

# Morphological and paleopathological report of the Late Jomon human remains from the Daizen-no-minami site, Chiba Prefecture

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**Abstract** The Daizen-no-minami site in Chiba prefecture located in the western region of the Boso Peninsula has yielded many Late Jomon human remains including 31 buried individuals and 130 scattered fragments. This article provides anthropological and paleopathological information about these human remains. The main findings are as follows: (1) The age and sex composition of the buried individuals comprise four adult males, eight adult females, seven adults of unknown sex, two children, three infants, and seven neonates: it is noteworthy that the percentage of juveniles, particularly neonates, is high. (2) The morphological characteristics and statures of the adult skeletons are common to those of the Jomon people. (3) The dental caries rate for permanent teeth of the Daizen-no-minami remains is clearly higher than the average caries rate of the Jomon period. (4) The occurrence rates of enamel hypoplasia in the Daizen-no-minami remains are high, which suggest that the Daizen-no-minami group suffered considerable stress in infancy and early childhood.

**Key words:** Daizen-no-minami site, Late Jomon, human remains

## Introduction

The Daizen-no-minami archaeological site in Chiba City, Chiba Prefecture is located in the Tokyo Bay area in the western region of the Boso Peninsula. An excavation survey conducted at this site between 2012 and 2013 led to the discovery of the Jomon shell mounds, pit dwellings, graves, pottery coffins, artifacts, faunal remains, and human remains. The human remains consisted of 31 buried individuals and more than one hundred of scattered bone fragments of the Late Jomon period. In many Jomon sites in the western region of Boso Peninsula, such as Kasori (Suzuki *et al.*, 1976), Ubayama (Kondo, 1993a, b), and Horinouchi (Suzuki *et al.*, 1957), there are dispersed shell mounds, which have yielded many human remains. The Daizen-no-minami human remains comprise a new collection in this

region that it is hoped will provide rich information for anthropological and archaeological studies of the Jomon period.

The authors have previously described the fundamental findings of the Daizen-no minami human remains in Sawada *et al.* (2014). This article aims to report the anthropological information about the buried individuals from the Daizen-no-minami site, and to supplement this with a new data list on the scattered human remains found at the site, which was not presented in the previous description. This article also discusses the paleopathological features of the remains to clarify the quality of life and health conditions of the Daizen-no-minami Jomon Late people.

## Materials and Methods

### The Daizen-no-minami human remains

The excavated human remains comprise 31 buried human individuals and 130 scattered human bone fragments. The buried human individuals consisted of one inhumed remain excavated from a grave (Grave remains No. 1), three inhumed remains excavated from non-grave locations (Inhumed remains Nos. 1, 3, and 4), 20 inhumed remains excavated from pit dwellings (Pit dwelling remains Nos. 9, 11, 18-1, 18-2, 40, 67-1, 67-2, 67-3, 67-4, 74-1, 74-2, 74-3, 74-4, 74-5, 74-6, 74-extra, 77, 79, 88, and 95), and seven infant remains excavated from pottery coffins (Pottery coffin remains Nos. 1, 2, 3, 4, 5, 6, and unnumbered). In the Kanto region, several buried human remains of the Middle and Late Jomon periods were found in pit dwellings, also known as abandoned pit dwellings (Takahashi, 2007; Yamamoto, 2015). The pit dwelling human remains in the Daizen-no-minami site may be connected to this lineage.

The 130 scattered human bone fragments were found in 21 locations, and the relationships between the scattered fragments and buried human remains, as well as between the scattered fragments, were unclear. Due to excavation conditions, it was not possible to determine whether the remains had originally been buried and were disturbed in later generations, or whether they had never been buried.

The cranial measurements, dental measurements, limb bone measurements, and cranial nonmetric traits data of the Daizen-no-minami human remains were used in Sawada *et al.* (2014). The statures of the human remains were estimated from the maximum length of the femur using the methods of Pearson (1899) and Fujii (1960).

### Age and sex determination

Age stages of growth were categorized into neonate (including perinate), infant (0–5 yrs), child (6–12 yrs), adolescent (13–19 yrs), young adult (20–39 yrs), middle adult (40–59 yrs), and

old adult (60 yrs +). The ages of adolescents and younger were determined based on teeth formation and eruption (Smith, 1991; Ubelaker, 1999), and bone size and synostosis (Scheuer and Black, 2000; Seta and Yoshino, 1990). The ages of adults were determined based on overall consideration of tooth attrition, the closure of the cranial suture, the state of the auricular surface of the ilium, and the surface of the pubic symphysis (Seta and Yoshino, 1990; White *et al.*, 2012). In cases where it was difficult to categorize a set of remains into a specific post-adolescent group, they were generally categorized as adult.

Sex was determined for adolescent and adult remains based primarily on the morphological features of the os coxae and cranium, which demonstrate sexual characteristics (White *et al.*, 2012). The sex of child and younger was not determined.

### Paleopathological investigation

Our paleopathological survey targeted dental caries, vertebral osteoarthritis, and linear enamel hypoplasia. The diagnosis and identification standards for each disease are described below.

(1) Dental caries: The identification criteria were pursuant to Hillson (1996).

(2) Vertebral osteoarthritis: The superior and inferior articular surfaces of the adult cervical vertebrae (C2–C7), thoracic vertebrae, and lumbar vertebrae were examined for vertebral osteoarthritis. The definition of osteoarthritis was according to the criteria of Higuchi (1983).

(3) Enamel hypoplasia: Upper central incisors (UI1) and lower canines (LC) were observed with a 10× magnifying lens under an LED light; enamel defects such as horizontal furrows and pits in a row parallel to the perikymata on the crown surface were identified as enamel hypoplasia in accordance with Goodman and Rose (1990) and Hillson (1996). In principle, the teeth on the right side were observed. Any crown surfaces lacking more than half of the original crown height were out of scope to avoid the influences of tooth wear; the presence or absence of hypoplasia within half of the original crown

height were recorded.

## Results and Discussion

### Composition of the human remains

For each human remain of the 31 buried indi-

viduals and 130 scattered bone fragments, the condition of burial, age, sex, and main excavated parts are summarized in Tables 1 and 2.

