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An Archaeological Radiocarbon Database of Japan

DATA PAPER

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ABSTRACT

We present a radiocarbon database for the Japanese archipelago compiled from over 5,500 site excavation reports covering a chronological span from 55,000 BP to the present day. The complete database in Japanese contains over 44,000 entries, providing contextual information directly obtained from descriptions provided in the site reports. Here we provide a curated English translation of the database, containing a subset of 39,284 dates from the original database, which excludes duplicates and errors and includes new information concerning the dated material.

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(1) OVERVIEW

CONTEXT

Japan has experienced a remarkably high number of rescue excavations over the last five decades, with an average of over 8,300 sites per year excavated between 1990 and 2020 [1] and a total of over 460,000 registered archaeological sites [2]. An increasing effort is being made by different institutions to make this legacy data findable, accessible, interoperable, and reusable, including the creation of several databases (e.g. [3, 4]) and a repository containing indexed and digitised PDFs of over 34,000 site reports [2].

The dataset associated with this paper was the result of several projects funded by the Japan Society for the Promotion of Science (JSPS), the National Museum of Japanese History (NMJH), and the European Research Council (ERC). Data collation were initiated under two JSPS-funded projects: *Temporal correspondence between human activities and paleo-environment in the Paleolithic and Jomon period* (2015–2017, PI: Y.Kudo,#15K02995) and *Comprehensive study of prehistoric human activities and paleoenvironment based on high-precision 14C dating* (2018–2021, PI: Y. Kudo, #18H00757), *Creation of an international database for the reconstruction of human history by means of high-precision chronology of archaeological sites* (2022–2025, PI: Y. Kudo, #22H00743) with the additional funding supported by the NMJH. The database became publicly accessible in January 2018 with radiocarbon dates collated from the Kanto and the Tohoku regions and has been subsequently updated with additional dates from other regions. The first complete dataset was published in March 2022 and contained a total of 44,425 dates. Details of this complete Japanese version of the database are provided elsewhere [5] (URL: https://www.rekihaku.ac.jp/up-cgi/login.pl?p=param/esrd/db_param).

The objective of this original dataset was to provide reference material for easing the search for radiocarbon data published in Japanese site excavation reports. Thus, the collation process aimed to report as faithfully as possible the information provided in the original context. As a result, the database contains duplicates (e.g. in the case the same data was published in multiple reports), inconsistencies (e.g. across reports), and errors from the original context. The ERC-funded ENCOUNTER project (2019–2024, PI: E.Crema), which is currently exploring the timing and the impact of the dispersal of rice and millet farming in prehistoric Japan, has been extensively using the data from the database [e.g. 6–8] and as part of this process has translated the database into English, added additional fields, and removed errors, inconsistencies, and duplicates to facilitate its use. Here we present details of this new version of the database containing over 39,284 radiocarbon dates from the Japanese archipelago.

SPATIAL COVERAGE

The dataset covers a geographic area corresponding to the national border of Japan. Geographic coordinates (in WGS84) of the minimum-bounding box are as follows:

Northern boundary: 45.397
Southern boundary: 24.387
Eastern boundary: 124.156
Western boundary: 145.719

TEMPORAL COVERAGE

The dataset covers the timespan corresponding to the calibration of ^{14}C dates (i.e. 55,000 ~ 0 uncal BP), although less than 1% of the samples (n = 272) are before 30,000 uncal BP.

(2) METHODS

STEPS

The original data collection was carried out by manually inputting all contextual information from the site reports, and additionally assigning standardised categories for the site period and the class of material dated (see section 3 below for further details). Geographic coordinates of each site location were obtained by using the geocoding tools and utilities service of the University of Tokyo (URL: https://geocode.csis.u-tokyo.ac.jp/home/csv-admatch/).

