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Bioarchaeological Insights into Korean Prehistoric Diet and Disease Patterns

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ABSTRACT

The restoration of dietary and disease modalities is an extremely crucial task in archaeological research. Such restoration has been directed towards a variety of sources, yet none is as pivotal and direct as Ancient Human Skeletons. Particularly, the approaches of bioarchaeology based on biocultural models have been frequently adopted, enhancing its status.

The restoration of the prehistoric diet and diseases in Korea is also yielding its own outcomes due to the inflow of analysis results such as skeletal science, pathology, and molecular biology on the remains. Nevertheless, the results are seldom developed into population-level studies that guarantee a wide area. Such research is based on a comprehensive collection of data and an understanding of the socio-cultural context. With the aspiration of providing a foundation for such work, this paper endeavors to compare various achievements, commencing with the collection of existing research based on human remains analysis. Such an attempt ultimately serves as a basis for comprehending how the research achievements contribute to the explanation of the socio-cultural processes of prehistoric Korea.

Keywords: Korean Prehistory, (Palaeo)Diet, Disease, Bioarchaeology, Population Level Studies

Ⅰ. INTRODUCTION

Diet and disease are very important issues that determine human life and death and have been the subject of important research in various studies dealing with the human past. Among them, archaeology has been devoted to restoring human diets and diseases in the past while analyzing various data.

Until now, Korean academia has also absorbed several archaeological achievements. Nevertheless, it can be said that discussions are only beginning on how to use archaeological remains excavated human remains data. It is expected that the development of science and technology will reveal more than the information currently available from human remains, and for this purpose, it is necessary to complete the legal system related to the systematic collection and preservation of Goingol and to improve statistical processing of the data investigated so far. In addition, training such as standardization of measurement and detailed excavation is also essential in archaeological sites.

In order to restore the culture of people in the past, which is the goal of archaeology, it is necessary to share the perception that human remains must be treated with courtesy before it is archaeological data. Next, in order to increase the value of the data, it is absolutely necessary to study fusion and integration through cooperation and sharing of perceptions with experts in various fields of anthropology, geneticists, and biochemists.

In addition to the inconvenience of the lack of comprehensive research, this paper aims to identify the characteristics of the excavation and analysis data reported in the archaeological investigation process so far, and explore the possibility of connecting with social and cultural changes at the time.

Ⅱ. THE BIOARCHAEOLOGICAL APPROACH TO PREHISTORIC DIETS AND DISEASES

There are various archaeological materials to deal with dietary and disease issues, ranging from animal and plant figures in ruins, various production tools, substances containing dormant and dead pathogens, petroglyphs of rituals and artworks, cave murals, and sculptures. However, they have some limitations. More direct evidence comes from the body, or remains.

The active use of the characteristics of such remains in archaeological interpretation is largely attributed to the development of natural scientific analysis technology and the establishment of awareness of the human body as a cultural relic.

1. Restoration of diet and disease through ancient human skeletons analysis

Currently, several types of isotope analysis are widely used to restore a diet before death from remains. In particular, the Korean academic community is actively utilizing the isotope ratio of carbon ($^{13}C/^{12}C$) and nitrogen ($^{15}N/^{14}N$) extracted from collagen in the skeleton. Specifically, by analyzing the stable isotopes left behind in the collagen in the human bone, it is possible to review the main intake made during the 10 years before death, and among the stable isotope analysis, the elements used for the restoration of diet are carbon and nitrogen. In the case of carbon, the plant group consumed may be mainly identified, and representatively, C3 and C4 plants may be distinguished. Their isotope values are -22 to 38% for C3 plants and -9 to 21% for C4 plants. Nitrogen can identify carnivorous and vegetarian characteristics, and since the isotope value of nitrogen also rises as the food chain rises, the main intake of the individual is estimated through this. In particular, since there is a study result that nitrogen isotopes increase by 3-5% whenever the food chain rises by one step, it is estimated which biological group was used as the main intake group by considering the corresponding value. It also focuses on its dynamic pattern, that is, changes in diet according to the life cycle.

Although genetic analysis is actively used to identify the causative agent of the epidemic, identification of diseases or pathological phenomena still relies on skeletal and tooth observation. This is also the case in Korean academia. Diseases similar to infectiousness leave traces of bone membrane reactions and osteonitis in the limb bone, and tooth diseases also leave traces such as peri-dental histitis and (preventive) tooth loss on the jawbone. Of course, diseases that leave traces on the appendicular skeleton or teeth are mainly chronic, making it difficult to grasp even temporary infections in detail.

In addition, restoration of human diets and diseases in the past has been carried out through a wide variety of professional analyses. However, as the focus of this article is not on the actual determination of diet or disease, it does not discuss the various analysis techniques and procedures involved.

Of course, it is clear that the development of analysis technology in the process of establishing biological archaeology has greatly amplified its speed and contribution. For example, in recent years, biological archaeology has come to present a higher resolution answer to problems such as migration and livelihood than traditional archaeology. However, it is also clear that the process of interpretation and explanation is not so direct or simple to say that the answer is completed only with the information provided by cutting-edge analysis technology. Therefore, I would like to point out several points that archaeological research to actively utilize the results of archaeological analysis of the remains not only for the progress of this paper but also for understanding various socio-cultural processes including diet and disease.