The 31 buried individuals comprise four males (one late adolescent, one young adult, one young/middle adult, one middle/old adult), eight

Table 1. Daizen-no-minami burial individuals

Burial No.	Burial No.in Japanese	Age	Sex	Skeletal remains	Preservation
Inhumed remains No. 1	1号单独	young/middle adult	female	cranium, mandible, upper limbs	poor
Inhumed remains No. 3	3号单独	middle/old adult	unknown	cranium	poor
Inhumed remains No. 4	4号单独	adult	unknown	cranium, upper limbs, lower limbs	poor
Grave remains No. 1	1号土坑墓	adult	unknown	cranium, upper limbs, lower limbs	poor
Pit dwelling No. 9 remains	9号住	neonate	unknown	deciduous teeth, lower limbs	poor
Pit dwelling No. 11 remains	11号住	adult	unknown	cranium, mandible, upper limbs, lower limbs	poor
Pit dwelling No. 18 remains (18-1)	18号住-1	young adult	female	cranium, mandible, vertebrae, upper limbs, lower limbs	good
Pit dwelling No. 18 remains (18-2)	18号住-2	child	unknown	cranium, mandible, vertebrae, upper limbs, lower limbs	good
Pit dwelling No. 40 remains	40号住	young/middle adult	male	cranium, vertebrae, upper limbs, lower limbs	poor
Pit dwelling No. 67 remains (67-1)	67号住-1	young adult	female	cranium, mandible, vertebrae	moderate
Pit dwelling No. 67 remains (67-2)	67号住-2	middle/old adult	unknown	cranium, mandible	poor
Pit dwelling No. 67 remains (67-1 and 2)	67号住-1・2	adult	unknown	vertebrae, upper limbs, lower limbs	moderate
Pit dwelling No. 67 remains (67-3)	67号住-3	adult	unknown	vertebrae, upper limbs, lower limbs	poor
Pit dwelling No. 67 remains (67-4)	67号住-4	child	unknown	cranium	poor
Pit dwelling No. 74 remains (74-1)	74号住-1	young adult	female	cranium, mandible, vertebrae, upper limbs, lower limbs	good
Pit dwelling No. 74 remains (74-2)	74号住-2	middle/old adult	female	cranium, mandible, vertebrae, upper limbs, lower limbs	good
Pit dwelling No. 74 remains (74-3)	74号住-3	infant	unknown	cranium, mandible, vertebrae, upper limbs, lower limbs	poor
Pit dwelling No. 74 remains (74-4)	74号住-4	middle adult	female	mandible, vertebrae, upper limbs, lower limbs	moderate
Pit dwelling No. 74 remains (74-5)	74号住-5	late adolescent	male	mandible, vertebrae, upper limbs, lower limbs	moderate
Pit dwelling No. 74 remains (74-6)	74号住-6	young adult	female	cranium, mandible, vertebrae, upper limbs, lower limbs	moderate
Pit dwelling No. 74 remains (74-extra)	74号住-番外	young/middle adult	female	cranium	poor
Pit dwelling No. 77 remains	77号住床下	infant	unknown	vertebrae, upper limbs, lower limbs	moderate
Pit dwelling No. 79 remains	79号住	middle/old adult	male	cranium, mandible, vertebrae, upper limbs, lower limbs	moderate
Pit dwelling No. 88 remains	88号住	young adult	male	cranium, mandible, upper limbs, lower limbs	poor
Pit dwelling No. 95 remains	95号住	neonate	unknown	vertebrae, lower limbs	poor
Pottery coffin remains No. 1	1号小児土器棺	neonate	unknown	cranium, mandible, vertebrae, upper limbs, lower limbs	good
Pottery coffin remains No. 2	2号小児土器棺	infant (3–6 months)	unknown	cranium, mandible, vertebrae, upper limbs, lower limbs	poor
Pottery coffin remains No. 3	3号小児土器棺	neonate	unknown	cranium, mandible, vertebrae, upper limbs, lower limbs	good
Pottery coffin remains No. 4	4号小児土器棺	neonate	unknown	cranium, mandible, vertebrae, upper limbs, lower limbs	poor
Pottery coffin remains No. 5	5号小児土器棺	neonate	unknown	cranium, mandible, vertebrae, upper limbs, lower limbs	moderate
Pottery coffin remains No. 6	6号小児土器棺	neonate	unknown	cranium, mandible, vertebrae, upper limbs, lower limbs	good
Pottery coffin remains unnumbered	北貝層Q26区土器内	neonate	unknown	vertebrae, limbs	poor