The English version of the database was created by translating standardised fields (e.g. prefecture location of the sampling site, material dated, etc.) and adding several additional fields (see Tables 1 and 2). Site names were first manually converted into *Furigana* (examining the source material when necessary) and then automatically romanised. A new field for site classification (*SiteType*) was created by semi-automatically extraction the suffix of each site name (e.g. XXX遺跡群 was classified as "site cluster", XXX貝塚 as "shell midden", XXX城 as "castle"). Note that the classification refers to the entire site, and not to the particular deposit from which the sample was recovered from (e.g. a prehistoric sherd might have been recovered from a medieval castle site with a prehistoric layer). Finally, a taxa field (*MaterialTaxa*) was added by manually inspecting unpublished fields from the original database, extracting relevant information on the animal and plant taxa of the dated material. All steps for the translation and the cleaning were semi-automatically executed using R scripts available on a dedicated repository (https://github.com/ercrema/japan_c14db) and permanently archived on Zenodo along with the full dataset (https://doi.org/10.5281/zenodo.8377215).

SAMPLING STRATEGY

The dataset was collated from the ca. 60,000 site excavation reports available at the time at the library collection of the National Museum of Japanese History. The process was

carried out by finalising prefectures one at a time. As such, the publication year of the most recent site report with a radiocarbon date from any given prefecture, in the database, ranges from 2015 to 2021. Data from more recent site reports will be included in future versions of the database.

QUALITY CONTROL

The curated English version of the database went through strict quality control consisting of identifying and excluding all entries that did not meet our requirements. A total of 5,144 records (less than 12% of the original data) were removed after the quality checks. More specifically, we removed:

- Entries for which the ^{14}C age was missing, or had a ^{14}C age outside the radiocarbon calibration range (i.e. 55,000 ~ 0 uncal BP).
- Entries without a Laboratory Code, or with a Laboratory Code that was regarded as incorrect (e.g. contained only numbers or letters, or did not match an existing laboratory, etc.)
- Duplicated entries (identified from the Laboratory Code) with inconsistencies (e.g. different site names, ^{14}C age, dated material, etc.). Duplicates with consistent data were merged, recording all site report references together in a single field separated by a double pipeline ("||").
- Entries where the discrepancy between the rounded and unrounded date after isotopic fractionation was larger than 50 years.
- Entries which had no site name.

Latitude and Longitude values were removed in the following cases:

- Entries with an inconsistency between the geographic coordinates and the recorded administrative unit (i.e. prefecture).
- Entries with identical site names in the same prefecture, but with different geographic coordinates

CONSTRAINTS

The objective of the original database was to provide a direct and fast link to the original source material. While a substantial effort was made to make the data usable by taking a conservative approach and eliminating all unreliable records, there are still possible outstanding errors and inconsistencies that might not have been captured. Geographic coordinates were made available for over 85% of the data, but it should be noted these were derived via geocoding using the address provided in the site report, and as such precision and accuracy might not be sufficient for certain analytical purposes. In all cases, we recommend checking the original database for some additional information and, where possible, checking the source material.

(3) DATASET DESCRIPTION

The dataset consists of a flat table with 21 fields and a text file containing relevant metadata for each. Tables 1 and 2 contain the list of fields in the original and the curated English version of the database. Over 84% (n = 33,170) of the dated material are of terrestrial origin, with a smaller percentage of dates from organic residues attached to ceramics (12%, n = 4,889) and less than 3% from materials of marine origin (n = 1,033).

The spatial distribution of the radiocarbon dates shows clear intra- and inter-regional variation in sampling intensity. This is a result of geographic variations in the overall number of rescue excavations, for example, with lower numbers in less urbanised areas, or regions with higher attitudes. Further, such variation is also tied to variation in the level of investment in scientific dating across different local CRMs (Figure 1).

Given the expected correlation between population size and the number of radiocarbon dates, identifying clear variations in sampling intensity over time is difficult. However, the summed probability distribution (SPD) of all terrestrial dates (Figure 2) peaks around the end of the Kofun period (250 – 538 CE), indicating how the increased availability of historical documents drastically reduces the need for radiocarbon dating, resulting in a decrease in sampling intensity.

OBJECT NAME

c14db_1.1.0.csv
c14db_1.1.0metadata.csv

DATA TYPE

Secondary data, and processed data from originally published materials.

FORMAT NAMES AND VERSIONS

.csv

CREATION DATES

The original dataset was created between 2017 and 2021.

DATASET CREATORS

Original data entries were coordinated by YK, YS, and MH; EC performed the cleaning process and semi-automated translations; CJS entered the Taxa field.