First, the result of a specific archaeological analysis is that it can be used in multiple ways and interpreted in multiple ways in restoring socio-cultural phenomena. Take, for example, the results of isotopic analysis of the limb bone zone and teeth. Analyzing the limb bone zone reveals that he died while living an inland grain-oriented diet, but if it is concluded that the teeth were mainly the products of distant coasts, it is possible to not only restore the diet of the remains before life, but also to assume a socio-cultural phenomenon of migration. Therefore, it is necessary to know exactly the scope of the use of analysis techniques and comprehensively understand the results.

Second, a more probable interpretation can be derived only when the results of natural science analysis are reviewed in a comprehensive socio-cultural context. Let's proceed with the discussion by adding additional scientific information to the previous case. Suppose that the remains are not well-equipped graves, but an adult woman found in a roughly flat pit, with developed attachments to the limb bone and a healed depression in the head bone. It can be presumed that the woman was taken as a slave as a result of war or looting, suffered from abuse and severe labor, and then died. There are not a few such cases known around the prehistoric world. 由此 The cause of migration and the poor life cycle of a woman are restored.

As seen in this case, biological archaeology has established a biological model that considers various biological characteristics, environmental pressures, and socio-cultural backgrounds at the same time as a framework for interpretation and explanation. The fact that this paper is based on a collection of ancient human skeletons information and various general archaeological information such as relics, association relics, and historical background will also be the basis for applying such a framework.

Third, although what is obtained from the remains of the previous hypothetical case is about a woman's life, the situation cannot be extended to all women in the society. Of course, tracking a person's life is also a research topic. However, this is bound to be limited to the discussion of the individual identity of a society consisting of vertical and horizontal segments, and the relationship of group identity is a separate matter. In addition to being able to compose an individual's history, one of the important advantages of biological archaeology is that researchers often have access to a large number of individuals within a group. The analysis is closely related to socio-cultural fluctuations at such a population-level. In particular, a careful and systematic approach is required to absorb information provided by samples, such as the situation in Korea, that may be biased on a very small scale due to poor preservation of prehistoric and ancient remains, into the understanding of society as a whole.

2. Sociocultural Variations and Biological Archaeological Approaches

Biological archaeology's approach, which extends the analysis and interpretation formed while focusing on the individual's history to understanding at the group level, requires a wide range of data acquisition as well as demographic treatment. This is because grasping the pattern of the group level cannot be directly called as an explanation of socio-cultural changes that presuppose metropolitanity.

In order to ensure the probability of such a connection, a diachronic approach that encompasses a fairly long period of time as well as appropriate metropolitanity is needed. In other words, it is necessary to track differences over a long period of time, starting in the Paleolithic Age for specific areas. As will be described later, it seems necessary to consider in connection with such a general context that there are few pathological phenomena that cause malnutrition after the Korean Neolithic Age, when crops are incorporated into the food composition.

However, in order for such research to ensure greater dynamics and probability, it must be linked to an understanding of demographic structure or social segmentation of vertical and horizontal. In particular, it will be even more so given that differences in nutrition and health conditions after social stratum occurrence show different patterns depending on the class. The Korean Bronze Age, especially after the middle of the period, which is estimated to have entered stratification, should be approached in that respect. However, in this case, a connection with a variable that can indicate a hierarchy must be attempted.

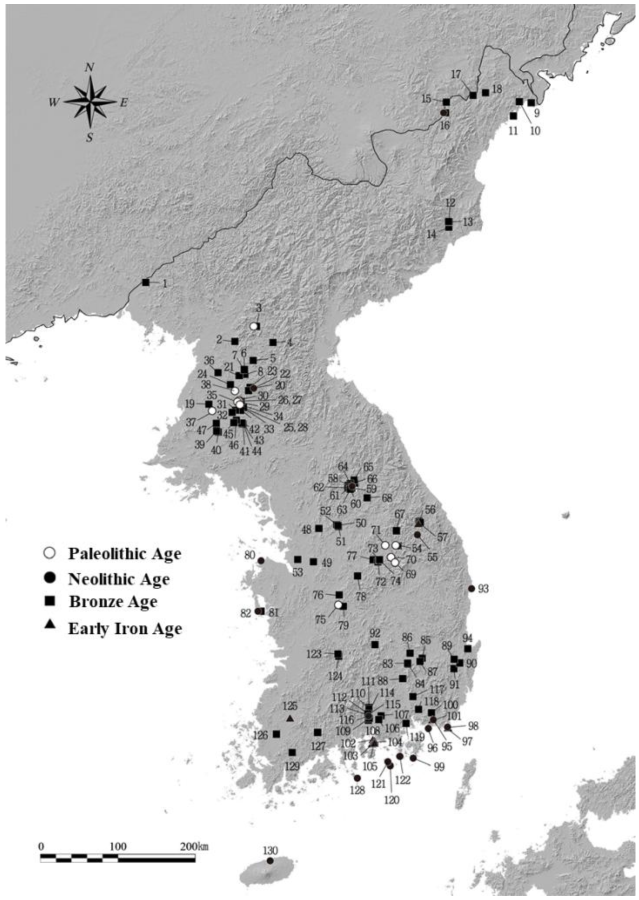
The above discussion is the basis for critically reviewing the results of existing reports and research that dealt with the problems of diet and disease in prehistoric Korea based on the analysis of remains.

Ⅲ. PREHISTORIC KOREAN HUMAN SKELETONS DATA AND DIET AND DISEASE PATTERNS

This paper begins by studying the data of prehistoric remains reported through excavation and recovery. There are 681 pieces of Korean prehistoric remains reported so far, obtained from 130 ruins. Some are two-story ruins, so the total number of ruins (130) does not match with the sum of the periods (136).

