament ossification in T9 and T10, but it is unknown if he had other ailments. All those lesions had an impact on back problems and functioning and performing tasks by Ł3/55/82a. Enthesopathies may probably be responsible for a reduced range of motion in joints and possibly also for the subsequent development of osteoarthritic changes (Mader et al. 2009).

Ł3/55/82a could have benefited from the income for the sick granted by the monks, especially because it was granted from the proceeds of hemp production in the village of Tarnowo (*Kronika wągrowiecka* 2004) to which parish he belonged. The Cistercians from Łekno established income for the sick, as mentioned earlier in this text (*Kronika wągrowiecka* 2004), after they found a new monastery in nearby Wągrowiec. People who were obliged to donate to the sick but did not do this, could have been excommunicated (*Kronika wągrowiecka* 2004). Excommunication is the highest ecclesiastical punishment consisting in exclusion from the life of the Church. This indicates that the Cistercians did not hesitate to use the highest church punishment for those who did not want to support the sick.

Discussion

Back Pain and Disability in the Past

Of eight analysed chronicles and hagiographies from medieval Poland, none explicitly describe back pain as impairment or disability (Matczak 2020). Certainly, back cramps were recognized as conditions that affected a person's ability to work and deformed the body in medieval Poland (*Vita Beatae Hedwigis* 1993). A hagiographer described a woman distorted by contraction by using word "languida" in *Vita Sanctae Hedwigis* (1961: 607–608). The word languidus, -a, -um means: weak, feeble, ill, sick, diseased, invalid, inactive, sluggish, torpid, and slow-moving (*Dictionary of Medieval Latin from British Sources*). This might indicate that back problems that deformed the body as in her case were seen as sickness and possibly as impariment. This might confirm findings of other researchers (Allan and Waddell 1989) that back pain was noticed and considered as a condition, but it was not considered as "chronic disability". Acute illness such as infectious diseases, plagues, malnutrition and high mortality rate were regarded as bigger health problems by medieval society rather than LBP and DJD. People who were suffering from "cramps" and "stiffness" of limbs and begged in front of the churches and were marginalised, in our modern sense could be considered as disabled. However, we do not find descriptions of begging and marginalisation in texts associated with back pain. Of course, not all the medieval texts have survived, and secondly, not all diseases and impairments were recorded in the texts. Third, not all texts have been analysed in this regard.

From a biological and medical point of view, Ł3/55/82a from Łekno could have been physically challenged but he was not impaired. When we consider his cultural context – living conditions and the texts from the era – it seems that Ł3/55/82a with his IDD causing pain could have been regarded as ill and unable to work at a later stage of his life, thus needing help and healing. He was not likely considered disabled in medieval and early modern Poland. However, he was clearly not completely physically fit. Due to his challenging conditions (fracture, IDD, DISH), he could have been cared for and supported by his family, other peasants and the monastic Order.

Kinkopf et al. (2021) found that less economic access was associated with increased risk for degenerative spine disease in medieval Italy. However, the monastic community with better economic access in medieval Łekno was obliged by Cistercian rules to undertake hard physical work (Wyrwa 2020), which might have influenced development of DJD. Peasants from Cistercian villages also had to perform physical work, which in turn had an impact on the development of DJD including IDD. Despite the status differences between monastic and peasant community in Łekno, DJD and IDD might have similar degrees of expression in these populations, something that should, however, be investigated.

The BIDDGS helped to move beyond the biological description of IDD towards biocultural and social interpretation of the life of Ł3/55/82a. The detailed comparison of the BIDDGS with medical grading systems enabled us to establish which grades of expression of IDD in Ł3/55/82a could have led to temporal and chronic pain and how this affected the ability of this individual to perform various tasks. This allowed us to (re)construct the functioning of this individual with IDD from the late medieval and early modern periods in Poland. This osteobiography brought us closer to the past people and helped us to better understand how they experienced IDD and perceived LBP. More texts from medieval Poland should be analysed to establish whether LBP was considered a disability. Moreover, Ł3/55/82a is an example of a case that demonstrates how to distinguish IDD from possible DISH.

Influence of Degenerative Changes on Functioning

Degenerative disease is characterized by various stages of development, which translates into different occurrences and perceptions of pain. However, even at an advanced stage of the disease, there may be no symptoms (Roberts and Manchester 2010). Studies indicate that a person may complain of severe pain in, e.g., the knee joints, although they do not show degenerative changes, and another person, despite the advanced degenerative process, may not feel pain (Rogers and Waldron 1995; Bedson and Croft 2008; Waldron 2012). Thus, studies show contradictory results: the same bone lesion can be asymptomatic, cause pain or even lead to disability (Plomp 2017). The above fact indicates a highly subjective perception of the symptoms of a degenerative disease, which is also confirmed in clinical practice, where the diagnosis of the cause of pain often requires numerous tests and imaging examinations, and, thus, different types of grading systems used by a medical practitioner (e.g., Kellgren et al. 1963; Lane et al. 1993; Kettler and Wilke 2006; de Schepper et al. 2010). This subjective nature of pain has important implications for bioarchaeology and palaeopathology, as the palaeopathologist does not know if pain was felt with particular bone lesions.

As discussed, using a scale to measure pain in modern clinical settings is problematic because pain associated with degenerative changes is subjective and depends on the patient (de Schepper et al. 2010; Swift 2012). Pain may not happen every day, but it may be present most days and can take many forms and many different ways. When pain occurs, it may be accompanied by stiffness of the joint and other ailments related to the inability to use it. This makes it difficult for people who suffer from degenerative changes to plan their daily activities, which results in low mental well-being and stress (Australian Institute of Health and Welfare 2020).

