Data Article

Carbon and nitrogen stable isotopic data of premodern human skeletons from mainland Japan and the Ryukyu islands

Takumi Tsutaya\textsuperscript{a,}\textsuperscript{*}, Minoru Yoneda\textsuperscript{b}

\textsuperscript{a} Department of Evolutionary Studies of Biosystems, The Graduate University for Advanced Studies, Shonan Village, Hayama, Kanagawa, 240-0193, Japan
\textsuperscript{b} The University Museum, The University of Tokyo, Hongo 7-3-1, Bunkyo, Tokyo, 113-0033, Japan

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\textbf{Abstract}

This dataset consists of carbon and nitrogen stable isotope ratios of bulk collagen extracted from 229 human skeletons from premodern Japan. All samples were derived from different individuals excavated from mainland Japan and the Ryukyu Islands. Most of the skeletal individuals were identified, sexed, and aged by physical anthropologists. Collagen samples were extracted from bone or root portion of tooth dentin. Collagen samples were measured by an elemental analyzer coupled to stable isotope ratio mass spectrometry. Stable isotope ratios are the useful proxy of palaeodiet, and this dataset can be used for dietary reconstruction of premodern people living in the Japan archipelago.

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* Corresponding author.

\textit{E-mail addresses:} tsutayatakumi@gmail.com, tsutaya_takumi@soken.ac.jp (T. Tsutaya).

Social media: (T. Tsutaya)

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Specifications Table

| Subject                      | Archaeology                          |
|------------------------------|---------------------------------------|
| Specific subject area        | Stable isotope analysis               |
|                              | Bioarchaeology                        |
| Type of data                 | Table                                 |
| How data were acquired       | Thermo Flash 2000 elemental analyzer, Finnigan ConFlo III interface, Thermo Delta V mass spectrometer, Calir Erba NA1500 elemental analyzer, Finnigan MAT ConFlo II interface, and Finnigan MAT 252 mass spectrometer |
| Data format                  | Raw                                   |
| Parameters for data collection | Bone or dentin samples of archaeological human (*Homo sapiens*) skeletal remains from mainland Japan or the Ryukyu Islands were used. These individuals were buried during the premodern period. Most samples were derived from different adult individuals. |
| Description of data collection | Collagen was extracted from bone or dentin samples. Extraction protocols followed standard methodologies [1]. Carbon and nitrogen stable isotope ratios of the bulk extracted collagen samples were measured by using an elemental analyzer coupled to stable isotope ratio mass spectrometry (EA-IRMS). |
| Data source location         | Repository name: IsoArch [2]          |
|                              | Data identification number: [3]
|                              | Direct URL to data: https://doi.org/10.48530/isoarch.2021.006 |

Samples
Archaeological site name: Kumanashi(8), Uwano, Araya, Takasu-bouzawa, Satohama, Dainichikita, Hachiman-hayashi, Uozukou, Kamizawa-o’ne, Hodokubo, Shiokawa, Anrakuju-Higashi, Komekuyama B, and Kyomachi from mainland Japan. Yacchino-gama, Isonoirime-gohairyobaka, Mekarukobo, Nakandakariyama, Ayafune, Nusuku, Suubaru, and Tonoshiro from the Ryukyu Islands.
Details: Please see Table 1.

Institutions
Institution 1: University Museum, the University of Tokyo
City/Town/Region: Bunkyo, Tokyo
Country: Japan
Institution 2: Environmental Chemistry Division, National Institute for Environmental Studies
City/Town/Region: Tsukuba, Ibaragi
Country: Japan

Data accessibility
Repository name: IsoArch [2]
Data identification number: https://doi.org/10.48530/isoarch.2021.006
Direct URL to data: https://doi.org/10.48530/isoarch.2021.006

Related research article
M. Yoneda, I. Tayasu, R. Ishimaru, F. Hyodo, S. Kusaka, T. Gakuhari, T. Yumoto, Doitai kara mita Nihon-retto no shoku seitai no hensen (Stable isotopic evidence of chronological changes in diet of ancient Japan). In: M. Takahara, N. Murakami, editors. Nihon-retto no kankyo-shi (Environmental records of Japan archipelago), Vol. 6. Tokyo: Bun-ichi Shuppan, (2011) p. 85–103 [3].

