International Journal of Osteoarchaeology

WILEY

SHORT REPORT OPEN ACCESS

Skeletal Dysplasia During the Bronze Age in Northeast Thailand (3000–2500 BP)

Nuttheera Kaoboriboon[1] | Nancy Tayles[2] | Sarah Agatha Villaluz[3] | Pratiwi Yuwono[4] | Kate Domett[5] | Melandri Vlok[6]

[1]Department of Archaeology, Silpakorn University, Bangkok, Thailand | [2]Department of Anatomy, University of Otago, Dunedin, New Zealand | [3]School of Archaeology, University of Philippines, Diliman, Quezon City, Philippines | [4]Geoarchaeology and Archeometry Research Group, Faculty of Science of Engineering, Southern Cross University, Lismore, New South Wales, Australia | [5]College of Medicine and Dentistry, James Cook University, Townsville, Queensland, Australia | [6]School of Dentistry and Medical Sciences, Charles Sturt University, Wagga Wagga, New South Wales, Australia

Correspondence: Kate Domett (kate.domett@jcu.edu.au) | Melandri Vlok (mvlok@csu.edu.au)

Received: 27 February 2025 | **Revised:** 22 January 2026 | **Accepted:** 9 February 2026

Keywords: Asia | differential diagnosis | disability | dwarfism | prehistory

ABSTRACT

This study examines a case of skeletal dysplasia in an adult male (B290) from the Bronze Age at the site of Ban Non Wat, Northeast Thailand. Skeletal dysplasia, a group of genetic disorders affecting bone and cartilage growth, presents diagnostic challenges due to overlapping clinical features. B290 exhibited rhizomelia, humeral varus deformity, coxa vara, and block thoracic vertebra. A thorough differential diagnosis comparing 56 skeletal dysplasias identified that B290's skeletal pathology was consistent with conditions including hypochondroplasia or pseudoachondroplasia. The case contributes to a growing body of literature identifying extreme short stature and/or skeletal dysplasia in adults from the prehistory of Mainland Southeast Asia, indicating inclusion of differently abled individuals in society was not rare in this region, potentially highlighting a shared understanding of human value.

1 | Introduction

Skeletal dysplasia (also known as osteochondrodysplasias) is a term used to describe atypical growth in bone and cartilage (Biswas et al. 2022). Skeletal dysplasias result from disruptions in typical skeletal morphogenesis and development and are major contributors to short stature (Krakow 2015). They can present any time from prenatal period to adult life; they are most frequently identified at birth and present as disproportion of limbs, radiological signs of pathophysiology, and occasionally other organic systems that are impacted. The combined incidence of skeletal dysplasia is approximately 1 in 5000 live births (Alanay and Lachman 2011). To date, over 450 disorders causing skeletal dysplasia have been described (Alanay and Lachman 2011). Most of these conditions are the result of genetic defects. The diagnosis of skeletal dysplasia is usually based on a combination of clinical, radiographic, morphologic, and biochemical and molecular studies (Yadav 2023). Each disorder usually involves different combinations of clinical signs, which can range from mild to severe. However, these clinical signs can overlap significantly, which can make differential diagnosis challenging. The many genetic variants that have been identified have considerable overlap in skeletal appearance, making diagnosis challenging in the archaeological record (see Data S1).

Documenting cases of skeletal dysplasia in the archaeological record is important, as they can have significant consequences for human mobility and function. Thus, they are commonly associated with accommodation of the community for the individual's difference, providing introspect into the values and decisions of the broader community. A young female with short

All authors contributed equally to this work.

https://doi.org/10.1002/oa.70088

and gracile limb bones, possibly due to hypothyroidism, pseudoachondroplasia, or multiple epiphyseal dysplasia, was identified in Iron Age China. State-sponsored social care was provided for those characterized to have dwarfism in pre-Qin China (Zhou et al. 2022). In Egypt's Third Intermediate Period, a middle-aged female with extreme disproportionate short stature probably from achondroplasia was identified. The authors argue that artistic depictions of individuals with dwarfism indicate in many circumstances that they were held in high esteem, potentially representing a spiritual link to the Egyptian pantheon (Molto and Kirkpatrick 2018).