It should be remembered that age-related wear and tear of the joints play a key role in the development of degenerative changes and in developing of disability. Osteophytes increase in “severity with age, individuals who died prior to becoming an ‘old’ adult (65 + years) may not have developed large, diffused osteophytes and therefore, the associated pain and disability reported by older adults in modern clinical studies” (Plomp 2017: 150). This has an important implication for bioarchaeology as archaeological populations are on average younger than modern ones. In Poland, the average life expectancy at birth was 22 years in the medieval population in Kałdus, 23.1 years in the 16th to 18th centuries in Kamionki Duże and 29.2 years in the 14th to19th century in Płonkowo (Kozłowski 2012). According to the World Bank (2021b), the global average life expectancy was more than 72.74 years and 77.85 years in Poland in 2019. In modern populations another age-related issue is that disability due to lesions in the spine is more common among middle-aged individuals, followed by the elderly and young adults (Candotti et al. 2015). Back pain, and especially chronic LBP, has a high prevalence in middle adulthood and old age. Disability in chronic LBP patients increases with advancing age, but indicators of quality of life are equal or even higher in older individuals (Wettstein et al. 2019). This refers to the “well-being paradox” (Wettstein et al. 2019) that states that although older individuals have to face cognitive and physical declines, other loss experiences and a higher risk of disability, their well-being is not lower compared with younger individuals. Despite higher disability scores with advancing age, older patients do not have lower quality of life, or they may have even higher quality of life than younger individuals. Bioarchaeologists should consider age when interpreting and discussing the relationship between spinal lesions, pain and disability. Moreover, the types of work and level of activity differ between modern and past populations (Plomp 2017). It can be assumed that people in the past performed many activities related to physical work, e.g., in the field, cultivating grain or vegetables, as artisans and warriors, etc. The pain associated with degenerative changes could be very difficult alongside heavy physical work. On the other hand, these people could also be more used to pain and thus learn to live with it and accept it more than people of the 21st century. The archaeological populations were much more active than the contemporary ones and "the activity requirements of a younger archaeological population may off-set the age-related increase in symptoms of an older clinical population" (Young and Lemaire 2014: 717).

There are also other factors that should be considered in research on DJD in past populations: gender, ethnic origin, genetic predisposition, past diseases and injuries (Aufderheide and Rodríguez-Martín 2006; Waldron 2012). For example, according to Rosemann et al. (2007), women have a lower quality of life than men, which is associated with greater pain, reduced life satisfaction and disability in Germany today. We also should keep in mind that modern populations use certain interventions (e.g., drugs) that mitigate symptoms, which have an impact on clinical studies of joint disease and pain, and which were unavailable to past populations. Thus, some areas of comparison of joint changes between modern and past populations might remain challenging.

Conclusions

As this study shows, the understanding of the impact of IDD and DJD in the spine on human functioning has significant value because this disease was, and still is, one of the most frequent in populations. We proposed the Bioarchaeological Intervertebral Disc Disease Grading System (BIDDGS) and its comparison to the medical grading systems to assess the impact of IDD on impairment and disability in past populations, which is a novel approach in biocultural studies in archaeology. The BIDDGS for thoracic and lumbar spine is compatible with the medical grading system proposed by Lane et al. (1993) and thus might be used for quality-of-life assessment in past populations. We hope that the methodological discussion of medical and bioarchaeological grading systems for IDD assessment will contribute to further analyses.

The analysis of the life of the adult male Ł3/55/82a shows that he was affected by IDD and other spinal diseases. The historical texts, archaeological context and palaeopathological assessment indicate that he could have been physically challenged and his physical fitness could have been limited. There were probably a significant number of individuals with similar pathological lesions, and they were probably not regarded as disabled in the medieval and early modern period since a number of contemporary texts do not allude to this. This study shows that these people were included within society despite their functional limitations. The future quantitative studies on the impact of DJD on impairment or disability on a population level might shed more light on daily life and functioning of such individuals. Further analyses that are in progress will reveal more information about diet, date and origin that will allow for more precise description of lives of individuals.

Acknowledgments

We thank Dr. George Milner for his comments on the Transition Analysis 2, Professor Marta Krenz-Niedbała and Dr. Sylwia Łukasik for comments on spinal disease, the editors of Forum Kritische Archäologie for inviting us to publish an article in this special issue and for their comments and to the anonymous reviewers for their comments. This research is part of the „Past Lifeways and Deathways of the Disabled in 14th–18th Century Central Europe: an Interdisciplinary Study" project, which is funded by the European Union's Horizon 2020 research and innovation programme within Marie Sklodowska-Curie Actions under grant agreement No 796917.

Bibliography

Allan, David B. and Gordon Waddell. 1989. An Historical Perspective on Low Back Pain and Disability. *Acta Orthopaedica Scandinavica Supplementum* 234: 1–23.

Aufderheide, Arthur C. and Conrado Rodríguez-Martín. 2006. *The Cambridge Encyclopedia of Human Paleopathology*. Cambridge: Cambridge University Press.

Australian Institute of Health and Welfare 2020. *Back Problems*. Cat. no. PHE 231. Canberra: AIHW. https://www.aihw.gov.au/reports/chronic-musculoskeletal-conditions/back-problems. Viewed: 21.07.2021.

Barnes, Colin and Geof Mercer. 2010. *Exploring Disability. A Sociological Introduction*. Cambridge: Polity Press.

Beaudry, Jonas-Sebastien. 2020. Theoretical Strategies to Define Disability. In Adam Cureton and David T. Wasserman, eds: *The Oxford Handbook of Philosophy and Disabilitypp*, pp. 1–21. Oxford: Oxford University Press. DOI: 10.1093/oxfordhb/9780190622879.013.3.

Bedson, John and Peter R. Croft. 2008. The Discordance between Clinical and Radiographic Knee Osteoarthritis: A Systematic Search and Summary of the Literature. *BioMed Central Musculoskeletal Disorders* 9(116): 1–11.

Boldsen, Jesper L., George R. Milner, Lyle W. Konigsberg and James W. Wood. 2002. Transition Analysis: A New Method for Estimating Age from Skeletons. In Robert D. Hoppa and James W. Vaupel, eds.: *Paleodemography: Age Distributions from Skeletal Samples*, pp. 73–106. Cambridge: Cambridge University Press.

Boutin, Alexis. T. 2016. Exploring the Social Construction of Disability: An Application of the Bioarchaeology of Personhood Model to a Pathological Skeleton from Ancient Bahrain. *International Journal of Paleopathology* 12: 17–28.