Value of the Data

- This data is useful to reconstruct regional variation of palaeodiet in premodern Japan.
- This data can benefit archaeologists, anthropologists, and historians interested in palaeodietary reconstruction.
- This data can be used for international comparison of premodern diets among different regions. Also, more efficient sampling and stable isotope analyses are possible to understand the overview of the dietary habits of premodern Japan archipelago by considering the regions with few stable isotopic data reported.
- Stable isotope ratios previously reported either in excavation report, book chapter, or museum bulletin were compiled to this dataset. Most of them were written in Japanese, without a digital object identifier, and reported only in Figs. without raw data tables. This compilation of the data enables easier access.
1. Data Description

This dataset consists of carbon and nitrogen stable isotope ratios (δ\(^{13}\)C and δ\(^{15}\)N values, respectively) of bulk collagen extracted from premodern human skeletons from mainland Japan and the Ryukyu Islands. There are a number of archaeological sites that yielded premodern human skeletons in Japan. Among such premodern human skeletal collections from Japan, accessible ones were selected and stable isotopic data were collected by the second author (Fig. 1). The diet of consumers, such as humans, can be estimated and compared through the carbon and nitrogen stable isotope analysis of their tissues, such as bone collagen.

Archaeological contexts of the target sites are summarized in Table 1. Stable isotopic data of 229 human skeletal individuals from 22 archaeological sites were compiled in this dataset (Fig. 2). Archaeological ages of the sites or individual graves were mostly determined from the typology of excavated remains, such as coins, ceramics, and grave stones. Skeletal individuals from mainland Japan were mostly dated to the Edo period (AD 1603–1867), but some individuals possibly came from the late 19th century. Skeletal individuals from the Ryukyu Islands were

![Map of the location of the included archaeological sites. The map was drawn with the R package “rnaturalearth” [8].](image)

![Carbon and nitrogen stable isotope ratios of collagen with acceptable C/N ratio extracted from 166 skeletal individuals in premodern Japan.](image)
Table 1
Details of the archaeological sites included in this dataset. If the isotopic data (raw data or figures) of human skeletons have been reported previously, references were shown. Note that these references are written in Japanese.

| Site             | Japanese site name | Period                          | Prefecture | Latitude  | Longitude | Altitude | Type of coordinates | N. all individuals | N. acceptable individuals | References |
|------------------|--------------------|---------------------------------|------------|-----------|-----------|----------|---------------------|---------------------|--------------------------|------------|
| Kumanashi (8)    | 増田 (8)           | After Late 17th century         | Aomori     | 40.757    | 140.525   | 20.5     | Exact               | 7                   | 1                        | [3,9]       |
| Uwano            | 上野              | Late 17th–18th century          | Aomori     | 40.475    | 141.421   | 30       | Exact               | 12                  | 7                        | [3]         |
| Araya            | 荒谷              | Premodern                       | Aomori     | 40.404    | 141.483   | 200      | Approximate         | 25                  | 6                        | [3]         |
| Takasu-bouzawa   | 嘉泉坊沢          | Premodern                       | Akita      | 40.230    | 140.338   | 94       | Approximate         | 12                  | 12                       | [3]         |
| Satohama         | 里浜              | Premodern                       | Miyagi     | 38.333    | 141.133   | 0        | Approximate         | 1                   | 1                        | [3]         |
| Dainichikita     | 大日北            | Late 17th–Late 18th century     | Miyagi     | 38.288    | 140.288   | 101      | Exact               | 5                   | 5                        | [3]         |
| Hachiman-hayashi | 八幡谷            | Premodern                       | Fukushima  | 37.535    | 140.957   | 95       | Approximate         | 7                   | 6                        | [3]         |
| Uozukou          | 魚津港            | 195 ^14C BP                     | Toyama     | 36.821    | 137.394   | 2        | Approximate         | 1                   | 1                        | [3,10]      |
| Kamiizawa-o’ne  | 上屋間尾根        | Premodern                       | Nagano     | 35.974    | 138.216   | 955      | Exact               | 4                   | 4                        | [3,11]      |
| Hodokubo         | 程久保            | Premodern                       | Nagano     | 35.968    | 138.205   | 960      | Exact               | 1                   | 1                        | [3,11]      |
| Shiokawa         | 坂川              | 18th–19th century               | Yamanashi  | 35.859    | 138.509   | 843      | Exact               | 10                  | 10                       | [3]         |
| Anrakuji-Higashi | 安楽寺東          | Late 18th–Early 20th century    | Yamanashi  | 35.605    | 138.944   | 366      | Exact               | 9                   | 5                        | [3,12]      |
| Komekuyama B     | 米倉山B           | 17th–18th century               | Yamanashi  | 35.584    | 138.573   | 380      | Approximate         | 10                  | 10                       | [3]         |