This paper explores possible diagnoses for skeletal dysplasia in a Bronze Age individual from the site of Ban Non Wat in Northeast Thailand.

2 | Material and Methods

2.1 | Archaeological Context: Ban Non Wat

Ban Non Wat is a large moated prehistoric site in the upper Mun Valley, Northeast Thailand (Figure 1). Intensive excavations of Ban Non Wat took place between 2002 and 2011, uncovering 699 burials (Domett et al. 2016). The culture at Ban Non Wat can be divided into 12 phases, each with distinct burial characteristics. The earliest phase featured flexed burials, characteristic of a forager phase (3500–3600 BP), followed by mixed forager-farmer Neolithic (3500–3300 BP), Bronze (3000–2500 BP), and Iron phases (2500–1500 BP) all with supine burials. The Bronze Age is divided into five phases (Higham and Kijngam 2012). B290, the individual under study, was found within the context of Bronze Age 2 (3000–2850 BP). B290 was also radiocarbon dated using associated shell and charcoal adhering to the femur, yielding a calibrated date of 3005–2915 cal BP (OxA-16340 and OxA-16341) consistent with radiocarbon dates from other individuals from Bronze Age 2 (Higham and Higham 2009).

Bronze Age 2 is a layer characterized by discernible mortuary wealth. Thirty-four individuals are associated with this phase. All noninfants were buried extended supine, wrapped either in a shroud, or buried in a wooden coffin. All individuals past infancy were buried with numerous shell bangles, diverse ceramic forms, shell disk beads, and bronze and stone artifacts representing an intricate and vast trade network. Mortuary wealth in terms of quantity and quality significantly exceeded that of Bronze Age 1 and contemporary Bronze Age sites on the Khorat Plateau including Ban Chiang, Ban Na Di, Non Nok Tha and Ban Lum Khao (Higham 2011).

2.2 | B290

Burial 290 was a middle-aged adult male (Tayles, personal communication; Higham and Kijngam 2012). Sex estimation was based on pelvic morphology, and age-at-death estimation was based on the pubic symphysis (Brooks and Suchey 1990; Buikstra and Ubelaker 1994). Unfortunately, many of the bones were covered in a hard calcareous deposit that could not be removed during cleaning without also removing the periosteal surface. His skeleton was complete (Figure S1). Severely shortened humeri with deformity of the humeral heads were clearly apparent during excavation, prompting further skeletal analysis.

2.3 | Differential Diagnosis

A thorough differential diagnosis was conducted to account for the physical and mental health implications of possible disability for B290. All skeletal and dental pathology was systematically recorded for the individual. Pathological features, including long bone deformities and short stature (see below), were consistent with skeletal dysplasia. The skeletal characteristics of B290 were compared with clinical descriptions of skeletal dysplasias to assess the most plausible group of disorders consistent with B290's pathology. Table S1 provides an extensive, albeit nonexhaustive, list of 56 dysplasias reported in the clinical literature that were considered in the differential diagnosis.

3 | Results

3.1 | Pathological Description

B290 presented with a complete skeleton with some bone surfaces was covered in concretions that could not be removed. Regions of the cranium, scapulae, and ribs were fragmented, particularly at bone ends with a higher trabecular to cortex bone ratio. Many features were observable in the original burial photos but were no longer clearly present following postexcavation and curation.