< Table 1> Excavation of remains by period

	Relics	Individuals	Minimum	Maximum	Average
Paleolithic period	11	30	1	10	2.7
Neolithic period	19	148	1	48	7.8
Bronze Age	98	330	1	40	3.4
Early Iron Age	8	173	1	72	21.6
Total	130	681	1	72	5.2



<Figure 1> Remains excavated from prehistoric remains in Korea

001. Uiju Misongli	002. Gacheon Mukbang-ri	003. Deokcheon Seungsansan
004. Mengshan Yinxingli Qiyang	005. Bukchang Daepyeong-ri	006. Seongcheon Longsan-ri
007. Shengcheon Longshanli (Sacrificial Burial tomb)	008. Seongcheon Baekwon-ri Vulmal	009. Najin Chodo
010. Ungi Songpyeong-dong	011. Ungi Seopo Port	012. Gilju Pyeongnyeong-ri
013. Yeongam Village, Pyeongland-ri, Gilju	014. Gimbap Deokin-ri	015. Musan Jichori
016. Musan Hogok-dong	017. Hoeryeong Namsan-ri	018. Changhyo-ri, Hoeryeong
019. Gangnam Sinheung-ri Dolbagigol	020. Gangdong Juhyeon-dong	021. Gangdong Munheung-ri
022. Gangdong Samdung-ri Eomigol	023. Gangdong Songseok-ri Gul-eung	024. Pyongyang Namgyeong
025. Sangwon Guili	026. Senate Yonggok-ri Bangulmu	027. Sangwon Yonggok-ri Hoegol
028. Sangwon Bundong-ri	029. Senate Yonggok No. 1 Cave	030. Senate Yonggok No. 2 Cave
031. Sangwon Jang-ri Waksae-bong	032. Senate Jang-ri Jiseok-dong	033. Sangsan-ri Seonemi
034. Sangwon Jungri Geumcheon	035. Senwon Black Anvil	036. Damhwagol, Osan-ri, Pyongyang
037. Pyongyang Mandali	038. Pyongyang Station Battery	039. Sariwon Gwangsungdong
040. Sariwon Sangmae-ri	041. Briquette Dumuri Dumudong	042. Yeontan Odok-ri Seokjanggol
043. Yeontan Odok-ri Songshin-dong	044. Pyeongchon, Odok-ri, Yeontan	045. Yeontan Pungdap-ri Gwangseok-dong
046. Yeontan Sincheon-dong	047. Hwangju Chimchon-ri Gindong	048. Gwangju Dynamic

049. Anseong Manjeongri Shingi	050. Yangpyeong Boxpori (Ewha Womans University)	051. Yangpyeong Boxpori (Jungbak)
052. Yangpyeong Angdeok-ri	053. Pyeongtaek Tojin-ri	054. Yeongwol Refuge Cave (Ssanggul)
055. Madun Cave, Jeongsun	056. Jeongseon Aurage (1st)	057. Jeongseon Aurage (2nd)
058. Chuncheon Jungdo (Gangwon National University)	059. Chuncheon Jungdo (Jungbak)	060. Chuncheon Jungdo (Area A)
061. Chuncheon Jungdo (Area B)	062. Chuncheon Jungdo (D3 Area)	063. Chuncheon Gyodong Cave
064. Chuncheon Shinmari (District I)	065. Chuncheon Balsan-ri	066. Chuncheon Cheonjeon-ri
067. Pyeongchang Hari	068. Hongcheon Eosampori	069. Danyang Geumgul
070. Danyang Sangsiri 1 Boulder Shade	071. Jecheon Jumal Yonggul	072. Jecheon Yangpyeong-ri District D
073. Jecheon Hwangseok-ri B District	074. Jecheon Hwangseok-ri Jiseoktomb	075. Cheongju Heungsugul Cave
076. Cheongju Wolodong	077. Jecheon Stream-ri District D	078. Gosan Sachang-ri
079. Boeun Busuri	080. Seosan Daedeok-ri Shell Mound	081. Taean Gonam-ri Shell mound (1st)
082. Taean Gonam-ri Shell mound (8th)	083. Daegu Wolseong-dong (1150-1)	084. Jincheon-dong, Daegu
085. Daegu Sinsu-dong	086. Dongcheon-dong, Daegu	087. Maeho-dong, Daegu
088. Pyeongchon-ri, Daegu	089. Seokjang-dong, Gyeongju	090. Gyeongju Cheongun-dong
091. Deokcheon-ri, Gyeongju	092. Gimcheon Songjuk-ri	093. Uljin Hupori
094. Hodong, Pohang	095. Busan Beombangbangchong	096. Janghang, Gadeokdo, Busan
097. Busan Jodopae Chong	098. Busan Dongsam-dong Shell mound	099. Geoje Daepo Shell mound
100. Gimhae Naedong	101. Gimhae Yonghwa Shell mound	102. Sacheon Neukdo Island (District C)
103. Sacheon Neukdo Island (District A)	104. Sacheon Woldo (IC District)	105. Sacheon Nwoldo (Entrance Road)
106. Sacheon Bonchon-ri	107. Sancheong Gangnuri	108. Jinju Gaho-dong
109. Jinju Jungcheon-ri	110. Jinju Daepyeong-ri (Eoeun 1 District)	111. Jinju Daepyeong-ri (Eoeunji Stone Tomb)
112. Jinju Daepyeong-ri (Okbang District 1)	113. Jinju Daepyeong-ri (Okbang 4 District)	114. Jinju Daepyeongli (Okbang District 5)
115. Jinju Daepyeong-ri (Okbang District 7)	116. Jinju Sangchon-ri	117. Changnyeong Sachang-ri
118. Changwon Deokcheon-ri	119. Changwon Jinhyeon-ri	120. Tongyeong Sanyeong shell mound
121. Tongyeong Yeondaedo Island shell mound	122. Tongyeong Yogyodapchong	123. Jinan Samrak-ri Gugok
124. Jinan Samrak-ri An-dong	125. Gwangju Sinchang-dong	126. Naju Langdong
127. Suncheon Sinpyeong-ri	128. Yeosu Andopapchong	129. Jangheung Songjeongri (Galdu)
130. Jeju Samhwa District (District D)		

The average number of remains from a site is 5, but the actual number varies greatly from 1 to 72, especially in the Neolithic period and Early Iron Age. The proportion of samples and analysis at the ruins is similar.