(continued on next page)
Table 1 (continued)

| Site               | Japanese site name | Period                      | Prefecture | Latitude  | Longitude  | Altitude | Type of coordinates | N. all individuals | N. acceptable individuals | References |
|--------------------|--------------------|-----------------------------|------------|-----------|------------|-----------|---------------------|--------------------|-----------------------------|------------|
| Kyomachi           | 京町               | Late 17th–Early 19th century | Fukuoka    | 33.881    | 130.885    | 10        | Exact               | 10                 | 5                           | [3]        |
| Yacchino-gama      | ヤッチのガマ         | Middle 18th century         | Okinawa    | 26.355    | 126.739    | 8         | Exact               | 26                 | 16                          | [3,6,13]   |
| Isonoirime-gohairyobaka | 伊祖の入縄御狩     | AD 1665–1927               | Okinawa    | 26.256    | 127.727    | 55        | Exact               | 20                 | 7                           | [3,6]      |
| Mekarukobo         | 銘崎古墓群          | 17th–20th century           | Okinawa    | 26.234    | 127.696    | 28        | Exact               | 3                  | 3                           | [3,6]      |
| Nakandakariyama    | ナカンダカリヤマ     | 16th–17th century           | Okinawa    | 26.200    | 127.717    | 673       | Approximate         | 14                 | 14                          | [3,6]      |
| Ayafune            | 絵船               | Premodern                  | Okinawa    | 24.729    | 125.364    | 37        | Approximate         | 3                  | 3                           | [3,6]      |
| Nusuku             | 野底               | 18th–19th century           | Okinawa    | 24.494    | 124.232    | 20        | Approximate         | 2                  | 2                           | [3,6]      |
| Suubaru            | 湿原               | Premodern–Modern           | Okinawa    | 24.471    | 122.996    | 24        | Exact               | 39                 | 39                          | [3,6]      |
| Tonoshiro          | 登野城             | 15th–18th century           | Okinawa    | 24.386    | 124.178    | 3.5       | Approximate         | 8                  | 8                           | [3,6]      |
mostly dated to the Ryukyu Kingdom period (AD 1429–1879). These periods are regarded as premodern periods in mainland Japan and the Ryukyu Islands, respectively.

Individual data includes δ^{13}C and δ^{15}N values and atomic carbon-to-nitrogen ratio (C/N ratio), at least. Quality indicators of collagen preservation (i.e., atomic concentration of carbon and nitrogen and collagen yield) and physical anthropology measures (e.g., age, sex, and skeletal element sampled) were shown if such information was available. Samples with atomic C/N ratios within the acceptable range (i.e., 2.9–3.6) are regarded to provide reliable stable isotope ratios [4]. Samples with unreliable C/N ratios are also included in this dataset (Fig. 3), but should be omitted for further analyses. Eleven samples with unknown C/N ratios were regarded as acceptable and shown in Fig. 2.

All collected data represents stable isotopic data from single human (H. sapiens) individuals without duplication. Most data was derived from adults (i.e., skeletons aged older than puberty). Because the δ^{13}C and δ^{15}N values of breastfed infants systematically differ compared with those of adults due to the trophic level enrichment between mother and infant [5], data from infants should be analyzed separately from those from adults. This dataset was presented in previous literature written in Japanese [3,6] but only shown in figures without raw data.