Table 2. Daizen-no-minami scatterd human bone fragments

Scatterd bone No.	Excavated place	Excavated place in Japanese	Skeletal parts
S-001	Pit dwelling remains No 67	67号住	limb bones fragments
S-002	Pit dwelling remains No 67	67号住	mandible fragment
S-003	Pit dwelling remains No 67	67号住	cranium fragment
S-004	Pit dwelling remains No 67	67号住	zygomatic bone (right)
S-005	Pit dwelling remains No 67	67号住	zygomatic process (left)
S-006	Pit dwelling remains No 67	67号住	vertebra fragment
S-007	Pit dwelling remains No 67	67号住	rib fragment
S-008	Pit dwelling remains No 74	74号住	first metatarsal (left)
S-009	Pit dwelling remains No 74	74号住	fibula diaphysis (left)
S-010	Pit dwelling remains No 74	74号住	proximal hand phalanx
S-011	Pit dwelling remains No 74	74号住	femur unfused distal end (right)
S-012	Pit dwelling remains No 74	74号住	medial cuneiform (right)
S-013	Pit dwelling remains No 74	74号住	intermediate hand phalanx
S-014	Pit dwelling remains No 74	74号住	metatarsal fragment
S-015	Pit dwelling remains No 74	74号住	iliac crest
S-016	Pit dwelling remains No 74	74号住	talus (left)
S-017	Pit dwelling remains No 74	74号住	navicular (left)
S-018	Pit dwelling remains No 74	74号住	calcaneus (left)
S-019	Pit dwelling remains No 74	74号住	distal pollical phalanx
S-020	Pit dwelling remains No 74	74号住	first metatarsal (left)
S-021	Pit dwelling remains No 74	74号住	fifth metatarsal (right)
S-022	Pit dwelling remains No 74	74号住	metatarsal fragment
S-023	Pit dwelling remains No 74	74号住	proximal pollical phalanx
S-024	Pit dwelling remains No 74	74号住	UM1 (left)
S-025	Pit dwelling remains No 74	74号住	navicular (left)
S-026	Pit dwelling remains No 74	74号住	fourth? metatarsal (right)
S-027	Pit dwelling remains No 74	74号住	proximal hand phalanx
S-028	Pit dwelling remains No 74	74号住	fifth metacarpal (right)
S-029	Pit dwelling remains No 74	74号住	fifth metacarpal (left)
S-030	Pit dwelling remains No 74	74号住	metacarpal fragment
S-031	Pit dwelling remains No 74	74号住	metacarpal fragment
S-032	Pit dwelling remains No 74	74号住	proximal hand phalanx
S-033	Pit dwelling remains No 74	74号住	cuboid (left)
S-034	Pit dwelling remains No 74	74号住	scaphoid
S-035	Pit dwelling remains No 74	74号住	UM2 or UM3 (right)
S-036	Pit dwelling remains No 74	74号住	third metacarpal (left)
S-037	Pit dwelling remains No 74	74号住	fourth metacarpal (left)
S-038	Pit dwelling remains No 74	74号住	patella (right)
S-039	Pit dwelling remains No 74	74号住	proximal hand phalanx
S-040	Pit dwelling remains No 74	74号住	femur unfused distal end fragment
S-041	Pit dwelling remains No 74	74号住	talus (right)
S-042	Pit dwelling remains No 74	74号住	tibia proximal end fragment
S-043	Pit dwelling remains No 74	74号住	hamate (left)
S-044	Pit dwelling remains No 74	74号住	lumbar vertebra fragment
S-045	Pit dwelling remains No 74	74号住	femur distal end fragment
S-046	Pit dwelling remains No 74	74号住	metatarsal fragment
S-047	Pit dwelling remains No 74	74号住	navicular (right)
S-048	Pit dwelling remains No 74	74号住	first metatarsal (right)
S-049	Pit dwelling remains No 74	74号住	medial cuneiform (left)
S-050	Pit dwelling remains No 74	74号住	thoracic vertebra fragment
S-051	Pit dwelling remains No 74	74号住	thoracic vertebra fragment
S-052	Pit dwelling remains No 74	74号住	thoracic vertebra fragment
S-053	Pit dwelling remains No 74	74号住	mandibular condyle (right)
S-054	Pit dwelling remains No 74	74号住	odontoid process of the axis
S-055	Pit dwelling remains No 74	74号住	vertebra fragment
S-056	Pit dwelling remains No 74	74号住	vertebra fragment
S-057	Pit dwelling remains No 74	74号住	vertebra fragment
S-058	Pit dwelling remains No 74	74号住	rib multiple fragments
S-059	Pit dwelling remains No 74	74号住	scapla fragment
S-060	Pit dwelling remains No 74	74号住	hamate (left)
S-061	Pit dwelling remains No 74	74号住	vertebra fragment (infant)
S-062	Pit dwelling remains No 74	74号住	vertebra fragment (infant)
S-063	Pit dwelling remains No 74	74号住	vertebra fragment (infant)
S-064	Pit dwelling remains No 74	74号住	limb bone fragment (infant)
S-065	Pit dwelling remains No 74	74号住	limb bone fragment (infant)
S-066	Pit dwelling remains No 74	74号住	proximal foot phalanx fragment

Table 2. Continued

Scattered bone No.	Excavated place	Excavated place in Japanese	Skeletal parts
S-067	Pit dwelling remains No 79	79号住	parietal fragment
S-068	Pit dwelling remains No 79	79号住	upper molar (fragment)
S-069	Pit dwelling remains No 80	80号住	femur diaphysis fragment
S-070	Pit No. 404	404号土坑	cranium fragment
S-071	Layer III	III層	cranium fragment
S-072	Topsoil layer at Area No. AA27	AA27区表土	tibia diaphysis (left)
S-073	Test trench No. 23	試掘23トレンチCC24区	cranium fragment
S-074	Test trench No. 23	試掘23トレンチCC24区	cranium fragment
S-075	Test trench No. 23	試掘23トレンチCC24区	cranium fragment
S-076	Test trench No. 23	試掘23トレンチCC24区	cranium fragment
S-077	Test trench No. 23	試掘23トレンチCC24区	cranium fragment
S-078	Test trench No. 23	試掘23トレンチCC24区	cranium fragment
S-079	Test trench No. 23	試掘23トレンチCC24区	cranium fragment
S-080	Test trench No. 23	試掘23トレンチCC24区	cranium fragment
S-081	Test trench No. 23	試掘23トレンチCC24区	cranium fragment
S-082	Test trench No. 23	試掘23トレンチCC24区	cranium fragment
S-083	Test trench No. 23	試掘23トレンチCC24区	cranium fragment
S-084	Test trench No. 23	試掘23トレンチCC24区	cranium fragment
S-085	Test trench No. 23	試掘23トレンチCC24区	cranium fragment
S-086	Test trench No. 23	試掘23トレンチCC24区	cranium fragment
S-087	Test trench No. 23	試掘23トレンチCC24区	cranium fragment
S-088	Surface of Area No. Q25	Q25区表採	femur diaphysis fragment
S-089	Shell mound	貝層	tibia diaphysis (right)
S-090	Shell mound	貝層	tibiam unfused diaphysis (left)
S-091	Shell mound	貝層	fibula diaphysis fragment
S-092	North shell mound	北貝区 貝表層	cranium fragment
S-093	North shell mound	北貝区 貝表層	cranium fragment
S-094	North shell mound	北貝区 貝表層	cranium fragment
S-095	North shell mound	北貝区 貝表層	cranium fragment
S-096	North shell mound	北貝層	intermediate hand phalanx
S-097	North shell mound	北貝層	LM1 (right)
S-098	Topsoil layer of South shell mound	南貝BB24区表土層	cranium fragment
S-099	Topsoil layer of South shell mound	南貝BB24区表土層	cranium fragment
S-100	Topsoil layer of South shell mound	南貝BB24区表土層	cranium fragment
S-101	Topsoil layer of South shell mound	南貝BB24区表土層	cranium fragment
S-102	Topsoil layer of South shell mound	南貝BB24区表土層	cranium fragment
S-103	Topsoil layer of South shell mound	南貝BB24区表土層	cranium fragment
S-104	Topsoil layer of South shell mound	南貝BB24区表土層	cranium fragment
S-105	Topsoil layer of South shell mound	南貝BB24区表土層	cranium fragment
S-106	Topsoil layer of South shell mound	南貝BB24区表土層	cranium fragment
S-107	Topsoil layer of South shell mound	南貝BB24区表土層	cranium fragment
S-108	Layer III of South shell mound	南貝BB23区III層	cranium fragment
S-109	Layer III of South shell mound	南貝BB23区III層	cranium fragment
S-110	Layer III of South shell mound	南貝BB23区III層	cranium fragment
S-111	Layer III of South shell mound	南貝BB23区III層	cranium fragment
S-112	Layer III of South shell mound	南貝BB23区III層	cranium fragment
S-113	Layer III of South shell mound	南貝BB23区III層	cranium fragment
S-114	Layer III of South shell mound	南貝BB23区III層	cranium fragment
S-115	Layer III of South shell mound	南貝BB23区III層	cranium fragment
S-116	Layer III of South shell mound	南貝BB23区III層	cranium fragment
S-117	Layer III of South shell mound	南貝BB23区III層	cranium fragment
S-118	Layer III of South shell mound	南貝BB23区III層	cranium fragment
S-119	Layer III of South shell mound	南貝BB23区III層	cranium fragment
S-120	Topsoil layer of South shell mound	南貝V26区表土層	UI2 (right)
S-121	Topsoil layer of South shell mound	南貝V26区表土層	cranium fragment
S-122	Topsoil layer of South shell mound	南貝V26区表土層	cranium fragment
S-123	Topsoil layer of South shell mound	南貝V26区表土層	rib fragment
S-124	Topsoil layer of South shell mound	南貝V26区表土層	triquetral
S-125	Layer III of South shell mound	南貝区III層	talus (left)
S-126	Second sediment in South shell mound	南貝区近世掘削層	Limb bone fragment
S-127	Area No. R27	R27区	cranium fragment
S-128	Area No. S27	S29区	cranium fragment
S-129	Area No. T28	T28区	parietal bone fragment (right)
S-130	Area No. T28	T28区	temporal bone fragment (left)