Geographical distribution also varies considerably from time to time. Most of the Neolithic period and Early Iron Age remains are on the coast, and the Bronze Age is distributed somewhat evenly throughout the Korean Peninsula.

1. Time-space distribution of human skeletons data from prehistoric times in Korea

Most of the remains of the Paleolithic Age were found together with animal fluids and relics in the 'cultural class' rather than in the shaped remains. In addition, it was not easy to identify because it was excavated as a piece, and it was not easy to identify it until a long time later. As shown in Table 1, on average, there are 2.7 individuals, but the remains of 30 individuals are not evenly distributed in 11 ruins. Nearly half of them are excavated from three caves (mudums), including Yonggok No. 1 Cave (10 individuals), Mandali Cave (5 individuals), and Yeongwol Evacuation Cave (4 individuals), which are distributed near Pyongyang in North Korea, where the topography has developed, and in inland areas of Gangwon and Chungbuk in South Korea.

The 148 Neolithic human individuals are 7.8 per site by simple arithmetic, but the variation is actually quite large. The concentrated land is in the order of Janghang (48 individuals) in Gadeok Island in Busan, Hupori in Ulsan (40 individuals), and Solidarity Shelling in Tongyeong (15 individuals). Remains are mainly found in the shell layer, which is advantageous for the preservation of organic matter, or in the tombs around the residential area. On the other hand, there are not many cases, but they are also confirmed in inland cave culture layers such as Juhyeon-dong (9 individuals) in Pyongyang or Gyodong (3 individuals) in Chuncheon.

The 330 remains of the Bronze Age are not distributed similarly in 98 historical sites, but vary from 1 to 40 with an average of 3.4. They are excavated from tombs such as stone tombs and sarcophagi tombs, shell layers on the coast, and various relics.

The number of remains from the early Iron Age is 173 from eight ruins, with an average of 21.6. Among the various eras, the concentrated distribution or average is the highest. Seven ruins are located in the southern part of the Korean Peninsula, and four of them are not only related to the Neukdo Island A district, IC district, C district, and Shell Mounds, but also the concentration is remarkable. Representatively, 60 individuals were identified in the IC district and 72 individuals were identified in the IC district.

2. Restoration of Prehistoric Diet and Disease Patterns in Korea Based on Ancient Human Skeletons Analysis

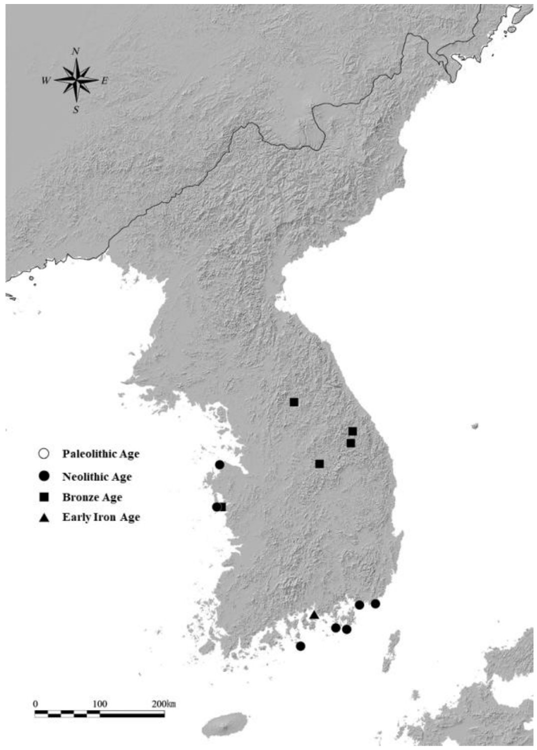
As we saw earlier, even at a glance at the ruins and population alone, there are so few data that some eras are insufficient to attempt demographic and quantitative analysis. Regardless of the era, the reality that samples are excessively concentrated in very few ruins only worsens that trend. However, although it does not guarantee quantitative significance, it is worth paying attention to repeatedly confirmed phenomena. This is because the information itself is not meaningless, and considering that the preservation of remains is poor due to the characteristics of Korean soil, it is unlikely that the number of samples will increase dramatically.

（1）The Diet Patterns

There are other reasons why demographic and quantitative analysis is difficult in the work of restoring dietary patterns in prehistoric Korea from the data of ancient human skeletons. As we saw earlier, the restoration of dietary patterns is based on the analysis of several isotopes. The use of such analysis techniques in archaeological analysis already began in the 1970s, but in Korean academia, it is from the 1990s. The development period is relatively short, and it is difficult to say that the analysis has become generalized even now. Therefore, the results of the analysis are inevitably small. As shown in Table 2, isotopic analysis for dietary restoration in 681 individuals of 130 historical sites is only slightly over 10% based on the population.