2. Experimental Design, Materials and Methods

Approximately 10 individuals were randomly selected from each archaeological site to investigate regional variation of diet rather than intra-population variation. Adult individuals were prioritized. Most of such skeletal individuals were identified, sexed, and aged by physical anthropologists. Skeletal element that has relatively fewer morphological information, such as ribs, were selectively used for the stable isotope analysis.

Collagen protein was extracted from the sampled skeletal elements following the “powder” method described in a previous research [1]. At first, 0.2–0.5 g of bone pieces, or dentin pieces in a few cases, were cut from the skeletal element. In order to avoid breastfeeding effect [5], root tip of dentin, which represent older ages during the tooth development, was sampled in case of dentin samples. Surface of the bone/dentin pieces was mechanically cleaned by sandblasting of baked aluminum oxide powder. The cleaned bone/dentin pieces were soaked in Milli-Q water under ultrasonication at 4°C for 10 min and then 0.2 M NaOH at 4°C overnight to remove exoge-
noous organic matter, such as humic acids. The samples were rinsed with Milli-Q water, and then freeze-dried and crushed into coarse powders. The crushed samples were sealed in cellulose tubes and treated with 1.0 M HCl at 4°C overnight for demineralization. The HCl solution was replaced with Milli-Q water by dialysis. The demineralized remaining portion was recovered from cellulose tubes and concentrated by centrifuging. The samples were then gelatinized in Milli-Q water at 90°C for 12 h, filtered using a glass fiber filter (Wattmann GF/F), and freeze-dried. Although typical collagen extraction protocols apply NaOH-treatment after the demineralization step, collagen samples of this dataset were treated with NaOH before the demineralization step. However, no significant difference in δ\(^{13}\)C and δ\(^{15}\)N values was observed between collagen samples extracted with these different protocols [7]. Therefore, this data is comparable with other stable isotopic datasets that adopted NaOH-treatment after the demineralization step.

Carbon and nitrogen stable isotope ratios were measured using an EA-IRMS (Thermo Flash 2000 elemental analyzer, Finnigan ConFlo III interface, and Thermo Delta V mass spectrometer) at the University Museum, University of Tokyo, Japan or an EA-IRMS (Calro Erba NA1500 elemental analyzer, Finnigan MAT ConFlo II interface, and Finnigan MAT 252 mass spectrometer) at National Institute for Environmental Studies, Ibaragi, Japan. The δ\(^{13}\)C and δ\(^{15}\)N values were calibrated against the laboratory working standards (L-alanine 1: δ\(^{13}\)C = −18.5 ± 0.2‰, δ\(^{15}\)N = −1.02 ± 0.2‰; L-alanine 2: δ\(^{13}\)C = −19.6 ± 0.2‰, δ\(^{15}\)N = 8.7 ± 0.2‰; L-alanine 3: δ\(^{13}\)C = −19.6 ± 0.2‰, δ\(^{15}\)N = 20.0 ± 0.2‰; L-histidine: δ\(^{13}\)C = −7.6 ± 0.2‰, δ\(^{15}\)N = 11.4 ± 0.2‰) provided by SI Science Co. (Saitama, Japan), whose values were determined by the NBS 19 and the International Atomic Energy Agency (IAEA) Sucrose ANU (calibrated against Vienna Pee Dee Belemnite) and IAEA N1 and IAEA N2 (calibrated against AIR) international standards, respectively. Based on repeated measurements of the calibration standard, precision was determined to be less than ±0.1‰ and ±0.2‰ standard deviation (SD) for δ\(^{13}\)C and δ\(^{15}\)N values, respectively.

**Ethics Statement**

Use of the archaeological human skeleton were approved by appropriate organizations or persons, such as the collection managers, governmental board of education, and descendant communities.

**CRediT Author Statement**

*Takumi Tsutaya:* Conceptualization, Methodology, Software, Validation, Investigation, Data Curation, Writing, Visualization; *Minoru Yoneda:* Conceptualization, Methodology, Validation, Resources, Investigation, Data Curation, Project administration, Funding acquisition.

**Declaration of Competing Interest**

The authors declare no competing interest.

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