Table 3. Cranial measurements (mm) and indices

Martin's No.	Measurement	Daizen-no-minami						Jomon <sup>1</sup>		Immigrant Yayoi <sup>2</sup>		Kofun <sup>3</sup>	
		Male			Female			Male	Female	Male	Female	Male	Female
		n	Mean	SD	n	Mean	SD						
1	Maximum cranial length	2	176.5	3.5	3	176.3	5.5	183.0	173.1	183.4	176.7	180.8	174.6
5	Basion-nasion length	0	—	—	3	102.0	2.6	103.8	98.1	101.8	96.4	100.6	96.3
8	Maximum cranial breadth	2	140.5	4.9	5	136.0	1.7	143.0	140.3	142.3	137.9	141.6	135.7
8/1		2	79.6	1.2	3	76.8	2.3	78.2	81.0	77.7	78.0	78.8	77.6
9	Least frontal breadth	1	96.0	—	4	91.0	2.2	96.9	95.2	96.3	93.1	95.1	92.2
9/8	Transversaler Frontoparietal index	1	70.1	—	4	66.8	1.8	—	—	—	—	—	—
17	Basionbregma height	0	—	—	4	132.8	2.6	140.9	133.6	137.0	130.0	134.0	130.6
17/1		0	—	—	3	75.9	3.2	77.0	77.2	75.0	73.8	74.2	74.7
17/8		0	—	—	4	98.2	2.1	98.7	96.6	96.3	94.7	94.5	95.8
45	Bizygomatic breadth	1	141.0	—	0	—	—	143.1	130.8	139.8	131.4	136.6	128.3
48	Upper facial height	1	68.0	—	0	—	—	66.1	59.3	74.3	69.5	68.8	66.3
48/45		1	48.2	—	0	—	—	46.3	47.0	53.0	53.0	50.7	50.8
51	Orbital breadth	0	—	—	5	38.4	1.7	43.5	41.4	43.3	41.6	43.0	41.8
52	Orbital height	2	30.5	0.7	3	31.0	2.0	33.4	33.6	34.5	33.9	34.1	33.1
52/51	Orbital index	0	—	—	3	78.8	3.3	77.1	80.9	79.7	81.5	79.4	79.3
54	Nasal breadth	0	—	—	2	24.5	0.7	27.8	25.1	27.1	26.4	26.4	25.4
61	External palate breadth	1	65.0	—	0	—	—	66.4	61.0	—	—	—	—
70	Condylloid height	2	60.0	1.4	4	56.5	4.7	61.4	55.1	63.7	58.1	61.4	56.8
71	Astbreite	2	38.0	4.2	6	35.7	1.6	34.7	34.1	37.0	34.9	35.4	32.4
71/70		2	63.5	8.6	4	61.7	3.6	57.6	61.6	58.7	60.6	58.1	58.0

In principle, the measurements of right side were used.

<sup>1</sup>Dodo (1986), <sup>2</sup>Nakahashi and Nagai (1997), <sup>3</sup>Ikeda (1993).

females (four young adults, two young/middle adults, one middle adult, one middle/old adult), seven adults of unknown sex, and 12 children and younger of unknown sex (two children, three infants, seven neonates). It is worth noting that in the age composition of the excavated human bones there are many juveniles, especially neonates. The risk of death for neonates is generally considered to be high in economically poor countries as well as regions with low levels of public health, which continue to have a significantly high infant mortality rate (WHO, 2013). Dozens of neonate remains have been found in several Jomon sites near the Daizen-no-minami site, such as the Saihiro Shell Mound in Chiba Prefecture and Komatsu Shell Mound in Ibaraki Prefecture (Morimoto *et al.*, 1977; Sawada, 2012), implying that newborn survival was by no means guaranteed in the living environment of the Jomon period.

### Morphological characteristics

Cranial measurements, measurements of permanent teeth and deciduous teeth, the appearance frequencies of cranial nonmetric traits, upper

limb bone measurements, and lower limb bone measurements are summarized in Tables 3, 4, 5, 6, 7, and 8, respectively.

#### (1) Cranial and dental morphology

The skulls excavated from the Daizen-no-minami site display features common among the Jomon people, such as lower facial skeleton, prominent nasalia, low and broad orbits, and no tendency to alveolar prognathism (Figure 1). Since the six skulls of relatively good condition were all females, the Penrose shape distance was calculated between the Daizen-no-minami females and Jomon females (Dodo, 1986), Immigrant Yayoi females (Nakahashi and Nagai, 1997), and Kofun Period females (Ikeda, 1993) using the values of the eight cranial measurements: maximum cranial length, basion-nasion length, maximum cranial breadth, basionbregma height, orbital breadth, orbital height, and nasal breadth. The Jomon females were closest to the Daizen-no-minami females, while the Immigrant Yayoi was farthest (Table 9). As a result of investigating the appearance of nonmetric traits, supraorbital foramina were present in only three

Table 4. Crown diameters of permanent teeth (mm)