<Table 2> Status of dietary analysis by period

	Diet（Analysis rate）	
	Relics	Individuals
Paleolithic period	0/11 (0.0%)	0/30 (0.0%)
Neolithic period	6/19(31.6%)	21/148 (14.2%)
Bronze Age	7/98 (7.1%)	12/330 (3.6%)
Early Iron Age	1/8(12.5%)	42/173 (24.3%)
Undecided part	121/130(93.1%)	605/681 (88.8%)



<Figure 2> Distribution of Human Remains Analysis Sites for Dietary Restoration

Paleolithic period

As shown in Table 2, no human bone analysis has been reported for the purpose of restoring the Paleolithic diet. However, there has been a problem with the diet as a number of cavities were found in the remains of No. 1 (child) excavated in Hungsu Cave, Cheongju, widely known as Hungsu Child. This is because tooth decay, or tooth decay, becomes frequent only after the introduction of agriculture in the Neolithic Age, and due to this, its authenticity as a 'fossil of the Paleolithic Age' is suspected. However, rather than evaluating the validity of the analysis, it is stated in this paper with the aim of reflecting all existing reports.

Neolithic period

Despite the regional limitations of the distribution of Neolithic ruins, it seems that Neolithic people had very limited intake of grains through the results of stable homology analysis on human bones. As a result of data survey on the remains of Dongsam-dong Shell Mound and Gonam-ri Shell Mound, it is estimated that the actual intake of grains was insignificant. Vegetable protein seems to have been supplied from fish and terrestrial herbivores.

In addition, the analysis of collagen excavated from the site of Janghang, Gadeok Island, Busan, the largest collective cemetery in the early Neolithic period, showed that marine foods such as shellfish, mammals, and marine fish were mainly consumed, providing important information for Neolithic people's dietary restoration research.

<Figure 3> Busan Gadeok Island Ruins No. 6 skeleton (wearing a shell bracelet and necklace)

Bronze Age

Among the prehistoric sites subject to this paper, remains have been reported at the most sites, but only a few analysis results are known as dietary analysis has not been actively conducted. Before the stable isotope analysis, carbon dating was first performed on human bone samples to accurately date the absolute. In general, the results of isotope analysis conducted at sites such as the Maedun Cave in Jeongseon, Auraji, Jungdo, Chuncheon, and Hwangseok-ri inJecheon, which are located in inland river alluvial areas, are representative. The distribution range of carbon stable isotopes in human bones was -12 to -9‰, the average value was11.2 ‰, and the distribution range of nitrogen stable isotope values was 6.3 to 7.7 ‰, and the average value was 7.0 ‰. As a result of isotope analysis, it was found that people mainly obtained food materials from C4 plants such as millet. In particular, as the proportion of nitrogen isotopes in human bones was low, it was found that terrestrial herbivores occupied a small part of the diets of people in the Bronze Age. In addition, as a result of the narrow distribution range, it seems that rather than consuming animal proteins raised by C4 plants, they directly consumed millet or millet. Therefore, as a result of the above analysis, it was confirmed that most of the people of the Bronze Age in the central inland area relied on C4 plants such as millet / proso millet and a small amount of terrestrial herbivores. As seen from the Gonam-ri A-1 Shell Mounds, it is estimated that the Bronze Age on the coast was more dependent on C4 plants, especially joe, while using all marine resources such as land resources, sea mammals, and fish and shellfish than the Neolithic Age (B-3 Shell Mounds) or inland.

Early Iron Age

The analysis results of human bones excavated from the ruins of Sacheon Neukdo Island, the ruins of the early Iron Age and the Proto-Three Kingdoms Period, including the ancient tombs of Yean-ri in Gimhae, Songhyeon-dong No. 15 in Changnyeong, the stone chamber tomb of Eunha-ri in Wanju, and the ancient tombs of Imdang in Gyeongsan, are estimated to have consumed crops such as rice, barley, red beans, beans, and wheat, and grains such as millet, millet, and blood, as well as shellfish from the 7th century A.D. It is also estimated that rice intake was not absolute even among the ruling class at that time. Information on the diet of people in the Joseon Dynasty is based on the results of biochemical research on human bones excavated from Hoogwak Tomb in Oknam-ri, Seocheon, and the analysis of carbon-stable isotopes shows that the four people ate more than 85% of grains from plants such as rice, barley, and beans, and from the geopolitical perspective of Seocheon, there must have been a lot of opportunities to eat seafood from a long time ago.

（2）The Disease Patterns

Not all diseases that an individual has in his or her lifetime can be identified through bones. Because most of the diseases we suffer from on a daily basis are passing lesions that do not leave a large mark on the body. Nevertheless, information on the disease situation of the ancient people can be obtained through extreme cases of death or diseases that leave traces on the bones, and recent research is steadily progressing.

To date, there are 18 types of prehistoric diseases in Korea that have been revealed through harmful analysis that have occurred in four major body parts: teeth, head bones, limb bones, and spine. There are 6 types of diseases observed in teeth, of which fraudulent dysplasia, dental caries, dental head dislocation, and tooth loss are relatively frequent. There are 4 types of diseases observed in the head bone, of which the frequency of porous bone hyperplasia is overwhelmingly high. There are 5 types of diseases observed in the limb bone zone, among which the frequency of osteonitis/bone membrane reaction, bone arthritis/bone deflection is relatively high. There are 3 types of diseases observed in the spine, and most of them are degenerative deformation/adhesion/Shimor nodules, but the incidence is not high.