B290 exhibited bilateral shortening of his humeral shafts (left = 255 mm), while retaining typical maximum lengths for his radii (right = 265 mm) and ulnae (right = 287 mm). The mean maximum length of the humeri for Bronze Age males from the site was 318 mm (range = 297–337 mm, excluding B290), the radius 257 mm (range = 241–279 mm), and ulna 278 mm (range = 260–298 mm) (Clark et al. 2014). The femoral epiphyses were too fragmented to determine maximum length, but at the time of excavation, the femora were proportionate in length to that of the tibiae, indicating femoral shortening (Figure 2). These findings are consistent with mild to moderate rhizomelia, where the proximal bones of the limbs are shorter than the distal bones (Yadav 2023). Both humeral heads displayed varus deformity (inferiorly slipped humeral heads), associated with severe osteophytic development (likely secondary to the varus deformity; Figure 2; Canci et al. 2024), and concave deformity of the glenoid cavities of the scapulae. It is also possible that the right shoulder joint exhibited ankylosis, but this was difficult to discern due to the poor preservation and soil concretions on the affected bone surfaces. The shafts of the humerii were short and thick, with mild medial bowing at the region of the deltoid tuberosities that were markedly robust. Radiographic examination revealed thin humeral shaft cortices, indicative of atrophy (Figure 2). The femoral necks displayed bilateral coxa vara (inferior depression of the femoral head epiphyses and necks leading to an angle < 120°), and the tibiae demonstrated mild bowing, particularly along