LANGUAGE

English, Japanese

LICENSE

FIELDID	FIELD NAME	TRANSLATION/NOTES
JP01	都道府県	Prefecture
JP02	遺跡名	Site Name
JP03	所在地	Address
JP04	緯度	Latitude
JP05	経度	Longitude
JP06	サンプル採取地点等	Sample Location (within the site)
JP07	時代	Period; Standardised into categorical levels; Reference to the site and/or dated material and not based on the estimated age.
JP08	時代詳細	Period Details; Non-standardised minor periodisation and ceramic phases.
JP09	試料の種類	Material dates; Standardised
JP10	試料番号	Laboratory Code
JP11	測定方法	Dating Method (AMS or Beta)
JP12	^{14}C年代	^{14}C age (rounded)
JP13	暦年較正用14C年代	^{14}C age (unrounded)
JP14	δ ^{13}C（AMS）（‰）	δ ^{13}C, AMS
JP15	δ ^{13}C（IR-MS）（‰）	δ ^{13}C, IR-MS
JP16	分析者（著者）	Analyst
JP17	測定機関	Laboratory
JP18	刊行年	Publication Year
JP19	報告タイトル（ページ）	Title and page number of the report
JP20	備考	Notes
JP21	報告書名	Site report title
JP22	発行者	Publisher

Table 1 Field names in the original radiocarbon database.

REPOSITORY LOCATION

The dataset is hosted on the following webpage:
https://www.rekihaku.ac.jp/up-cgi/login.pl?p=param/esrd_en/db_param
R scripts for cleaning and translation:
https://github.com/ercrema/japan_c14db
Zenodo archive with R scripts and the dataset:
https://doi.org/10.5281/zenodo.8377215

PUBLICATION DATE

18/7/2023

(4) REUSE POTENTIAL

The radiocarbon database offers a robust foundation for providing an absolute chronological framework for the rich and detailed ceramic-based periodisation typical of Japanese archaeology. This is particularly relevant for the earliest prehistoric periods with ceramic technology (i.e. Jomon and Yayoi periods), where substantial efforts have already been made [e.g. 9–13], often revealing new insights into the role of past climate changes [e.g. 14–15], and in some cases radically changing established chronologies such as the transition from the Jomon to the Yayoi period (see [16] for review). Subsets of the database in the original Japanese language have already been used in several publications to further pursue these endeavours, including investigations on the timing of the dispersal of rice farming in Japan [8, 17], the chronology of Jomon ceramic phases [6], and Paleolithic mobility patterns [18].

Analytical opportunities for the reuse of large collections of radiocarbon dates have grown substantially over the last few decades, promoted in particular by the so-called "Dates as Data" approach to prehistoric demography [19], but also by other synthetic approaches focused on regional chronologies. These attempts have undoubtedly offered new insights, but often with a rather superficial acknowledgement of key contextual details. This database represents one of the largest, single-country collations of radiocarbon records that still offer links to the original site reports. This process is facilitated by the field *NabunkenURL*, which, where applicable, provides a link to the "Comprehensive Database of Archaeological Site Reports in Japan" of the Nara National Research Institute

FIELDID	FIELD NAME	ORIGINAL FIELD ID	NOTES
EN01	LabCode	JP10	–
EN02	Prefecture	JP01	Translated
EN03	Region	–	Assigned based on JP01
EN04	SiteNameJP	JP02	–
EN05	SiteNameEN	–	Romanised from JP02
EN06	SiteType	–	Obtained from JP02
EN07	Latitude	JP04	–
EN08	Longitude	JP05	–
EN09	CRA	JP12	–
EN10	CRAError	JP12	–
EN11	UnroundedCRA	JP13	–
EN12	UnroundedCRAError	JP13	–
EN13	Delta13C	JP14	–
EN14	Delta13CError	JP14	–
EN15	Detla13CIRMS	JP15	–
EN16	DatingMethod	JP11	–
EN17	Material	JP09	Broader standardised categorisation (terrestrial, marine, others)
EN18	MaterialDetails	JP09	Finer standardised categorisation (e.g. bone, wood, seed, lacquer, etc..)
EN19	MaterialTaxa	–	Animal or Plant Taxa (where relevant).
EN20	NabunkenURL	–	Url linked to the "Comprehensive Database of Archaeological Site Reports in Japan"
EN21	Reference	JP18, JP21, JP22	Merged from several fields; aggregated into multiple entries separated with double pipelines ("||") in case of duplicates.