	Male					Female					Sex unknown				
	n	Mean	SD	Min.	Max.	n	Mean	SD	Min.	Max.	n	Mean	SD	Min.	Max.
Mesiodistal diameters															
UI1	0	—	—	—	—	3	7.93	1.11	6.76	8.97	3	8.35	0.17	8.22	8.54
UI2	0	—	—	—	—	4	7.00	0.51	6.37	7.53	1	7.34	—	—	—
UC	0	—	—	—	—	4	7.42	0.39	6.90	7.79	1	8.12	—	—	—
UP1	1	6.13	—	—	—	4	6.99	0.36	6.66	7.43	1	7.25	—	—	—
UP2	1	6.20	—	—	—	4	6.64	0.52	6.17	7.38	0	—	—	—	—
UM1	1	10.37	—	—	—	4	10.59	0.49	9.90	11.01	2	10.19	0.45	9.87	10.50
UM2	0	—	—	—	—	3	9.05	0.76	8.20	9.66	1	9.90	—	—	—
UM3	0	—	—	—	—	1	9.45	—	—	—	0	—	—	—	—
LI1	1	4.74	—	—	—	4	5.04	0.38	4.68	5.53	1	5.83	—	—	—
LI2	1	5.99	—	—	—	3	5.80	0.77	5.05	6.58	1	6.10	—	—	—
LC	1	6.74	—	—	—	5	6.50	0.48	5.79	7.04	0	—	—	—	—
LP1	1	6.56	—	—	—	5	6.59	0.55	5.93	7.28	0	—	—	—	—
LP2	2	6.91	0.64	6.46	7.36	5	6.94	0.52	6.37	7.49	1	6.98	—	—	—
LM1	2	11.89	0.43	11.58	12.19	5	11.61	0.75	10.76	12.58	2	11.42	0.79	10.86	11.98
LM2	1	11.31	—	—	—	5	10.71	0.94	9.59	11.97	1	11.54	—	—	—
LM3	1	10.54	—	—	—	4	11.33	0.67	10.65	12.00	0	—	—	—	—
Buccolingual diameters															
UI1	0	—	—	—	—	3	7.13	0.45	6.76	7.63	2	7.35	0.33	7.11	7.58
UI2	0	—	—	—	—	4	6.58	0.36	6.35	7.11	1	6.57	—	—	—
UC	0	—	—	—	—	5	7.68	0.51	6.97	8.42	1	8.50	—	—	—
UP1	1	9.00	—	—	—	5	9.14	0.57	8.60	10.06	1	9.92	—	—	—
UP2	1	8.89	—	—	—	4	9.30	0.72	8.83	10.38	0	—	—	—	—
UM1	2	11.65	0.64	11.20	12.10	5	11.67	0.53	10.85	12.29	2	11.28	1.01	10.56	11.99
UM2	0	—	—	—	—	3	10.90	0.77	10.43	11.79	1	11.73	—	—	—
UM3	0	—	—	—	—	1	11.90	—	—	—	0	—	—	—	—
LI1	1	5.59	—	—	—	4	5.83	0.34	5.38	6.19	1	6.18	—	—	—
LI2	1	5.93	—	—	—	4	6.17	0.32	5.87	6.59	1	6.13	—	—	—
LC	1	7.18	—	—	—	6	7.16	0.33	6.77	7.74	0	—	—	—	—
LP1	1	7.56	—	—	—	5	7.80	0.48	7.09	8.26	0	—	—	—	—
LP2	2	8.30	0.05	8.26	8.33	5	8.27	0.69	7.65	9.43	1	8.26	—	—	—
LM1	2	10.99	0.04	10.96	11.01	5	10.97	0.42	10.52	11.44	2	10.52	0.96	9.84	11.20
LM2	1	10.32	—	—	—	5	10.34	0.64	9.44	11.06	1	10.87	—	—	—
LM3	1	9.51	—	—	—	4	10.24	0.56	9.50	10.82	0	—	—	—	—

In principle, the measurements of right teeth were used.

supraorbital remains out of all the 15 remains (Table 6). In addition, no clear shoveling was found in any of the upper central incisors (UI1) (Sawada *et al.*, 2014). Both supraorbital foramina and shoveling in UI1 appear less frequently in the Jomon population than in the Honshu populations of the Yayoi, Kofun, and historical era (Dodo and Ishida, 1990; Matsumura, 1994). These findings indicate that the morphological characteristics of the craniums and teeth of the Daizen-no-minami human remains were those commonly seen in the Jomon population.

Of the seven adult maxillae with the anterior alveolar process, alveolar closures due to tooth extraction were observed in three females and

one male. One of the three females had an upper right lateral incisor extracted; the other two females and the one male had upper left lateral incisors extracted. This tooth extraction pattern is not rare among the Late Jomon people of the Honshu. On the other hand, no extraction was found in the remaining three maxillae and all mandibles.

## (2) Limb bone morphology

In the Daizen-no-minami males, the lengths of femurs and tibiae could be measured; the maximum length of femur and the total length of tibia were within the range of 1 standard deviation (SD) from the average of the Jomon males pre-

Table 5. Crown diameters of deciduous teeth (mm)

	n	Mean	SD	Min.	Max.
Mesiodistal diameters					
Udi1	1	6.45	—	—	—
Udi2	1	5.66	—	—	—
Udc	1	6.53	—	—	—
Udm1	1	6.73	—	—	—
Udm2	1	8.58	—	—	—
Ldi1	1	4.01	—	—	—
Ldi2	1	4.45	—	—	—
Ldc	2	5.74	0.42	5.44	6.04
Ldm1	3	8.58	0.16	8.46	8.76
Ldm2	3	10.76	0.37	10.52	11.19
Buccolingual diameters					
Udi1	1	4.67	—	—	—
Udi2	1	4.89	—	—	—
Udc	1	5.44	—	—	—
Udm1	1	8.55	—	—	—
Udm2	1	9.44	—	—	—
Ldi1	1	3.64	—	—	—
Ldi2	1	4.10	—	—	—
Ldc	2	5.34	0.04	5.31	5.36
Ldm1	3	6.90	0.09	6.79	6.97
Ldm2	3	9.18	0.31	8.82	9.38

In principle, the measurements of right teeth were used.

sented in Yamaguchi (1982). In the females, the maximal length of clavicle, and the maximum lengths of humerus and femur were also within the range of 1 SD from the average of Jomon females, respectively; the maximum lengths of radius and ulna, and total length of tibia were within 1.5 SD. Therefore, for both males and females of the Daizen-no-minami site, their limb bones are regarded as the standard sized ones of the Jomon people.

All the female humeri were slender and the deltoid tuberosities were undeveloped, while the male humeri were robust and the deltoid tuberosities were well developed; the sex difference was remarkable. Neither of the females' femurs developed linea aspera. In the males, there were two types of the femur: one with linea aspera well developed (pilastered femur), and the other with linea aspera not so well developed. The cross-sectional shapes and platycnemic index of the tibiae were diverse, with three hypercnemia (two females, one male), four mesocnemia (three females, one sex unknown), and two platycnemia (one female, one male).