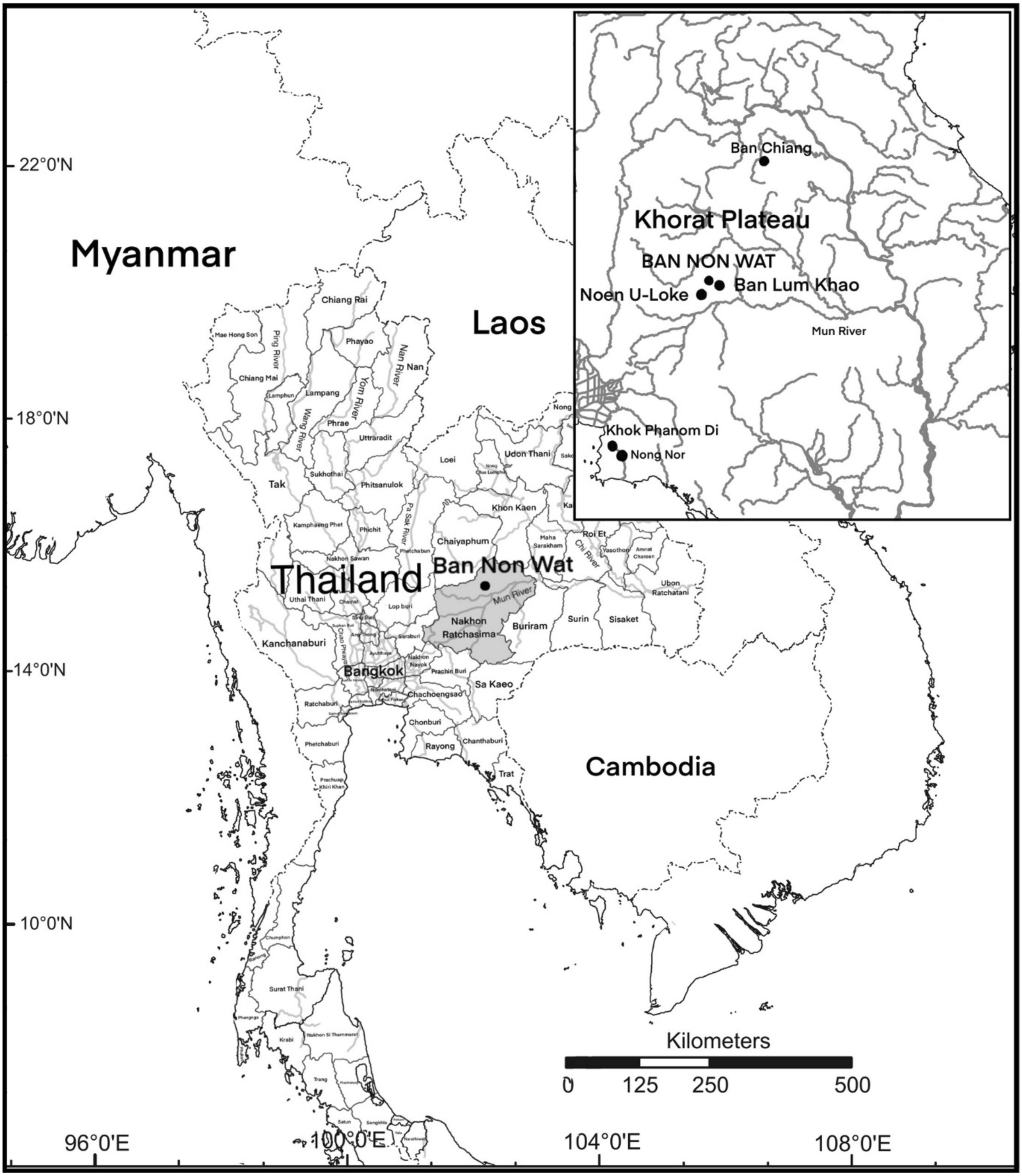

FIGURE 1 | Map of Thailand showing the location of Ban Non Wat in Northeastern Thailand. The left map represents current provinces; the right shows nearby archaeological sites and major riverways.

the anterior crest (genu valgum). The maximum lengths of the tibiae (left = 365 mm) were within the typical range for Early Bronze Age males at Ban Non Wat (mean for males = 378 mm; range = 350–423 mm) (Clark et al. 2014). The right tibia displayed remodeled new bone along the lateral shaft. The axial skeleton appeared typical, except for mild expansion of the cranial vault, more pronounced posteriorly (macrocephaly). Squared ilia were present. No clear deformities were observed on the hand and foot bones. B290 also exhibited complete bony fusion of the 11th and 12th thoracic vertebrae known as block vertebra (Barnes 2012, 92), inclusive of both the bodies and arches, with osteoarticular changes to the demifacets.