Table 2 Field names in the translated and curated version of the radiocarbon database presented in this paper.

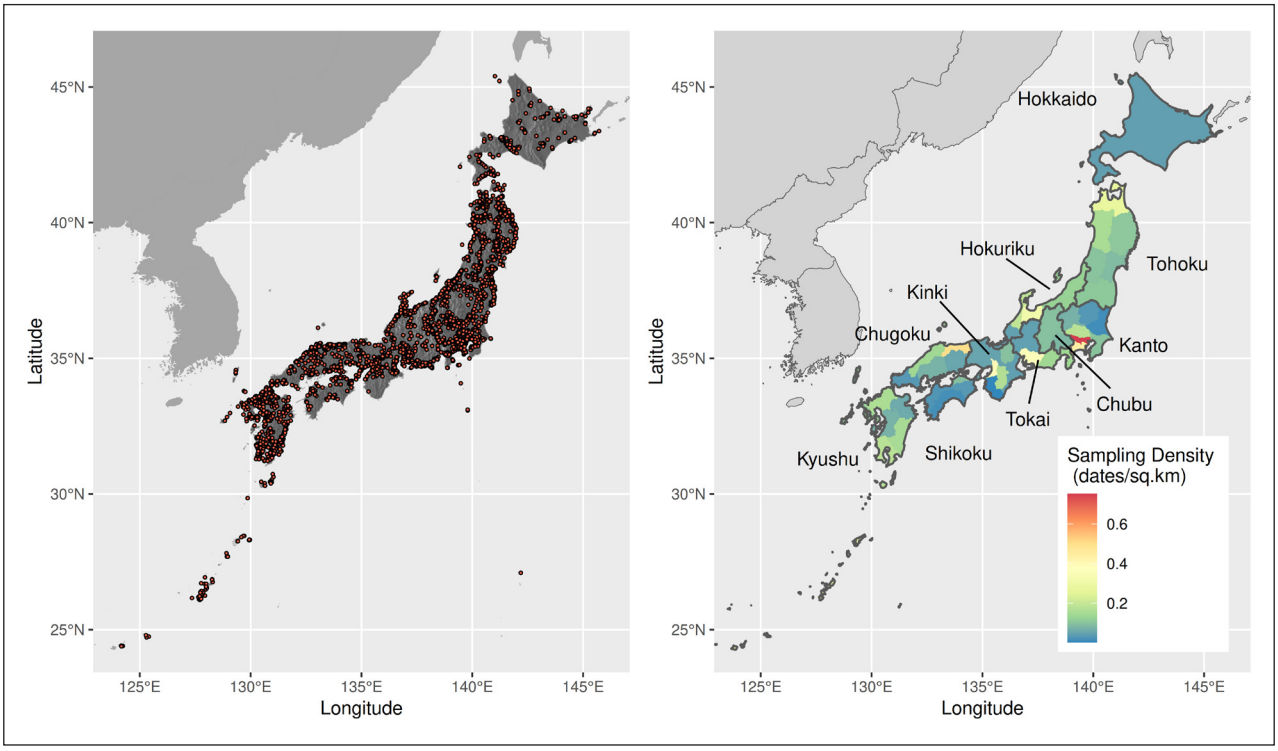

Figure 1 Spatial distribution of the radiocarbon data: left) sampling site locations; right) sampling density per administrative unit (prefecture) and key main geographic regions.