Table 6. Appearance frequencies of cranial non-metric traits

	N	%
Metopism	1/10	10.0
Supraorbital nerve groove	0/15	0.0
Supraorbital foramen	3/15	20.0
Ossicle at the lambda	0/10	0.0
Biasterionic suture trace	8/19	42.1
Asterionic bone	3/19	15.8
Occipito-mastoid wormians	0/13	0.0
Parietal notch bone	4/15	26.7
Condylar canal patent	8/9	88.9
Precondylar tubercle	0/11	0.0
Paracondylar process	0/0	—
Hypoglossal canal bridging	1/12	8.3
Foramen of Huschke	4/15	26.7
Foramen ovale incomplete	0/9	0.0
Foramen of Vesalius	3/7	42.9
Pterygo-spinous foramen	0/0	—
Medial palatine canal	0/6	0.0
Transverse zygomatic suture trace	6/11	54.5
Jugular foramen bridging	0/6	0.0
Sagittal sinus groove left	1/12	8.3
Clinoid Bridging	0/2	0.0
Mylohyoid bridging	3/24	12.5

N: number of the bones with nonmetric traits/total number of the bone remains.

### (3) Stature

The average stature of the Daizen-no-minami males, estimated by the method of Pearson (1899), was 161.2 cm, and, by the method of Fujii (1960), 159.8 cm; female stature was 146.2 cm (Pearson) and 145.5 cm (Fujii) (Table 10).

Hiramoto (1972) estimated the Kanto Jomon statures from their femurs by the method of Fujii (1960); the average stature of males was 159.1 cm (SD = 4.2 cm), and that of females was 148.1 cm (SD = 3.0 cm). Saeki (2006) used the anatomical method to link the skull, trunk, and lower limb bones and reconstruct the height of the Jomon people, estimating the average stature of males at 162.7 cm (SD = 5.7 cm), and that of females at 149.3 cm (SD = 3.8 cm). The average stature of the Daizen-no-minami human group was within 1 SD from the Jomon average stature of Hiramoto (1972) and Saeki (2006) for both males and females; thus their stature is considered the standard stature of the Jomon population.

Table 7. Upper limb bone measurements (mm) and indices

Martin's No.	Measurements	Daizen-no-minami									Jomon <sup>1</sup>		Immigrant Yayoi <sup>2</sup>		Kofun <sup>3</sup>	
		Male			Female			Sex unknown			Male	Female	Male	Female	Male	Female
		n	Mean	SD	n	Mean	SD	n	Mean	SD						
Clavicle																
1	Maximal length	0	—	—	2	137.0	17.0	0	—	—	152.1	132.0	—	—	—	—
4	Vertical diameter of mid-shaft	1	9.0	—	5	8.2	0.4	1	12.0	—	10.1	8.5	—	—	—	—
5	Sagittal diameter of mid-shaft	1	15.0	—	5	10.6	0.9	1	10.0	—	13.2	11.3	—	—	—	—
6	Circumference of mid-shaft	1	40.0	—	5	31.0	1.4	1	34.0	—	38.8	33.5	—	—	—	—
6/1		0	—	—	1	22.1	—	0	—	—	25.6	25.0	—	—	—	—
4/5		1	60.0	—	5	77.9	8.8	1	120.0	—	76.6	75.1	—	—	—	—
Scapula																
12	Vertical diameter of the glenoid fossa	1	34.0	—	4	27.5	0.6	0	—	—	—	—	—	—	—	—
13	Transverse diameter of the glenoid fossa	1	27.0	—	4	20.8	2.1	0	—	—	—	—	—	—	—	—
13/12		1	79.4	—	3	72.4	7.1	0	—	—	—	—	—	—	—	—
Humerus																
1	Maximum length	0	—	—	4	268.5	13.7	0	—	—	292.0	266.2	304.1	284.1	286.7	255.0
5	Maximum diameter of mid-shaft	2	24.0	2.8	5	18.8	1.1	0	—	—	23.9	20.4	23.2	20.7	22.4	18.3
6	Minimum diameter of mid-shaft	2	18.0	0.0	5	14.6	1.1	0	—	—	17.5	14.0	17.5	15.4	17.4	13.5
7	Least circumference of the shaft	3	62.3	2.9	5	52.4	2.3	1	54.0	—	65.2	55.3	63.8	56.5	60.2	51.2
7a	Mid-shaft circumference	2	68.5	4.9	5	55.0	3.2	0	—	—	—	—	67.7	59.8	64.2	58.8
7/1		0	—	—	4	20.6	0.9	0	—	—	22.8	20.5	21.0	19.6	20.3	20.8
6/5		2	75.5	8.9	5	77.8	6.3	0	—	—	72.7	69.0	75.6	74.7	77.6	75.0
Radius																
1	Maximum length	0	—	—	3	197.7	9.0	0	—	—	235.2	209.0	236.7	217.3	—	—
3	Minimum circumference	2	45.5	4.9	4	35.8	2.2	1	35.0	—	44.5	38.5	42.9	37.7	39.3	34.0
4	Maximum transverse shaft diameter	2	18.0	2.8	5	14.6	0.5	1	15.0	—	17.2	14.8	17.3	15.6	17.0	15.0
4a	Transverse mid-shaft diameter	2	17.5	2.1	5	14.2	1.1	1	15.0	—	—	—	16.0	14.3	—	—
5	Minimum sagittal shaft diameter	2	12.0	0.0	5	9.8	0.4	1	9.0	—	11.8	10.3	12.3	10.7	11.7	10.0
5a	Sagittal mid-shaft diameter	2	12.5	0.7	5	10.0	0.7	1	9.0	—	—	—	12.5	10.7	—	—
5 (5)	Mid-shaft circumference	2	46.5	3.5	5	37.4	2.2	1	39.0	—	—	—	—	—	—	—
Ulna																
1	Maximum length	0	—	—	2	211.5	2.1	0	—	—	252.5	226.0	256.8	236.8	—	—
3	Least circumference	1	45.0	—	4	32.8	1.7	1	31.0	—	39.3	33.9	37.7	34.3	36.5	31.0
11	Dorso-ventral shaft diameter	2	14.0	0.0	5	12.6	2.6	1	15.0	—	14.2	11.7	13.2	11.3	13.0	11.5
12	Transverse shaft diameter	2	17.5	0.7	5	13.2	0.4	1	12.0	—	16.3	14.0	17.5	15.8	15.1	12.5
13	Transverse diameter of the proximal shaft	1	20.0	—	5	17.8	1.8	1	18.0	—	—	—	—	—	—	—
14	Antero-posterior diameter of proximal shaft	1	29.0	—	5	21.4	1.3	1	27.0	—	—	—	—	—	—	—

In principle, the measurements of right side were used.