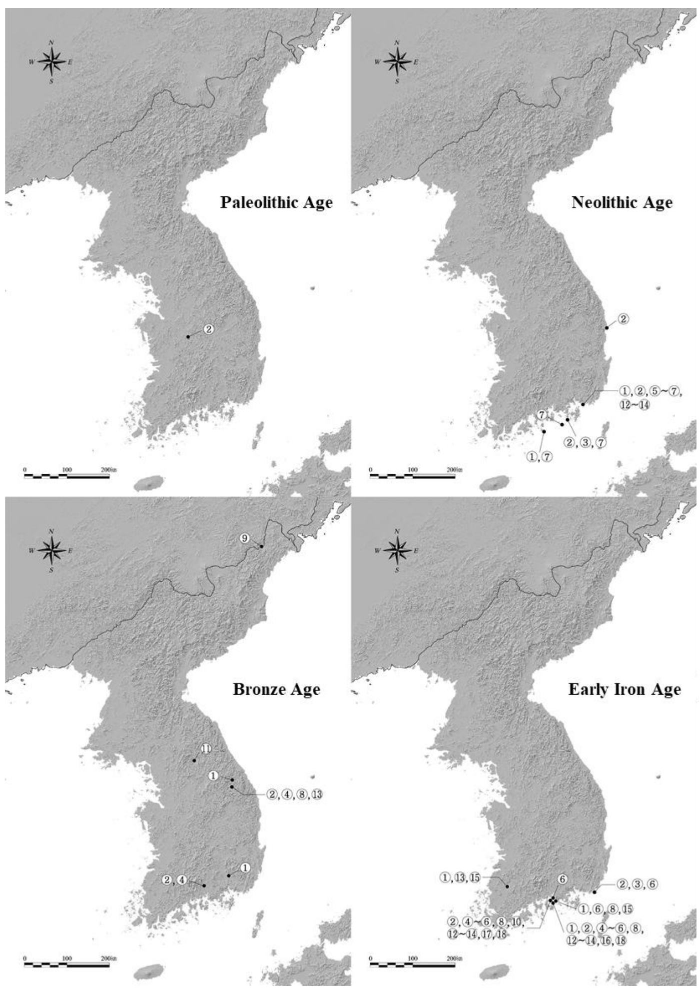
Table 3> Frequency of pathological phenomena in prehistoric remains in Korea

		Paleolithic Age	Neolithic Age	Bronze Age	Early Iron Age	Total
Tooth	① 사기질형성부전증 enamel hypoplasia	0/11 (0.0%)	13/91 (14.3%)	2/43 (4.7%)	4/57 (7.0%)	19
	② 치아우식 dental caries	1?/11 (9.1%?)	13/91 (14.3%)	2/43 (4.7%)	9/57 (15.8%)	25
	③ 치석 tartar	0/11 (0.0%)	1/91 (1.1%)	0/43 (0.0%)	1/57 (1.8%)	2
	④ 치아주위조직염 periodontitis	0/11 (0.0%)	0/91 (0.0%)	2/43 (4.7%)	7/57 (12.3%)	9
	⑤ 치아머리탈락 tooth crown decay	0/11 (0.0%)	11/91 (12.1%)	0/43 (0.0%)	10/57 (17.5%)	21
	⑥ 치아결실 tooth loss	0/11 (0.0%)	2/91 (2.2%)	0/43 (0.0%)	13/57 (22.8%)	15
Skull	⑦ 바깥귀길뼈종 external auditory canal osteoma	0/13 (0.0%)	10/85 (11.8%)	0/77 (0.0%)	0/98 (0.0%)	10
	⑧ 다공성뼈과다증 porotic hyperostosis	0/13 (0.0%)	0/85 (0.0%)	2/77 (2.6%)	38/98 (38.8%)	40
	⑨ 외상 trauma	0/13 (0.0%)	0/85 (0.0%)	1/77 (1.3%)	0/98 (0.0%)	1
	⑩ 뼈증식 osteophyma	0/13 (0.0%)	0/85 (0.0%)	0/77 (0.0%)	1/98 (1.0%)	1
Limb Bones	⑪ 선천적/원인 불명 변형 congenital/unknown deformities	0/8 (0.0%)	0/75 (0.0%)	1/66 (1.5%)	1/113 (0.8%)	1
	⑫ 뼈막염/뼈막반응 periostitis/periotseal reactions	0/8 (0.0%)	1/75 (1.3%)	0/66 (0.0%)	11/113 (9.7%)	12
	⑬ 뼈관절염/뼈변연 osteoarthritis/lipping	0/8 (0.0%)	1/75 (1.3%)	1/66 (1.5%)	16/113 (14.2%)	18
	⑭ 골절 fracture	0/8 (0.0%)	1/75 (1.3%)	0/66 (0.0%)	6/113 (5.3%)	7
	⑮ 뼈부착부 발달 developmental entheses	0/8 (0.0%)	0/75 (0.0%)	0/66 (0.0%)	2/113 (1.8%)	2
Spine	⑯ 클리펠-파일 증후군 Klippel-Feil syndrome	0/1 (0.0%)	0/16 (0.0%)	0/15 (0.0%)	1/53 (0.0%)	1
	⑰ 결핵성 척추염 tuberculous spondylitis	0/1 (0.0%)	0/16 (0.0%)	0/15 (0.0%)	1/53 (1.9%)	1
	⑱ 퇴행성 변형/유착/쉬모르 결절 degenerative deformity/adhesions/ Schmorl's nodule	0/1 (0.0%)	0/16 (0.0%)	0/15 (0.0%)	7/53 (1.9%)	7
Total		1?	53	11	127	192