Breitinger, Emil. 1937. Zur Berechnung Körperhöhe aus den langen Gliedmaßenknochen. *Anthropologischer Anzeiger* 14: 249–274.

Buikstra, Jane and Donald H. Ubelaker. 1994. *Standards for Data Collection from Human Skeletal Remains*. Arkansas Archaeological Survey Research. Fayetteville: University of Arkansas.

Burnham, Jeremy M., Daniel C. Kimund and Srinath Kamineni. 2016. Midshaft Clavicle Fractures: A Critical Review. *Orthopedics* 39(5): 814–821.

Burt, Nicole M., Dyan Semple, Kathryn Waterhouse and Nancy C. Lovell. 2013. *Identification and Interpretation of Joint Disease in Paleopathology and Forensic Anthropology*. Springfield, IL: Charles C Thomas Publisher.

Candotti, Cláudia T., Matias Noll, Bárbara Vendramini Marchetti, Bruna N. da Rosa, Maria da Graça Schultz Medeiros, et al. 2015. Prevalence of Back Pain, Functional Disability, and Spinal Postural Changes. *Fisioterapia em Movimento* 28(4): 711–722.

Conlogue, Gerald, Mark Viner, Ronald Beckett, Jelena Bekvalac, Ramon Gonzalez, et al. 2017. A Post-Mortem Evaluation of the Degree of Mobility in an Individual with Severe Kyphoscoliosis Using Direct Digital Radiography (DR) and Multi-Detector Computed Tomography (MDCT). In Lorna Tilley and Alecia Schrenk, eds.: *New Developments in the Bioarchaeology of Care: Further Case Studies and Extended Theory*, pp. 153–173. New York: Springer.

Cormier, Aviva A. and Jane Buikstra. 2017. Impairment, Disability, and Identity in the Middle Woodland Period: Life at the Juncture of Achondroplasia, Pregnancy, and Infection. In Jennifer F. Byrnes and Jennifer Muller, eds.: *Bioarchaeology of Impairment and Disability. Theoretical, Ethnohistorical, and Methodological Perspectives*, pp. 225–248. New York: Springer.

Dettwyler, Katherine A. 1991. Can Paleopathology Provide Evidence for “Compassion”? *American Journal of Physical Anthropology* 84: 375–384.

Dictionary of Medieval Latin from British Sources. 2012. http://www.dmlbs.ox.ac.uk/web/online.html. Viewed: 22.07.2021.

Długosz, Jan. 2004. *Roczniki czyli kroniki sławnego Królestwa Polskiego. Księga 12: 1445–1461*. Warszawa: Wydawnictwo Naukowe PWN.

Dobosz, Józef and Andrzej M. Wyrwa. 1999. Działalność gospodarcza cystersów na ziemiach polskich – zarys problemu. In Andrzej M. Wyrwa, Jerzy Strzelczyk and Krzysztof Kaczmarek, eds.: *Monasticon Cisterciense Poloniae Vol 1. Dzieje i kultura męskich klasztorów cysterskich na ziemiach polskich i dawnej Rzeczypospolitej od średniowiecza do czasów współczesnych*, pp. 189–212. Poznań: Wydawnictwo Poznańskie.

Domett, Kate, Caitlin Evans, Nigel Chang, Nancy Tayles and Jennifer Newton. 2017. Interpreting Osteoarthritis in Bioarcheology: Highlighting the Importance of a Clinical Approach through Case Studies from Prehistoric Thailand. *Journal of Archaeological Science: Reports* 11: 762–773.

Eberl, Immo. 2007. *Die Zisterzienser. Geschichte eines europäischen Ordens*. Ostfildern: Thorbecke.

Faccia, Kathleen J. and Robert C. Williams. 2008. Schmorl's Nodes: Clinical Significance and Implications for the Bioarchaeological Record. *International Journal of Osteoarchaeology* 18: 28–44.

Finlay, Nyree, ed. 1999. Disability and Archaeology. Theme Issue, *Archaeological Review from Cambridge* 15(2). Cambridge: Cambridge University Press.

Foster, Aimee, Rebecca Kinaston, Matthew Spriggs, Stuart Bedford, Andrew Gray et al. 2018. Possible Diffuse Idiopathic Skeletal Hyperostosis (DISH) in a 3000-year-old Pacific Island Skeletal Assemblage. *Journal of Archaeological Science: Reports* 18: 408–419.

Fujiwara, Atsushi, Kazuya Tamai, Minoru Yamato, Howard S. An, Hiroyuki Yoshida, et al. 1999. The Relationship between Facet Joint Osteoarthritis and Disc Degeneration of the Lumbar Spine: an MRI Study. *European Spine Journal* 8: 396–401.

Gellhorn, Alfred C., Jeffrey N. Katz and Pradeep Suri. 2013. Osteoarthritis of the Spine: The Facet Joints. *Nature Reviews Rheumatology* 9(4): 216–224.

di Girolamo, Carlo, Nicola Pappone, Carlo Rengo, Enzo Miniero, Claudio Crisci et al. 2001. Intervertebral Disc Lesions in Diffuse Idiopathic Skeletal Hyperostosis (DISH). *Clinical and Experimental Rheumatology* 19(3): 310–312.

Górski, Marian. 1983. Zębopochodne zapalenie kości szczęk i tkanek okołoszczękowych. In Zbigniew Jańczuk, ed.: *Zarys stomatologii. Podręcznik dla studentów medycyny*, pp. 224–236. Warszawa: Państwowy Zakład Wydawnictw Lekarskich.

Hillen, Robert J., Bart J. Burger, Rudolf G. Pöll, Arthur de Gast and C. Michael Robinson. 2010. Malunion after Midshaft Clavicle Fractures in Adults. The Current View on Clavicular Malunion in the Literature. *Acta Orthopaedica* 81(3): 273–279.

Jaguś, Iga. 2002. *Lecznictwo ludowe w Królestwie Polskim na przełomie XIX i XX wieku*. Kielce: Kieleckie Towarzystwo Naukowe.

Jamroziak, Emilia. 2012. Centres and Peripheries. In Mette Birkedal Bruun, ed.: *The Cambridge Companion to the Cistercian Order*, pp. 65–79. Cambridge: Cambridge University Press. DOI: 10.1017/CCO9780511735899.008.