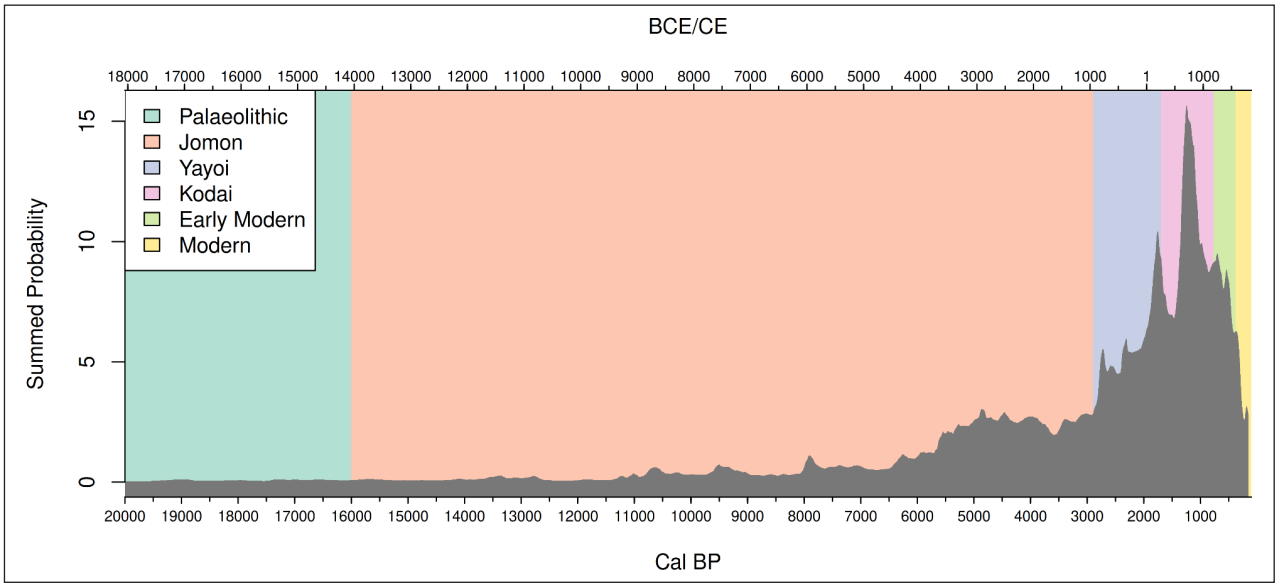

Figure 2 Summed Probability Distribution (SPD) of terrestrial radiocarbon dates between 18,000 BCE and 1868 CE.