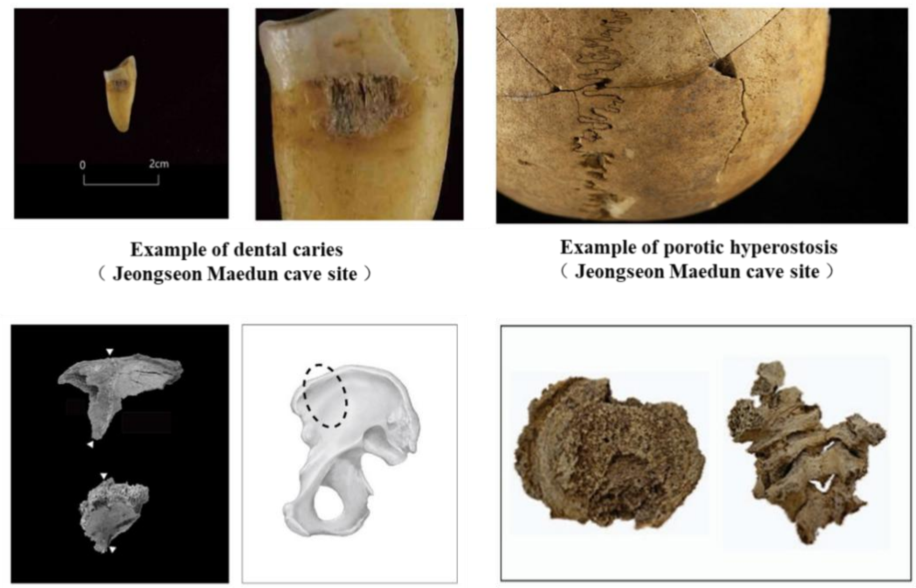
Unlike the restoration of diets using remains relies on advanced analysis techniques, diseases can also be determined by skeletal observation of teeth and skeletons. Therefore, as shown in Table 4, there seems to be no big problem even if it is considered to be the confirmation of pathological phenomena rather than the ratio of analysis.

<Table 4> Identification of diseases of remains of ancient humans by period

	Total	Observation/Analysis	Simple Reporting	Pathology Identification
Paleolithic period	30	16	14	1
Neolithic period	148	132	16	34
Bronze Age	330	115	215	6
Early Iron Age	173	156	17	48
Total	681	419	262	89



<Figure 4> The distribution of diseases identified through the analysis of human remains in prehistoric times in Korea



Example of dental caries
(Jeongseon Maedun cave site)

Example of porotic hyperostosis
(Jeongseon Maedun cave site)

Example of fracture
(Iksan Ssangneung)

Example of spondylosis deformans
(Archaeological Site on Neukdo Island, Sacheon)

<Figure 5> Examples of various diseases

Paleolithic period

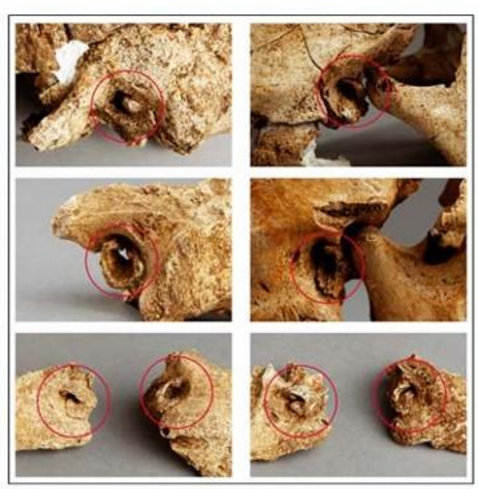
Several dental caries, or cavities, of the remains of children excavated from Hungsu Cave in Cheongju are the only cases where pathological phenomena in the Paleolithic era have been reported. However, as previously stated, it seems difficult to actively admit it if it is suspected that it is a "fossil of the Paleolithic Age" and the reason is that it is not common in the Paleolithic Age.

Neolithic period

In the remains of the Neolithic Age, pathology is observed in the rest of the body except the spine. In particular, toothrelated pathologies are overwhelming. Next, only external auditory canal osteomas have been reported in relation to the head bone. Outer ear boneoma is a disease that narrows the ear canal as the bones inside the ear canal grow slowly, and is now a rare benign bone tumor. It is mainly found in ancient people on the Korean Peninsula, especially in human bones excavated from Neolithic ruins.

As previously discussed, dental caries, or tooth decay, increase dramatically as the lifestyle changes from hunting and gathering to agriculture. It appears to be associated with the transition to a starchy diet, which is not as high in quality as grains and contains a lot of sugar. Malnutrition usually exacerbates fraudulence, which leaves traces of rough bands on the surface of teeth.

Although not definitive, external ear boneoma is known to be the likely cause of repeated stimulation by cold water. It is also found frequently in haenyeo, so it is understood to suggest the possibility of actively utilizing marine resources.



<Figure 6>An example of external auditory canal osteoma（Gimhae National Museum）

Bronze Age

11 types of Bronze Age diseases have been reported from 6 sites, and the cases are very few. This seems to be because only the existence of remains is often reported simply, and it is difficult to observe the skeleton or teeth due to being sculpted. Of the 11 known pathological phenomena, 5 were identified only in the Jeongseon Madun site. Even that was targeted at one individual. In the remains of this middle-aged woman, traces of bone formation, eye enlargement, degenerative joint disease, tooth caries and surrounding tissue-related diseases are confirmed. It is presumed to have been accompanied by malnutrition and considerable pain. The results of isotope analysis also support this, with field crops corresponding to C4 plants being used as the main food source, and terrestrial protein seems to have accounted for a small portion. Considering the age of death, it is also estimated that dietary and nutritional status or disease may have had an effect.