Kellgren, Jonas H., Maurice R. Jeffrey and John Ball. 1963. *The Epidemiology of Chronic Rheumatism. Vol 2: Atlas of Standard Radiographs of Arthritis*. Oxford: Blackwell Scientific Publications.

Kettler, Annette and Hans-Joachim Wilke. 2006. Review of Existing Grading Systems for Cervical or Lumbar Disc and Facet Joint Degeneration. *European Spine Journal* 15: 705–718.

Kinkopf, Katherine M., Sabrina C. Agarwal, Caroline Goodson, Patrick D. Beauchesne, Trent M. Trombley, et al. 2021. Economic Access Influences Degenerative Spine Disease Outcomes at Rural Late Medieval Villamagna (Lazio, IT). *American Journal of Physical Anthropology* 174(3): 500–518.

Klales, Alexandra R., Stephen D. Ousley and Jennifer. M. Vollner. 2012. A Revised Method of Sexing the Human Innominate Using Phenice's Nonmetric Traits and Statistical Methods. *American Journal of Physical*

Anthropology 149: 104–114.

Kolberg, Oskar. 1890. *Lud. Chełmskie Vol. 1*. Kraków: Uniwersytet Jagielloński.

Kozłowski, Tomasz. 2012. *Stan biologiczny i warunki życia ludności in Culmine na Pomorzu Nadwiślańskim (X–XIII wiek)*. Mons Sancti Laurentii 7. Toruń: Wydawnictwo Uniwersytetu Mikołaja Kopernika.

Kronika wągrowiecka. 2004. Unpublished manuscript. Poznań: Archive of the Łekno Archaeological Expedition.

Lane, Nancy E., Michael C. Nevitt, Harry K. Genant and Marc C. Hochberg. 1993. Reliability of New Indices of Radiographic Osteoarthritis of the Hand and Hip and Lumbar Disc Degeneration. *The Journal of Rheumatology* 20(11): 1911–1918.

Lovell, Nancy C. 2016. Tiptoeing through the Rest of his Life: A Functional Adaptation to a Leg Shortened by Femoral Neck Fracture. *International Journal of Paleopathology* 13: 91–95.

Mader, Reuven, Piercarlo Sarzi-Puttini, Fabiola Atzeni, Ignazio Olivieri, Nicola Pappone, et al. 2009. Extraspinal Manifestations of Diffuse Idiopathic Skeletal Hyperostosis. *Rheumatology* 48(12): 1478–1481.

Markiewicz, Mariusz. 2004. *Historia Polski 1492–1795*. Kraków: Wydawnictwo Literackie.

Matczak, Magdalena D. 2020. *Report on the Analysis of Written Sources from the Project "Past Lifeways and Deathways of the Disabled in 14th–18th Century Central Europe: an Interdisciplinary Study"*. Unpublished manuscript. Poznań.

Matczak, Magdalena D., Marta Krenz-Niedbała, Sylwia Łukasik, Jane E. Buikstra, Andrzej M. Wyrwa et al. 2022. Skeletal Dysplasia of an Adult Male from Medieval Łekno in Poland, Central Europe. *International Journal of Osteoarchaeology* 32(6): 1300–1309. DOI: 10.1002/oa.3155.

McGuire, Brian P. 2012. Constitutions and the General Chapter. In Mette Birkedal Bruun, ed.: *The Cambridge Companion to the Cistercian Order*, pp. 87–99. Cambridge, Cambridge University Press. DOI: 10.1017/CCO9780511735899.010.

Miłosz, Elżbieta. 2000. Kondycja biologiczna późnośredniowiecznej populacji z Łekna. *Studia i Materiały do Dziejów Pałuk* 3: 405–418.

Mucha, Elżbieta, Janusz Piontek and Beata Widelska. 1986. *Analiza antropologiczna materiałów kostnych odkrytych na cmentarzysku w Łeknie, stan. 3, woj., pilskie*. Manuscript in the Archive of the Archaeological Museum in Poznan.

Murphy, Eileen M. 2000. Developmental Defects and Disability: the Evidence from the Iron Age Semi-Nomadic Peoples of Aymyrlyg, South Siberia. In Jane Hubert, ed.: *Madness, Disability and Social Exclusion. The Archaeology and Anthropology of "Difference"*, pp. 60–80. London: Routledge.

Nieuwenhuizen, Chantal J., Peter L. J. van Veldhoven and Robert F. van Oosterom. 2020. Rare Case of a Traumatic Myositis Ossificans in the Tibialis Anterior Muscle. *The British Medical Journal Case Report* 13: Art. e233210. DOI: 10.1136/bcr-2019- 233210.

Persson, Liselott C. G., Jane Y. Carlsson and Leif Anderberg. 2007. Headache in Patients with Cervical Radiculopathy: A Prospective Study with Selective Nerve Root Blocks in 275 Patients. *European Spine Journal* 16: 953–959.

Phenice, T. W. 1969. A Newly Developed Visual Method of Sexing of the Os Pubis. *American Journal of Physical Anthropology* 30: 297–302.

Plomp, Kimberly A. 2017. The Bioarchaeology of Back Pain. In Jennifer F. Byrnes and Jennifer L. Muller, ed.: *The Bioarchaeology of Impairment and Disability. Theoretical, Ethnohistorical, and Methodological Perspectives*, pp. 141–157. New York: Springer.

Pye, Stephen R., David M. Reid, Mark Lunt, Judith E. Adams, Alan J. Silman et al. 2007. Lumbar Disc Degeneration: Association between Osteophytes, End-Plate Sclerosis and Disc Space Narrowing. *Annals of the*

Rheumatic Diseases 66(3): 330–333.

Raastad, Joachim, Michael Reiman, Remy Coeytaux, Leila Ledbetter and Adam P. Goode. 2015. The Association between Lumbar Spine Radiographic Features and Low Back Pain: A Systematic Review and Meta-Analysis. *Seminars in Arthritis and Rheumatism* 44: 571–585.

Roberts, Charlotte A. and Keith Manchester. 2010. *The Archaeology of Disease*. Stroud: The History Press.