<sup>1</sup>Yamaguchi (1982), <sup>2</sup>Nakahashi and Nagai (1997), <sup>3</sup>Ikeda (1993).

Table 8. Lower limb bone measurements (mm) and indices

Martin's No.	Measurements	Daizen-no-minami									Jomon <sup>1</sup>		Immigrant Yayoi <sup>2</sup>		Kofun <sup>3</sup>	
		Male			Female			Sex unknown			Male	Female	Male	Female	Male	Female
		n	Mean	SD	n	Mean	SD	n	Mean	SD						
Femur																
1	Maximum length	1	425.0	—	4	377.0	17.7	0	—	—	418.2	382.9	432.2	404.7	426.3	401.0
6	Anterior-posterior diameter of the mid-shaft	2	32.0	1.4	4	24.3	1.5	1	26.0	—	29.3	25.0	29.5	25.7	27.3	24.5
7	Medio-lateral diameter of the mid-shaft	2	25.5	2.1	4	23.8	2.1	1	26.0	—	25.5	24.0	27.8	26.3	26.8	24.7
8	Circumference of the mid-shaft	2	90.0	7.1	4	74.5	2.1	1	80.0	—	86.8	77.4	90.2	81.3	85.9	78.1
9	Subtrochanteric transverse diameter	2	30.5	2.1	4	27.8	0.5	1	30.0	—	—	—	32.6	30.7	30.1	30.4
10	Subtrochanteric anterior-posterior diameter	2	26.5	2.1	4	21.8	1.0	1	22.0	—	—	—	26.1	23.2	24.9	21.9
21	Bicondylar width	0	—	—	3	71.0	1.0	0	—	—	79.9	70.6	—	—	—	—
6/7		2	125.7	4.9	4	103.1	15.2	1	100.0	—	114.6	103.9	106.8	98.0	101.8	100.0
10/9		2	86.9	0.9	4	78.5	4.8	1	73.3	—	—	—	80.3	75.7	83.4	72.1
Tibia																
1	Total length	1	361.0	—	3	297.0	19.7	0	—	—	345.9	318.1	347.6	325.6	—	—
1a*	Maximum length	1	369.0	—	3	301.7	20.0	0	—	—	349.5	322.7	352.3	330.0	352.5	310.0
8	Sagittal diameter at the mid-shaft	2	32.0	1.4	4	26.8	2.4	2	26.5	3.5	32.1	26.8	31.5	26.9	28.9	26.9
8a	Anteroposterior diameter at nutrient foramen	2	36.5	2.1	4	29.0	2.7	1	26.0	—	—	—	36.3	30.7	33.3	29.5
9	Transverse diameter at the mid-shaft	2	21.5	2.1	4	17.8	1.7	2	17.0	0.0	19.6	17.7	22.7	19.8	21.4	19.0
9a	Medio-lateral diameter at nutrient foramen	2	24.5	4.9	4	18.8	1.5	1	18.0	—	—	—	25.3	22.1	23.4	21.1
10	Circumference of the mid-shaft	2	85.0	4.2	4	70.5	5.1	2	69.0	7.1	—	—	85.6	73.8	80.9	73.1
10a	Circumference at nutrient foramen	2	93.5	6.4	4	76.8	5.3	1	70.0	—	—	—	96.5	82.9	90.7	81.2
10b	Minimum circumference of the shaft	2	76.5	4.9	5	66.8	4.7	2	63.5	2.1	77.4	67.1	77.4	68.2	72.6	67.0
9/8		2	67.1	3.7	4	66.7	8.0	2	64.7	8.6	61.5	65.4	72.5	73.9	74.3	70.8
9a/8a		2	66.9	9.7	4	64.9	4.6	1	69.2	—	—	—	69.7	72.0	70.4	71.9
10b/1		1	23.0	—	3	21.9	0.8	0	—	—	22.4	21.0	22.2	20.8	21.8	22.3
Fibula																
1	Maximum length	0	—	—	1	277.0	—	0	—	—	334.0	312.1	345.2	324.4	—	—
2	Maximum diameter of mid-shaft	1	17.0	—	3	14.0	1.7	1	13.0	—	17.7	15.1	17.0	14.7	15.6	14.7
3	Minimum diameter of mid-shaft	1	13.0	—	3	9.7	1.5	1	9.0	—	12.1	9.9	11.5	9.7	11.4	9.8
4	Circumference of the mid-shaft	1	49.0	—	3	38.7	4.2	1	38.0	—	52.0	43.6	47.2	40.9	44.3	40.7
4a	Minimum circumference of the shaft	1	41.0	—	2	32.0	4.2	1	31.0	—	—	—	39.9	36.9	37.3	31.8
4a/1		0	—	—	1	10.5	—	0	—	—	—	—	11.5	11.5	12.9	14.4

In principle, the measurements of right side were used.

<sup>1</sup>Yamaguchi (1982), <sup>2</sup>Nakahashi and Nagai (1997), <sup>3</sup>Ikeda (1993).

## Paleopathological findings

### (1) Dental caries

Dental caries was found in 39 permanent teeth, representing 23.6% of the 165 permanent teeth

excavated. This caries rate in permanent teeth is clearly higher than the average rate of the Jomon period (11.0% in Inoue *et al.*, 1981; 8.6% in Turner, 1979; 8.2% in Fujita, 1995). In terms of



Fig. 1. Daizen-no-minami Late Jomon skulls

Table 9. Penrose's shape distance

	Jomon <sup>1</sup>	Immigrant Yayoi <sup>2</sup>	Kofun <sup>3</sup>
Daizen-no-minami	1.009	1.129	1.033

<sup>1</sup>Dodo (1986), <sup>2</sup>Nakahashi and Nagai (1997), <sup>3</sup>Ikeda (1993).