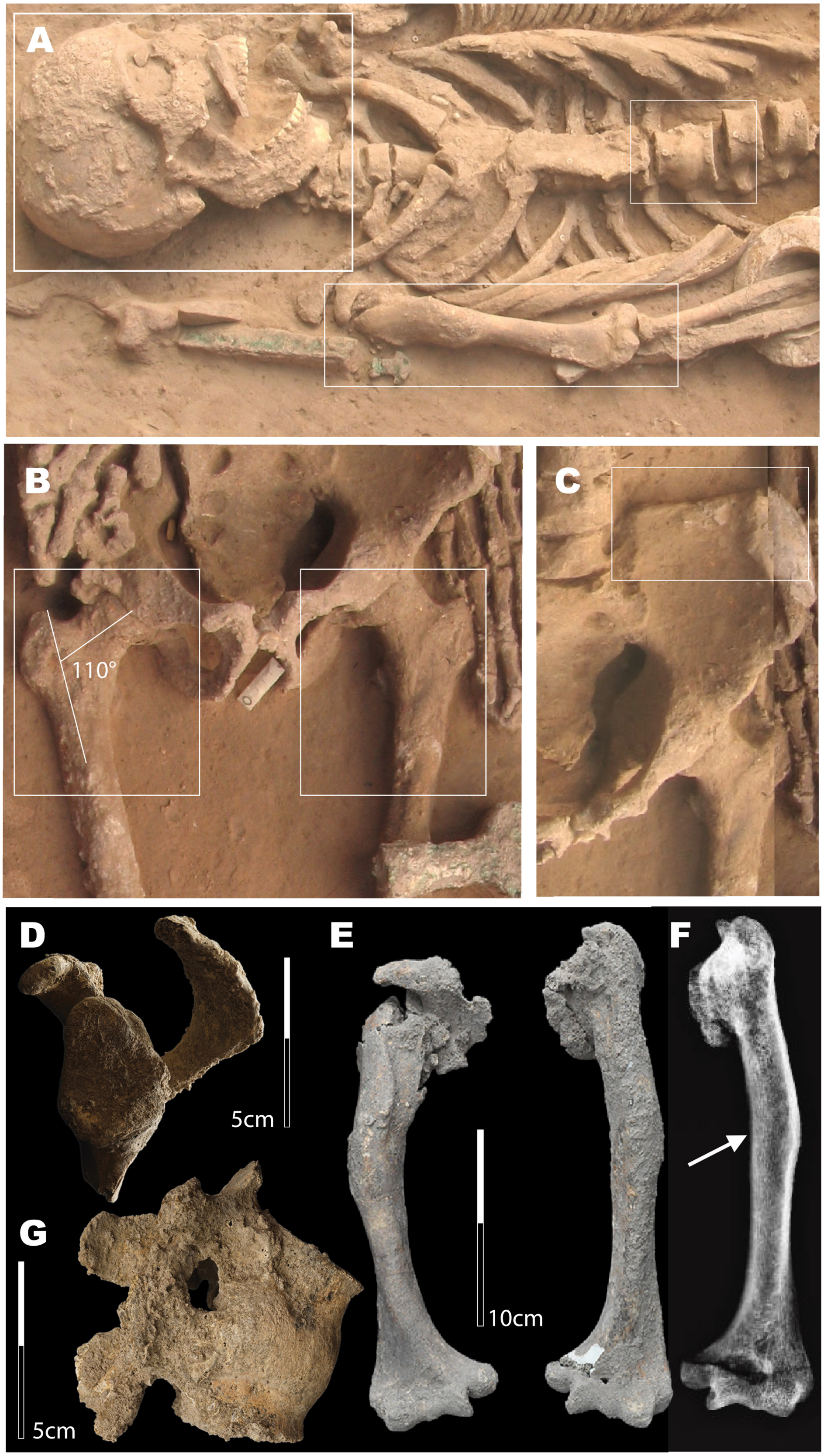

FIGURE 2 | Skeletal lesions consistent with skeletal dysplasia. Pathology identified by white squares. (A) Macrocephaly is apparent in relation to the size of the postcranium in situ. The right humerus deformity and the T11 and T12 block vertebra are also visible in situ. (B) Bilateral coxa vara observed in situ. (C) Square ilia observed in situ. (D) Deformity of the left glenoid fossa. (E) Bilateral shortage of the humeri and severe humerus varus, mild medial bending, marked deltoid tuberosities, and severe secondary osteoarticular changes to the shoulder joints. (F) Cortical thinning indicates likely disuse atrophy and confirmation of slipped proximal humeral epiphysis (white arrow). (G) Lateral view of thoracic block vertebra of T11 and T12. [Colour figure can be viewed at wileyonlinelibrary.com]

TABLE 1 | Skeletal features of B290 associated with three skeletal dysplasias.

Skeletal feature of B290	Characteristic of hypochondroplasia	Characteristic of pseudoachondroplasia	Characteristic of multiple epiphyseal dysplasia	References
Moderately short stature as evidenced by femoral and humeral shortening	Yes	No Typically, those with the condition are shorter than B290.	Yes	Bober et al. (2020); Unger and Hecht (2001)
Macrocephaly with typical facial features and lack of frontal bossing (mild)	Yes	No Facial features are typical, and so is cranial size.	No Facial features are typical, and so is cranial size.	Bober et al. (2020)
Rhizomelia	Yes	No	No	Bober et al. (2020); Weiner et al. (2019)
Block vertebra (T11-T12)	No specific reference to block vertebrae but thoracolumbar kyphosis and wedging (hemivertebrae) are observed in achondroplasia and hypochondroplasia alongside spinal stenosis. These findings indicate segmental anomalies of the mesoderm do occur.	No Condition is associated with “beaked” anterior vertebral bodies (platyspondyly).	No	Bober et al. (2020); Randolph et al. (1988); Weiner et al. (2019); Wynne-Davies et al. (1981)
Genu valgum (mild)	Yes	Yes	Yes	Bober et al. (2020); Weiner et al. (2019); Unger et al. (2008)
Squared ilia	Yes	No	No	Bober et al. (2020)
Prominent deltoid tuberosities	Yes	No	No	Bober et al. (2020)
Bilateral coxa vara	No	Yes	Yes	Fletcher and D'Ambrosia (1983); Weiner et al. (2019); Prinster et al. (2001); Anthony et al. (2015)
Bilateral humerus varus	No	Yes	Yes	Weiner et al. (2019); Anthony et al. (2015)
Secondary articular degeneration	Yes	Yes	Yes	Onesimo et al. (2023); Unger and Hecht (2001); Weiner et al. (2019)