Rogers, Juliet. 2000. The Palaeopathology of Joint Disease. In Margaret Cox and Simon Mays, eds.: *Human Osteology in Archaeology and Forensic Science*, pp. 163–182. New York: Cambridge University Press.

Rogers, Juliet and Tony Waldron. 1995. *A Field Guide to Joint Disease in Archaeology*. Chichester, New York et al.: John Wiley&Sons.

Rogers, Juliet and Tony Waldron. 2001. DISH and the Monastic Way of Life. *International Journal of Osteoarchaeology* 11: 357–365.

Rosemann, Thomas, Gunter Laux and Joachim Szecsenyi. 2007. Osteoarthritis: Quality of Life, Comorbidities, Medication and Health Service Utilization Assessed in a Large Sample of Primary Care Patients. *Journal of Orthopaedic Surgery and Research* 2(12): 1–9.

de Schepper, Evelien I. T., Jurgen Damen, Joyce B. J. van Meurs, Abida Z. Ginai, Maria Popham, et al. 2010. The Association Between Lumbar Disc Degeneration and Low Back Pain. The Influence of Age, Gender, and Individual Radiographic Features. *Spine* 35(5): 531–536.

de Schepper, Evelien I. T., Jurgen Damen, Pieter K. Bos, Albert Hofman, Bart W. Koes et al. 2013. Disk Degeneration of the Upper Lumbar Disks Is Associated with Hip Pain. *European Spine Journal* 22: 721–726.

Sofaer Derevenski, Joanna R. 2000. Sex Differences in Activity-Related Osseous Change in the Spine and the Gendered Division of Labor at Ensay and Wharram Percy, UK. *American Journal of Physical Anthropology* 111: 333–354.

Spoor, Fred, Chris Stringer and Frans Zonneveld. 1998. Rare Temporal Bone Pathology of the Singa Calvaria from Sudan. *American Journal of Physical Anthropology* 107(1): 41–50.

Swift, Amelia. 2012. Osteoarthritis 3: Impact on Patients. *Nursing Times* 108. www.nursingtimes.net/osteoarthritis-3-impact-on-patients/5042032.article. Viewed: 18.06.2021.

The World Bank. 2021a. *Disability Inclusion*. https://www.worldbank.org/en/topic/disability. Viewed: 29/07/2021.

The World Bank. 2021b. *Life Expectancy at Birth, Total (Years)*. https://data.worldbank.org/indicator/SP.DYN.LE00.IN?end=2019&start=2019&view=map. Viewed: 22.07.2021.

Tilley, Lorna. 2015. *Theory and Practice in the Bioarchaeology of Care*. New York: Springer.

Tilley, Lorna and Alecia Schrenk, eds. 2017. *New Developments in the Bioarchaeology of Care: Further Case Studies and Extended Theory*. New York: Springer.

Trinkaus, Erik. 1983. *The Shanidar Neanderthals*. New York: Academic Press.

Vita Sanctae Hedwigis. 1961. *Monumenta Poloniae Historica, Vol. IV*. Lwów: Akademia Umiejętności w Krakowie.

Vita Beatae Hedwigis. 1993. Wrocław: Tart.

Waldron, Tony. 2009. *Paleopathology*. Cambridge: Cambridge University Press.

Waldron, Tony. 2012. Joint Disease. In Anne L. Grauer, ed.: *A Companion to Paleopathology*, pp. 513–530. Chichester, West Sussex, Malden: Wiley-Blackwell.

Waldron, Tony. 2019. Joint Disease. In Jane E. Buikstra, ed.: *Ortner's Identification of Pathological Conditions in Human Skeletal Remains*, 3rd ed., pp. 719–748. London, San Diego et al.: Academic Press.

Walker, Philip L., Rhonda R. Bathurst, Rebecca Richman, Thor Gjerdrum and Valerie A. Andrushko. 2009. The Causes of Porotic Hyperostosis and Cribra Orbitalia: A Reappraisal of the Iron-Deficiency-Anemia Hypothesis. *American Journal of Physical Anthropology* 139(2): 109–125. DOI: 10.1002/ajpa.21031.

Weber, Jochen, Alfred Czarnetzki and Axel Spring. 2003. Paleopathological Features of the Cervical Spine in the Early Middle Ages: Natural History of Degenerative Diseases. *Neurosurgery* 53(6): 1418–1424.

Weiler, Christoph, Martina Schietzsch, Thomas Kirchner, Andreas G. Nerlich, Norbert Boos et al. 2012. Age-Related Changes in Human Cervical, Thoracal and Lumbar Intervertebral Disc Exhibit a Strong Intra-Individual Correlation. *Wuertz Eur Spine* 21(6): 810–818.

Wettstein, Markus, Wolfgang Eich, Christiane Bieber and Jonas Tesarz. 2019. Pain Intensity, Disability, and Quality of Life in Patients with Chronic Low Back Pain: Does Age Matter? *Pain Medicine* 20: 464–475.

Williams, Frances M. K., Nisha J. Manek, Philip N. Sambrook, Tim D. Spector and Alexander J. MacGregor. 2007. Schmorl's Nodes: Common, Highly Heritable, and Related to Lumbar Disc Disease. *Arthritis & Rheumatism (Arthritis Care & Research)* 57(5): 855–860.

World Health Organization. 2002. *Towards a Common Language for Functioning, Disability and Health*. http://www.who.int/classifications/icf/training/icfbeginnersguide.pdf. Viewed: 18.06.2021.

Wyczański, Andrzej. 1986. Społeczeństwo. In Andrzej Wyczański, ed.: *Polska w epoce Odrodzenia. Państwo, Społeczeństwo, kultura*, pp. 223–286. Warszawa: Wiedza Powszechna.

Wyrwa, Andrzej M. 2000. Romanische Architektur und ein Zisterzienserkloster. *Archäologie in Deutschland* 2000(3): 50–52.

Wyrwa, Andrzej M. 2002. Die „kölnischen Klöster" der Altenberger Linie in Großpolen. Die Frage der nationalen Exklusivität der Zisterzienserabteien in Lekno Wągrowiec (Lekno-Wongrowitz), Ląd, (Lond) und Obra. *Analecta Cisterciensia* 54(1–2): 186–216.