Table 10. Stature estimation (cm)

	Male			Female		
	n	Mean	SD	n	Mean	SD
Pearson (1899)'s method	1	161.2	—	4	146.2	3.5
Fujii (1960)'s method	1	159.8	—	4	145.5	4.0

Table 11. Occurrence rates of dental caries

	Daizen-no-minami		Jomon <sup>1</sup>	
	N	%	N	%
Upper teeth				
Incisors	1/13	7.7	6/170	3.5
Canines	0/8	0.0	4/69	5.8
Premolars	3/23	13.0	22/242	9.1
Molars	8/24	33.3	28/287	8.4
Upper total	12/68	17.6	60/768	7.8
Lower teeth				
Incisors	1/20	5.0	11/157	7.0
Canines	1/10	10.0	8/107	7.5
Premolars	11/22	50.0	26/275	9.5
Molars	14/45	31.1	82/390	21.0
Lower total	27/97	27.8	127/929	13.7
Total	39/165	23.6	187/1697	11.0

N: number of teeth with caries/total number of present teeth.

<sup>1</sup> Inoue *et al.* (1981).

tooth type, the caries rates of premolars and molars in the Daizen-no-minami were particularly higher than those of the average Jomon (Table 11). When the proportion of elderly individuals in the population increases, the caries rate tends to be high; but there are not many old adults amongst the Daizen-no-minami human remains, so it is considered that the high dental caries rate is not due to the influence of age composition.

In general, the caries rate of hunter-gatherers

is lower than those of farmers and urban inhabitants respectively (Larsen, 1997; Turner, 1979). The average dental caries rate of the Jomon people, who were hunter-gatherers, is higher than those of modern hunter-gatherers (0.0 to 4.6%) (Fujita, 1995). The caries rate of the Daizen-no-Minami group is even higher than the Jomon average. As a background of the high dental caries rate of the Daizen-no-minami remains, it is expected that there was some kind of specificity in their caries-causing factors, such as their eating habits, lifestyle, and/or oral hygiene.

## (2) Vertebral osteoarthritis

Vertebral osteoarthritis is caused by an excessive load or mechanical stress to the spinal column over a long period (Brothwell, 1981; Ortner, 2002). Several studies have reported the presence of vertebral osteoarthritis in ancient human remains from the Japanese archipelago (Suzuki, 1998; Moromizato *et al.*, 2007; Shimoda *et al.*, 2012; Saeki *et al.*, 2016). The Jomon people tend to have a higher occurrence frequency of vertebral osteoarthritis compared with other era groups (Table 12).

Of nine adult Daizen-no-minami individuals who had vertebrae remaining, six had vertebral osteoarthritis on the superior/inferior articular facets of the vertebrae. All four males with vertebrae remains had 58 vertebral osteoarthritis (of the total 173 articular facets), but only two out of five females with vertebrae remains had 28 osteoarthritis (of the total 243 articular facets), thus demonstrating sex differences in the frequency of occurrence of vertebral osteoarthritis. This indicates that the Daizen-no-minami males were mainly engaged in the work that subjected them to mechanical stress on their spinal columns; that is, that a sexual division of labor was present.

## (3) Enamel hypoplasia

Enamel hypoplasia was observed in 14 of the 15 individuals with permanent teeth. The occurrence rates of enamel hypoplasia in upper central incisors (UI1) and lower canines (LC), which

Table 12. Occurrence rates of vertebral osteoarthritis

	Daizen-no-minami				Nonomae Jomon, Iwate Prefecture <sup>1</sup>				Okhotsk <sup>2</sup>				Medieval Kamakura <sup>2</sup>				Pre-modern Kumejima <sup>3</sup>			
	Male		Female		Male		Female		Male		Female		Male		Female		Male		Female	
	N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	%
Cervical vertebrae	14/46	30.4	8/78	10.3	13/24	54.2	12/31	38.7	78/408	19.1	34/552	6.2	75/1283	5.8	75/1310	5.7	363/1160	31.3	262/835	31.4
Thoracic vertebrae	14/78	17.9	2/122	1.6	9/32	28.1	8/28	28.6	336/1456	23.1	208/1627	12.8	373/3828	9.7	239/3686	6.5	691/3401	20.3	425/2316	18.4
Lumber vertebrae	30/49	61.2	18/43	41.9	3/9	33.3	7/16	43.8	146/422	34.6	121/484	25.0	159/1205	13.2	137/1103	12.4	235/979	24.0	188/666	28.2

N: number of articular facets with osteoarthritis/total number of articular facets.

<sup>1</sup>Saeki *et al.* (2016), <sup>2</sup>Shimoda *et al.* (2012), <sup>3</sup>Moromizato *et al.* (2007).

Table 13. Occurrence rates of enamel hypoplasia in UI1 and LC

	Daizen-no-minami		Jomon <sup>1</sup>		Immigrant Yayoi <sup>1</sup>		Kofun <sup>2</sup>		Pre-modern Edo <sup>2</sup>		Modern <sup>2</sup>	
	N	%	N	%	N	%	N	%	N	%	N	%
UI1	4/5	80.0	114/147	77.6	106/157	67.5	2/9	22.2	11/33	33.3	28/94	29.8
LC	7/9	77.8	156/169	92.3	144/187	77.0	8/22	36.4	28/43	65.1	65/133	48.9

N: number of teeth with hypoplasia/total number of teeth remains.

<sup>1</sup>Sawada (2010), <sup>2</sup>Yamamoto (1988).

have often been used for surveys of hypoplasia (Goodman and Rose, 1990), were as high as 80.0% for UI1 (4/5 cases) and as 77.8% for LC (7/9 cases) (Table 13). The main causes of enamel hypoplasia are stress such as nutritional deficiencies and abnormal metabolism during the tooth enamel formation period (Goodman and Rose, 1990; Hillson, 1996). The high occurrence rate of enamel hypoplasia suggests that the Daizen-no-minami group suffered from considerable stress in infancy and early childhood. The occurrence rate of enamel hypoplasia in the Jomon period is higher than the rates of other eras (Table 13) (Yamamoto, 1988; Sawada, 2010); the ratio of the Daizen-no-minami group does not differ greatly from those of the Jomon era.

### Conclusion

(1) The excavation at the Daizen-no-minami site unearthed 31 buried human individuals and 130 scattered human bone fragments. The age and sex composition of the buried individuals is as follows: four adult males, eight adult females, seven adults of unknown sex, two children, three

infants, and seven neonates. It is noteworthy that the proportion of juveniles, especially of neonates, is large.

(2) The morphological characteristics of the Daizen-no-minami human remains are common to those of the Jomon people. Their statures are also close to the Jomon average.

(3) The dental caries rate for permanent teeth of the Daizen-no-minami remains was 23.6%, which was clearly higher than the average caries rate of the Jomon period.

(4) The occurrence rates of enamel hypoplasia were as high as 80.0% for UI1 and as 77.8% for LC; these rates are higher than those of other era groups.

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