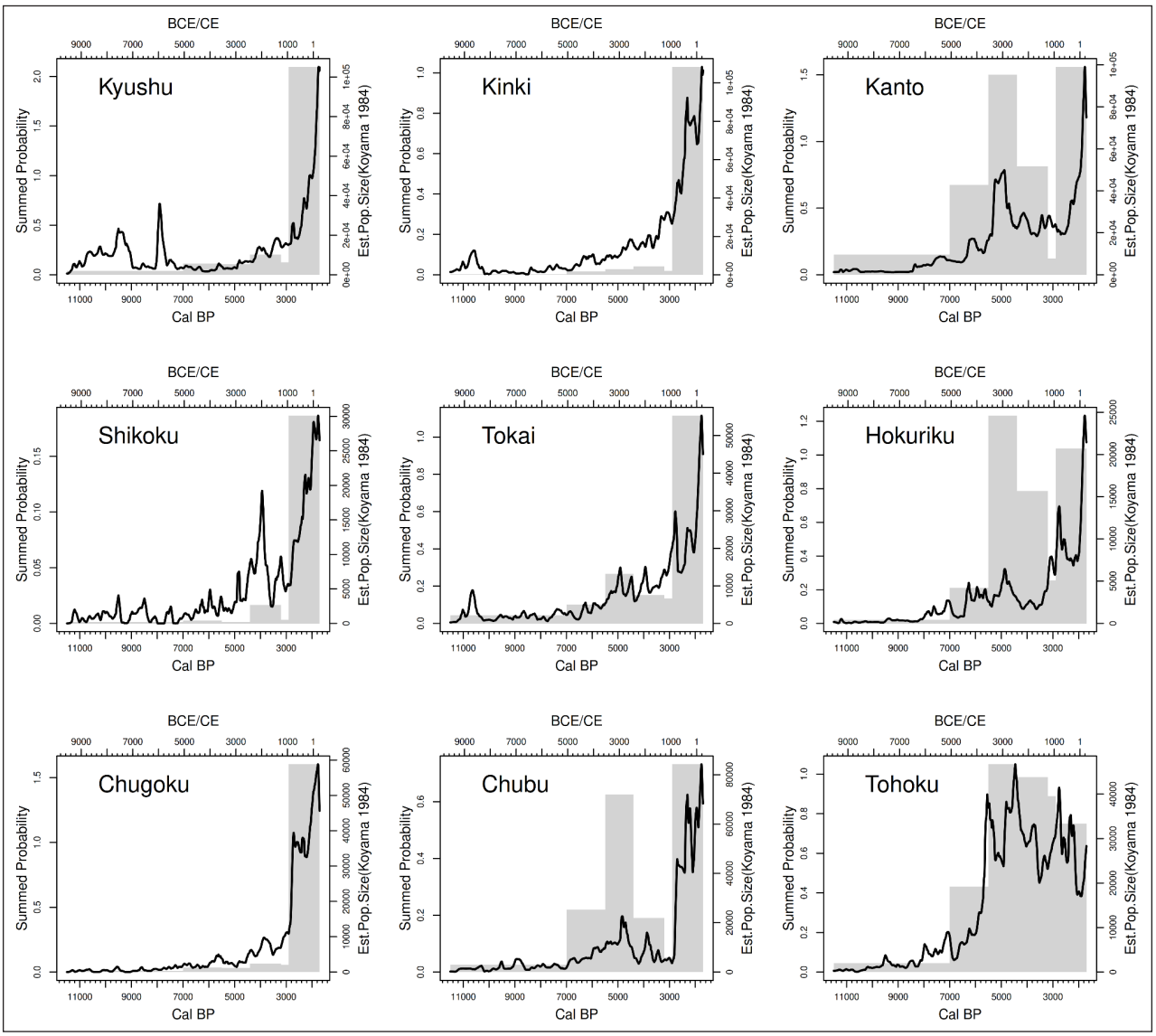

Figure 3 Comparison between regional SPDs generated from terrestrial radiocarbon dates (line) and Koyama's [25, 26] absolute population estimates (grey bars).

for Cultural Properties (URL: https://sitereports.nabunken.go.jp/ja). This database repository currently allows access and download to the PDF of over 34,000 site reports, providing an exceptional opportunity to obtain additional contextual details for our radiocarbon dataset [cf. 20].

The potential of demographic research based on the temporal frequency of radiocarbon dates has been extensively debated in the literature [e.g. 21–24], and ultimately its reliability as a proxy is contingent on the specific regional context. Figure 1 shows that the upper chronological limit of its applicability is the first half of the first millennium CE, although in some regions (e.g. northern Tohoku and Hokkaido), this could be extended by a few centuries due to different regional historical developments. For the Jomon (c.14,000 – c.950 BCE) and the Yayoi (c. 950 BCE – 250 CE) periods, it is possible to compare regional SPDs, constructed from terrestrial dates to the absolute population estimates computed by Koyama (Figure 3; [25, 26]). Koyama's population estimates are based on now outdated data and chronologies with a coarse chronological resolution of ca. 1,000 years, but they provide a still widely cited benchmark to characterise broadscale regional differences in Jomon and Yayoi demography. While some discrepancies are noticeable, most prominently the relative differences between the population peak during the Middle Jomon period (ca. 3,000 BCE) and the population level at the Yayoi period in Kanto, Hokuriku, and Chubu, the overall trajectories of the two proxies appear to be aligned. Future research, based on a more systematic selection of the radiocarbon sample, statistical adjustments accounting for inter-site variations in sampling intensity, and detailed comparison to other lines of proxies (cf. [6]) might provide deeper insights into Jomon and Yayoi demography, but it is paramount that this process is guided by a careful understanding of the underlying data and not based on an uncritical use of the entire database.

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COMPETING INTERESTS

Senior author (ERC) is a member of the editorial board of JOAD but did not take part in the editorial process.

AUTHOR CONTRIBUTIONS

Yuchiro Kudo: Conceptualization, Writing – Review & Editing, Resources, Data Curation Funding acquisition; Minoru Sakamoto: Resources, Data Curation; Masataka Hakozaki: Resources, Data Curation; Chris J Stevens: Writing – Review & Editing; Data Curation; Enrico R. Crema: Conceptualization; Writing – Original Draft, Writing – Review & Editing, Data Curation, Software, Formal analysis, Visualization, Funding acquisition.

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