Wyrwa, Andrzej M. 2006. Alberyk z Trois Fontaines i jego średniowieczna kronika świata. In Dariusz A. Sikorski and Andrzej M. Wyrwa, eds.: *Cognitioni Gestorum. Studia z dziejów średniowiecza dedykowane Profesorowi Jerzemu Strzelczykowi*, pp. 319–344. Poznań, Warszawa: Wydawnictwo DiG.

Wyrwa, Andrzej M. 2007. A Fortified and Sacred Site in Łekno until the Middle of the 12th Century. A Note. *Quaestiones Medii Aevi Novae* 12: 341–362.

Wyrwa, Andrzej M. 2008. Zabobony, "wampiry" i remedia antywampiryczne. Przyczynek do poznania zachowań funeralnych, In Jacek Wrzesiński and Wojciech Dzieduszycki, eds.: *Czarownice*. Funeralia Lednickie 2, pp. 43–66. Poznań: SNAP.

Wyrwa, Andrzej. M. 2010. *Klasztory cysterskie w Łeknie i Wągrowcu*. Bydgoszcz: Pejzaż.

Wyrwa, Andrzej M. 2011. *Klejnot architektury drewnianej ziem polskich. Kościół pw. św. Mikołaja w Tarnowie Pałuckim. Wielkopolska. The Jewel of Polish Architecture. St Nicolas Church in Tarnowo Pałuckie*. Bydgoszcz: Wydawnictwo Pejzaż.

Wyrwa, Andrzej M. 2016. *The Foundation Document Issued in 1153 by Zbylut for the Cistercian Monastery in Łekno*. Poznań, Gniezno: Muzeum Pierwszych Piastów na Lednicy.

Wyrwa, Andrzej M. 2017a. *Cisterciana. Studia z dziejów i kultury Zakonu Cysterskiego*. Kraków, Poznań: Societas Vistulana.

Wyrwa, Andrzej M. 2017b. Ehemalige Klosterstätten Łekno/Wągrowiec. *Cistercienser Chronik* 124(1): 137–142.

Wyrwa, Andrzej M. 2018. Grodowo-sakralny ośrodek w Łeknie. Podsumowanie badań (1982–2015). In Andrzej Buko, Karol Kollinger and Sylwia Jędrzejewska, eds.: *Badania interdyscyplinarne*, pp. 163–182. Rzeszów: Wydawnictwo Uniwersytetu Rzeszowskiego.

Wyrwa, Andrzej M. 2020. *Zasady życia w klasztorze mniszym według św. Bernarda z Clairvaux i ocena zakonu cystersów przez św. Hildegardę z Bingen*. Poznań: Uniwersytet im. Adama Mickiewicza w Poznaniu, Wydział Historii.

Wyrwa, Andrzej M. and Elżbieta Miłosz. 2006. Pochówek w prezbiterium kościoła cysterskiego w Łeknie (grób Ł3/30/86). Grób opata? *Studia i materiały do dziejów Pałuk* 6: 207–225.

Young, Janet L. and Edward D. Lemaire. 2014. Linking Bone Changes in the Distal Femur to Functional Deficits. *International Journal of Osteoarchaeology* 24: 709–721.

Yustos, Marta, Marina Lozano, Juan I. Morales, Javier Iglesias-Bexiga and Josep M. Vergès. 2021. Degenerative Joint Disease in the Chalcolithic Population of El Mirador Cave (Sierra de Atapuerca, Spain): The Vertebral Column. *International Journal of Osteoarchaeology* 31(2): 162–175.

Zakrzewski, Sonia. 2014. Paleopathology, Disability and Bodily Impairments. In Ryan Metcalfe, Jenefer Cockitt and Rosalie David, eds.: *Paleopathology in Egypt and Nubia: A Century in Review 6*, pp. 57–68. Oxford: Archaeopress Egyptology.

Appendix

Skeletal elements	**Stages**		
Pubic Symphysis	**Left**	**Right**	
Symphyseal Relief	Flat	Residual billowing – Flat	
Dorsal Symphyseal Texture	Coarse grained	Coarse grained	
Superior Protuberance	Integrated	Late protuberance – Integrated	
Ventral Symphyseal Margin	[Rampart completion without sulcus – Rim]	Rampart completion without sulcus	
Dorsal Symphyseal Margin	Rim	Flattening complete – Rim	
Iliac Auricular Surface	**Left**	**Right**	
Superior Demiface Topography	Flat to irregular	Flat to irregular	
Inferior Demiface Topography	Median elevation – Flat to irregular	Median elevation – Flat to irregular	
Superior Surface Characteristics	Flat (no billows)	1/3–2/3 covered by billows	
Middle Surface Characteristics	Flat (no billows)	<1/3 covered by billows	
Inferior Surface Characteristics	Flat (no billows)	Flat (no billows)	
Inferior Surface Texture	[Microporosity]	[Microporosity]	
Superior Posterior Iliac Exostoses	Rounded exostoses	Rounded exostoses	
Inferior Posterior Iliac Exostoses	PMD	[Touching exostoses]	
Posterior Iliac Exostoses	[Smooth (no exostoses or spicules) – Rounded exostoses]	[Smooth (no exostoses or spicules) – Rounded exostoses]	
Cranial Sutures	**Left**	**Center**	**Right**
Coronal Pterica	Obliterated		Obliterated
Sagittal Obelica		Partially obliterated	
Lambdoidal Asterica	PMD		Partially obliterated – Punctuated
Interpalatine		PMD	
Zygomaticomaxillary	PMD		Juxtaposed

Table 3. Stages of morphological changes of Ł3/55/82a used for age estimation in the Transition Analysis 2. PMD: post-mortem damage. Parentheses indicate post-mortem damage.