3.2 | Differential Diagnosis

The three disproportionate skeletal dysplasias most consistent with the pathology observed in B290 are hypochondroplasia, multiple epiphyseal dysplasia, and pseudoachondroplasia (Tables 1 and S1; Data S1). No single condition accounts for all the skeletal features observed in B290.

4 | Discussion

No other archaeological cases of skeletal dysplasia are currently reported for Southeast Asia. However, some individuals have been reported with significantly short stature that may be the result of genetically determined atypical growth, suggesting B290's case is not unique for the cultural contexts of ancient Southeast Asia. For example, Willis and Oxenham (2013) described a young adult female with gracile bones, short stature (~144–146 cm) and possible delayed epiphyseal fusion from An Son in Southern Vietnam dated to the Neolithic (4100–3050 cal BP) and buried with her full-term perinatal infant. She had a markedly small pelvic inlet and outlet, which the authors considered to be possibly related to the death of the mother and infant who was still in an apparent breech position. The features of this female individual are consistent with skeletal dysplasias accompanied with delayed pubertal development, possibly proportionate dwarfism such as hypopituitarism. Domett et al. (2016) presented a case of a proportionately short statured young female from Bronze Age 1 at Ban Non Wat (3050–3000 BP). Her estimated stature was 143.5 cm and 2.3 standard deviations below the mean stature for females at the site. Another female at Neolithic Khok Phanom Di in South Central Thailand was estimated to be 141.1 cm tall and 2.9 standard deviations below the mean stature for Khok Phanom Di females (Domett et al. 2016; Tayles 1999). This individual displayed pathological features consistent with genetic haemoglobinopathy that would have significantly stunted her growth (Tayles 1996). It is not unreasonable to suggest given the degree of interconnectedness of cultures across Thailand and Vietnam that these cases, in combination with B290, potentially reflect a shared collective understanding within Mainland Southeast Asian prehistory around the Neolithic to Bronze Age of the value of human life regardless of perceived ability.

Whereas other examples of markedly short statured individuals from ancient Mainland Southeast Asia represent inclusion across gender, status and age, B290 was born into an elite community. Therefore, abundant resources available to him and his community likely further supported the ability to accommodate his difference, mitigating some of the challenges he may have had in lower socioeconomic circumstances, and provided a greater diversity of less laborious yet socially meaningful roles available to him in his community. The hip, spine, and shoulder deformities of B290 would have significantly impaired mobility and function of his upper body, restricting the physical activities he may have been expected to participate in otherwise such as hunting, foraging, farming, other manual labor, or craftsmanship. The extreme exostoses of his shoulder joints suggest that B290 forced the mobility of his shoulders regardless of likely pain and inflammation, until the exostoses limited the mobility at the joint in its near entirety. Detailed description of the biological constraints of B290 not only provides insight into the role flexibility was required to allow B290 meaningful participation in his community but also indicates personal motivations to contribute, given the active mechanical actions required to develop the skeletal lesions of his shoulder.

4.1 | Study Limitations

Challenges in differential diagnosis due to overlapping clinical features of skeletal dysplasias and preservation issues of pathological bone limit the interpretation of B290's care. No destructive analyses such as histological or genetic testing were able to be undertaken. This research focused on describing the specific pathological and biological limitations of B290. Future research will involve an in depth Bioarchaeology of Care analysis incorporating social theory of disability (Kaoboriboon et al., forthcoming).