V	Vertebral body	BIDDGS	The facet joints and costovertebral joints
C1	Lipping: barely discernible on 1/3 surface of the articular surface for the dens.[2]	None	Lipping: barely discernible on the inferior articular surfaces.
C2	Porosity: pinpoint porosity on <1/3 of the inferior aspect of the body. Lipping on the anterior aspect of the dens.[3]	None	Eburnation: barely discernible on >2/3 surface of both superior and right interior articular facets.
C3	Porosity: pinpoint porosity on <1/3 of the superior and inferior aspects of the body.	None	Lipping: barely discernible on <1/3 surface of the superior and inferior articular facets. Eburnation: barely discernible and polish on <1/3 of the right inferior articular facet.
C4	Osteophytes: barely discernible multiple osteophytes on the antero-superior and singular osteophyte on the left inferior aspects of the body. Porosity: pinpoint porosity on <1/3 of the superior and inferior aspects of the body.	Mild	Lipping: barely discernible on 1/3 surface of both superior and right inferior articular surfaces. Sharp ridge, slight spicules on >2/3 of the left inferior articular surface. Eburnation: polish with grooves on <1/3 of the lower left articular surface.
C5	Porosity: pinpoint porosity on <1/3 of the superior and inferior aspects of the body.	None	Lipping: sharp ridge, slight spicules on 1/3 of the left superior articular surface. Eburnation: polish with grooves on <1/3 of the left superior articular surface.
C6	Porosity: pinpoint porosity on <1/3 of the superior and inferior aspects of the body.	None	Lipping: barely discernible on 1/3–2/3 of the left inferior articular surface.
C7	Porosity: pinpoint porosity on <1/3 of the superior and inferior aspects of the body.	None	Lipping: barely discernible on 1/3 of the inferior articular surfaces.
T1	Osteophytes: barely discernible osteophytes on the inferior aspect of the body. Porosity: pinpoint porosity on 1/3–2/3 of the superior and inferior aspects of the body.	Mild	Lipping: barely discernible on 1/3–2/3 surface of the right superior articular surface. Sharp ridge, slight spicules on >2/3 of the left superior articular surface.
T2	Osteophytes: barely discernible multiple osteophytes extending horizontally on the anterior and left inferior aspect of the body. Porosity: pinpoint porosity on 1/3–2/3 of the superior and inferior aspects of the body.	Mild	Lipping: barely discernible on 1/3–2/3 of the inferior articular surfaces.

2 C1 is an atypical vertebra and does not have a vertebral body, instead the dens of C2 sits where a body of a typical vertebra would be and articulates with the posterior facet for the dens on the anterior arch of C1. Therefore, we inserted the information about lipping in this column.

3 C2 is an atypical cervical vertebra that lacks a typical vertebral body but has the dens.

T3	Osteophytes: sharp ridge, slight spicules of singular osteophytes extending horizontally on the left superior and right inferior aspects of the body. Schmorl's node: on the inferior aspect of the body. Porosity: pinpoint porosity on <1/3 of the superior and inferior aspects of the body.	Moderate	Lipping: barely discernible on <1/3 of the superior articular surfaces and on >2/3 of the articular surfaces for the rib tubercle.
T4	Osteophytes: barely discernible singular osteophytes extending on the right superior aspect of the body. Sharp ridge, slight spicule of singular osteophyte extending horizontally on the right inferior aspect of the body. Schmorl's node: on the superior and inferior aspects of the body. Porosity: pinpoint porosity on <1/3 of the superior and inferior aspects of the body.	Mild and moderate	Lipping: barely discernible on <1/3 of the superior articular surfaces and the articular surfaces for the rib tubercle.
T5	Osteophytes: sharp ridge, slight spicule of singular osteophyte extending horizontally on the right superior aspect of the body. Schmorl's node: on the superior and inferior aspects of the body. Porosity: pinpoint porosity on >2/3 of the superior and inferior aspects of the body.	Moderate	Lipping: barely discernible on <1/3 of the superior articular surfaces. Eburnation: barely discernible on >2/3 of the superior articular surfaces.
T6	Enthesophytes: barely discernible multiple enthesophytes extending on the right superior and sharp ridge, slight spicules of multiple enthesophytes on the right inferior aspects of the body. Schmorl's node: on the inferior aspect of the body. Porosity: pinpoint porosity on 1/3–2/3 of the superior and inferior aspects of the body.	None	Lipping: barely discernible on <1/3 of the left superior and inferior articular surfaces.
T7	Osteophytes: barely discernible singular osteophyte extending on the right superior aspect of the body. Enthesophytes: sharp ridge of singular enthesophyte on the right and anteroinferior aspect of the body. Schmorl's node: on the superior and inferior aspects of the body. Porosity: pinpoint porosity on 1/3–2/3 of the superior and inferior aspects of the body.	Mild	Lipping: barely discernible on 1/3–2/3 of the left articular surfaces.
T8	Osteophytes: barely discernible singular osteophytes on the right superior aspect of the body. Enthesophytes: sharp ridge, slight spicules of enthesophytes extending on the right inferior aspect of the body. Schmorl's node: on the superior and inferior aspects of the body. Porosity: pinpoint porosity on 1/3–2/3 of the superior and inferior aspects of the body.	Mild	Lipping: barely discernible on 1/3–2/3 surface of all articular surfaces and the articular surfaces for the rib tubercle. Eburnation: barely discernible and grooves on >2/3 of the left superior articular surface.
T9	Osteophytes: barely discernible singular osteophytes on the right and left superior aspect of the body. Enthesophytes: extensive spicular formation of enthesophyte on the right superior aspect of the body. Sharp ridge, slight spicules of enthesophyte extending on the right inferior aspect of the body. Schmorl's node: on the superior and inferior aspects of the body. Porosity: pinpoint porosity on 1/3–2/3 of the superior and inferior aspects of the body.	Mild	Lipping: sharp ridge, slight spicules on >2/3 of superior articular surfaces. Barely discernible on 1/3–2/3 of inferior articular surfaces. Eburnation: polish with grooves on 1/3–2/3 of the left superior surface. Barely discernible on <1/3 of the right superior surface.

T10	Osteophytes: barely discernible singular osteophytes on the left superior aspect of the body. Sharp ridge, slight spicules of osteophytes extending horizontally on the right and left inferior aspect of the body. Extensive spicular formation of singular osteophyte on the left inferior aspect of the body. Schmorl's node: on the superior and inferior aspects of the body. Porosity: pinpoint porosity on 1/3–2/3 of the superior and inferior aspects of the body.	Mild, moderate and severe	Lipping: barely discernible on <1/3 of all articular surfaces of the facet joints and the right articular surface for the rib tubercle. Eburnation: barely discernible on > 2/3 of the left superior articular surface.
T11	Osteophytes: sharp ridge, slight spicules of multiple osteophytes on the left, anterior and right superior aspect of the body and the right inferior aspect of the body. Schmorl's node: on the inferior aspect of the body. Porosity: pinpoint porosity on 1/3–2/3 of the superior and inferior aspects of the body.	Moderate	Lipping: barely discernible on 1/3–2/3 of the left articular surface. Eburnation: barely discernible on 1/3–2/3 of the right superior and inferior articular surfaces.
T12	Osteophytes: barely discernible multiple osteophytes on the superior and the right inferior aspects of the body. Schmorl's node: on the superior aspect of the body. Porosity: pinpoint porosity on 1/3–2/3 of the superior and inferior aspects of the body.	Mild	Eburnation: barely discernible on >2/3 of all articular surfaces of the facet joints.
L1	Osteophytes: barely discernible singular osteophytes on the right superior and right and left inferior aspects of the body. Porosity: pinpoint porosity on 1/3–2/3 of the superior and inferior aspects of the body.	Mild	Lipping: barely discernible on <1/3 of all articular surfaces. Eburnation: barely discernible on >2/3 of the right superior and inferior articular surfaces.
L2	Osteophytes: barely discernible osteophytes on the whole superior and inferior aspects of the body. Porosity: pinpoint porosity on 1/3–2/3 of the superior and inferior aspects of the body.	Mild	Lipping: barely discernible on 1/3–2/3 surface of all articular surfaces.
L3	Osteophytes: sharp ridge, slight spicules of multiple osteophytes on the whole superior and inferior aspects of the body. Porosity: pinpoint porosity on 1/3–2/3 of the superior and inferior aspects of the body.	Moderate	Lipping: barely discernible on 1/3–2/3 surface of all articular surfaces.
L4	Osteophytes: sharp ridge, slight spicules of multiple osteophytes extending horizontally on the anterior and left superior aspect of the body and the right inferior aspect of the body. Porosity: pinpoint porosity on 1/3–2/3 of the superior and inferior aspects of the body.	Moderate	Lipping: barely discernible on 1/3–2/3 surface of the inferior articular surfaces. Sharp ridge, slight spicules of the superior articular surfaces.
L5	Osteophytes: extensive spicular formation of multiple osteophytes on the anterior and right superior and the right inferior aspects of the body. Porosity: pinpoint porosity on 1/3–2/3 of the superior and inferior aspects of the body.	Severe	Lipping: barely discernible on 1/3–2/3 surface of all articular surfaces. Eburnation: barely discernible on 1/–2/3 of the left superior articular facet.

Table 4. Pathological lesions identified on vertebrae of Ł3/55/82a from Łekno. V: vertebrae. BIDDGS: the Bioarchaeological Intervertebral Disc Disease Grading System.

Differential diagnosis	**Ł3/55/82a**
Intervertebral disc disease	
Osteophytes	Yes
Pitting on the inferior or superior surface of the vertebral bodies.	Yes
DISH	

Fusion of at least four vertebrae by bony bridges arising from the anterolateral aspects of vertebral bodies, involving the anterior and right aspects.	No
Flowing (“dripping candle wax”) appearance of bony bridges.	Yes in T8 and T9?
Lack of involvement of apophyseal joints.	No?
The process usually begins in the midthoracic spine.	T6–T10
Intervertebral disc space is spared.	Yes between T8–T9 and T10–T11, unknown between other vertebrae
Anterior longitudinal spinal ligament is ossified.	Yes between T6–T10
Extraspinal ligamentous and muscular attachments are prominently calcified (enthesopathies): in the insertion of triceps brachii at the olecranon of the right ulna, ischial tuberosities, iliac crests, pubic symphysis, patella, the patellar ligament at the tibial tuberosity, trochanters, femoral linea aspera, the Achilles’ tendon at the posterior calcaneus.	Present in the insertion of triceps brachii at the olecranon of the right ulna, ischial tuberosities, iliac crests, the patellar ligament at the tibial tuberosity, trochanters, femoral linea aspera, the Achilles’ tendon at the posterior calcaneus
Sacroiliac joint might be fixed by several bony bridges but not by intra-articular bony ankylosis.	No
Ankylosing spondylitis	
Syndesmophytes (ossifications of the annulus fibrosus of the intervertebral disc) are thin and vertically oriented.	No
Apophyseal joints are fused.	No
Bilateral involvement of the sacroiliac joints which commonly fuse.	No
Spinal fusion always begins in the lowest part of the spine and may progress inexorably upwards without any normal vertebra intervening (no “skip lesions”).	No
If the thoracic vertebrae are fused, then it is often found that the costovertebral and costotransverse joints are also fused.	No
No extraspinal bone formation is seen.	It is seen
Fluorosis	
Vertebral ankylosis: lumbar first, later total, central.	No
Thick osteophytes.	No
Narrowing of joint space.	No between T8–T9 and T10–T11, unknown between other vertebrae
Osteosclerotic bone.	?
Dentition: mottling, low rate of caries.	No
Ossification at any enthesis.	Yes
Reactive arthropathy	
Vertebral ankylosis: lower thoracic and upper lumbar. Lateral first.	No
Paravertebral ossification progressing to fusion with vertebral body. Ankylosis of vertebral bodies with “skip lesions”.	No
Asymmetrical sacroiliitis.	?
Erosions in MTP (particularly first) and IP joints of feet.	?
Dentition normal.	Yes
Entheseal ossification predominantly in pelvis, lower limb and feet.	No
Psoriatic arthropathy	
Vertebral ankylosis: lower thoracic and upper lumbar first. May involve cervical.	No
Paravertebral ossification progressing to fusion with vertebral body. Ankylosis of vertebral bodies with “skip lesions”.	No
Symmetric or asymmetric sacroiliitis. Erosions may be present within joint. Sclerosis.	?