Acknowledgments

This research was funded through a University of Sydney Southeast Asia Centre Workshop grant, financial support from the Thai Fine Arts Department, and the Faculty of Archaeology, Silpakorn University, Thailand. The original excavation of the cemetery site of Ban Non Wat was conducted with assistance from the current residents of Ban Non Wat and approved by the National Research Council of Thailand and the Fine Arts Department. The local residents have since built a museum dedicated to the education of the prehistory of their village. Open access publishing facilitated by Charles Sturt University, as part of the Wiley - Charles Sturt University agreement via the Council of Australasian University Librarians

Funding

This work was supported by the Sydney Southeast Asia Centre, University of Sydney; the Thai Fine Arts Department; and the Silpakorn University.

Conflicts of Interest

The authors declare no conflicts of interest.

Data Availability Statement

The data that support the findings of this study are available in the Supporting Information.

References

Alanay, Y., and R. S. Lachman. 2011. "A Review of the Principles of Radiological Assessment of Skeletal Dysplasias." *Journal of Clinical Research in Pediatric Endocrinology* 3, no. 4: 163–178.

Anthony, S., R. Munk, W. Skakun, and M. Masini. 2015. "Multiple Epiphyseal Dysplasia." *Journal of the American Academy of Orthopaedic Surgeons* 23, no. 3: 164–172.

Barnes, E. 2012. *Atlas of Developmental Field Anomalies of the Human Skeleton: A Paleopathology Perspective*. John Wiley & Sons.

Biswas, A., F. Furruqh, M. Raz, and M. Ditchfield. 2022. "Skeletal Dysplasias." In *Challenging Cases in Paediatric Radiology*, 1–25. Springer.

Bober, M. B., G. A. Bellus, S. M. Nikkel, and G. E. Tiller. 2020. "Hypochondroplasia." In *GeneReviews* (PMID: 20301650, edited by M. P. Adam. University of Washington.

Brooks, S., and J. M. Suchey. 1990. “Skeletal Age Determination Based on the Os Pubis: A Comparison of the Acsádi-Nemeskéri and Suchey-Brooks Methods.” *Human Evolution* 5, no. 3: 227–238.

Buikstra, J. E., and D. H. Ubelaker. 1994. “Standards for Data Collection From Human Skeletal Remains.” Arkansas Archaeological Survey Research Series No. 44. Fayetteville, AR: Arkansas Archaeological Survey.

Canci, A., D. Marchi, D. Caramella, and V. S. Sparacello. 2024. “A Severe Case of Bilateral Humerus Varus Deformity From the Middle Bronze Age Necropolis of Olmo di Nogara, Northeast Italy. The Contribution of Biomechanical Analysis to Paleopathological Study.” *International Journal of Paleopathology* 47: 12–20.

Clark, A. L., N. Tayles, and S. E. Halcrow. 2014. “Aspects of Health in Prehistoric Mainland Southeast Asia: Indicators of Stress in Response to the Intensification of Rice Agriculture.” *American Journal of Physical Anthropology* 153, no. 3: 484–495.

Domett, K., J. Newton, A. Colbert, N. Chang, and S. E. Halcrow. 2016. “Frail, Foreign or Favoured? A Contextualized Case Study From Bronze Age Northeast Thailand.” In *The Routledge Handbook of Bioarchaeology in Southeast Asia and the Pacific Islands*, 96–137. Routledge.

Fletcher, R., and R. D'Ambrosia. 1983. “Coxa Vara in Achondroplasia Treated by Valgus Osteotomy.” *Orthopedics* 6, no. 8: 1024–1028.

Higham, C. 2011. “The Bronze Age of Southeast Asia: New Insight on Social Change From Ban Non Wat.” *Cambridge Archaeological Journal* 21, no. 3: 365–389.

Higham, C. F. W., and T. Higham. 2009. “A New Chronological Framework for Prehistoric Southeast Asia, Based on a Bayesian Model From Ban Non Wat.” *Antiquity* 83, no. 319: 125–144.

Higham, C., and A. Kijngam. 2012. *The Excavation of Ban Non Wat: The Bronze Age*. Thai Fine Arts Department.

Kaoboriboon, N., N. Tayles, S. A. Villaluz, P. Yuwono, K. Domett, and M. Vlok. forthcoming. “Accommodation as Care in a High-Status Bronze Age Community in Northeast Thailand (3000–2500BP).” *Bioarchaeology International*.

Krakow, D. 2015. “Skeletal Dysplasias.” *Clinics in Perinatology* 42, no. 2: 301–319.

Molto, J. E., and C. L. Kirkpatrick. 2018. “How Short Is Short, and Why? A Probable Case of Proportionate Dwarfism From Egypt's Third Intermediate Period in the Dakhleh Oasis, Egypt.” *International Journal of Osteoarchaeology* 28, no. 1: 3–17.

Onesimo, R., E. Sforza, M. F. Bedeschi, et al. 2023. “How Pain Affect Real Life of Children and Adults With Achondroplasia: A Systematic Review.” *European Journal of Medical Genetics* 66: 104850.

Prinster, C., M. D. Maschio, G. Beluffi, et al. 2001. “Diagnosis of Hypochondroplasia: The Role of Radiological Interpretation.” *Pediatric Radiology* 31: 203–208.

Randolph, L., M. Shohat, D. Miller, et al. 1988. “Achondroplasia With Ankylosing Spondylitis.” *American Journal of Medical Genetics* 31, no. 1: 117–121.

Tayles, N. 1996. “Anemia, Genetic Diseases, and Malaria in Prehistoric Mainland Southeast Asia.” *American Journal of Physical Anthropology* 101, no. 1: 11–27. https://doi.org/10.1002/(sici)1096-8644(199609)101:1<11::aid-ajpa2>3.0.co;2-g.

Tayles, N. 1999. “The Excavation of Khok Phanom Di a Prehistoric Site in Central Thailand Volume V: The People.” Reports—Research Committee Society of Antiquaries London.

Unger, S., L. Bonafé, and A. Superti-Furga. 2008. “Multiple Epiphyseal Dysplasia: Clinical and Radiographic Features, Differential Diagnosis and Molecular Basis.” *Best Practice & Research Clinical Rheumatology* 22, no. 1: 19–32. https://doi.org/10.1016/j.berh.2007.11.009.

Unger, S., and J. T. Hecht. 2001. “Pseudoachondroplasia and Multiple Epiphyseal Dysplasia: New Etiologic Developments.” *American Journal of Medical Genetics* 106, no. 4: 244–250.

Weiner, D., J. Guirguis, M. Makowski, S. Testa, L. Shauver, and D. Morgan. 2019. “Orthopaedic Manifestations of Pseudoachondroplasia.” *Journal of Children's Orthopaedics* 13, no. 4: 409–416.

Willis, A., and M. F. Oxenham. 2013. “A Case of Maternal and Perinatal Death in Neolithic Southern Vietnam, c. 2100–1050 BCE.” *International Journal of Osteoarchaeology* 23, no. 6: 676–684.

Wynne-Davies, R. U. T. H., W. K. Walsh, and J. E. S. S. Gormley. 1981. “Achondroplasia and Hypochondroplasia. Clinical Variation and Spinal Stenosis.” *Journal of Bone & Joint Surgery British Volume* 63, no. 4: 508–515.

Yadav, S. S. 2023. *Skeletal Dysplasias & Congenital Malformations*. Springer.

Zhou, Y., Y. Lu, J. He, et al. 2022. “Bioarchaeological Insights Into Disability: Skeletal Dysplasia From the Iron Age Northern China.” *International Journal of Osteoarchaeology* 32, no. 2: 367–377.

Supporting Information

Additional supporting information can be found online in the Supporting Information section. **Figure S1:** Supporting Information **Table S1:** Notable Skeletal Dysplasias in the Clinical Literature and their Clinical Characteristics **Data S1:** Supplementary Text 1: Skeletal dysplasias in the context of the archaeological record