Early Iron Age

As we have seen earlier, although the number of remains excavated or secured in the early Iron Age is smaller than that of the Neolithic and Bronze Age, the ratio of dietary analysis is high and the rate of analysis and confirmation of pathology is high. In general, the remains of one individual are excavated, the remains are in good condition, and it is attributed to the intensive analysis of the remains.

In the case of Neukdo Island remains, all the excavated samples were analyzed in detail, and various pathological phenomena related to all four sites were identified. Spontaneously healing fractures or bone membrane reactions in the ulna, radius, Femur, and foot bones or bone membrane reactions may indicate exposure to hazardous living or working conditions. Considerable labor intensity is confirmed, and degenerative lesions such as degenerative arthritis and Schmorl's node and the development of attachments are also observed. Interestingly, a number of children's remains are found, in which porotic hyperostosis bones such as eye dilatation, polydisease, and tuberculous spondylitis are identified. In addition, diseases that would have suffered in childhood are observed in the remains of adults, allowing the overload of the growing season or poor nutritional status to be estimated. However, in teeth, it is necessary to distinguish from pathology because it is possible to estimate the tooth extraction custom due to unexplained loss as well as enamel hypoplasia, dental caries, periodontitis and tooth crown decay.

Ⅳ. A Critical Review on the Restoration of Dietary and Disease Based on Prehistoric Human Skeletons in Korea

This paper started with the expectation that by collecting research and reports that tried to restore the diet and disease patterns of prehistoric Korea using the remains, it could identify the phenomenon of accumulated information and provide the basis for future research to merge the restoration with socio-cultural changes. However, as previously examined, it is difficult to systematically merge the information obtained from the sample because demographics or quantitative approaches are difficult and the regional bias is severe. Moreover, since soil conditions make it difficult to add new samples dramatically, the future cannot be expected.However, it seems possible to partially support and supplement the current archaeology's understanding of social and cultural changes by comparing some of the information revealed in the current sample. Of course, a critical review of the problem of regional bias in the sample should be preceded. In such a review, it seems that the consideration of diet and disease should be examined in combination rather than separating it. In fact, the causes of diseases identified in this paper can be divided into four categories: malnutrition, overexertion, aging, and infection(due toinjury). Among them, nutritional deficiencies are not only directly related to diet, but various infections are also aggravated by them, so **there** seems to be enough reasons to examine both in combination.

1.Paleolithic period

As is widely known, the livelihood of hunter-gatherers in Korea was based on hunter-gatherer. It is generally acknowledged that the nutritional and health status of hunter-gatherers was not worse than that of agricultural occurrence, but at that time, especially in the late climatic environment, which dominated the mainstream of the Korean Paleolithic period, changed rapidly, making it somewhat difficult to generalize living conditions at a specific point in time. Even with that in mind, the frequency of cavities in Hungsu is difficult to accept.

2.Neolithic period

The main issues of economic research in the Neolithic Age in Korea are related to the proportion of crop production economy and the role of marine resources as food. Since primitive crop cultivation existed, but it was limited, it is basically estimated that the hunting-gathering economy was maintained. Food mainly depended on inland plants, and shellfish is considered to have played an important role, although auxiliary.

However, although it may be pointed out that it relies on small-scale samples, it is somewhat different from the current understanding that carbon isotope analysis of the remains obtained from the shell mound indicates that C4 plants were the main focus. On the other hand, it is also interesting to note that the west coast and the south coast differ in the mode of use of terrestrial marine animals. However, it can be said that it has some aspects in common with the fact that external auditory canal osteoma, a disease related to active diving and fishing, is only identified in the southern coast. However, since the results of trace element analysis indicate that the use of marine animals on the west coast was active, it seems necessary to consider the results between the analysis methods together.

As mentioned above, it is widely understood that after the introduction of agriculture, the height has decreased and the nutritional status has deteriorated. There are also matters indicating malnutrition in the remains of the Neolithic Age in Korea, suggesting the possibility, but it is difficult to confirm because there is no data from the Paleolithic Age for comparison. However, considering that even the Neolithic Age was a society that relied on hunting and harvesting rather than crop cultivation, the pervasive nutritional deficiency is not easily understood. This is even more so because fish and shellfish resources may have been abundant, and there are traces of overexertion.

3.The Bronze Age

Often, the research on livelihoods in the Bronze Age focuses on the form of cultivation on the premise that it has entered an agricultural society. Among them, the discussion on the role of cultivation, especially monoculture, was at the core.

However, the current isotope analysis results of the remains instruct the intake of C4 crops such as cultivated millet, barnyard millet, and sorghum. It is clearly contrary to current expectations and interests. However, since the ruins to be analyzed are located in the inland mountainous area and the middle stream of the Bukhangang River, the previous agriculture was an overwhelming production method, the analysis results are likely to be in line with the current understanding. In fact, there have been opinions that assume differences in the location of Rice Culture Practices /Pre-cropping for a long time, and there is no significant change today. More comprehensively, it is also worth referring to the possibility that the production method of livelihood resources was different depending on the soil characteristics, especially in the Bronze Age.

4.Early Iron Age

In general, remnants of the early Iron Age are found evenly throughout South Korea, but it is highly likely that the population density was significantly lower than that of the Bronze Age. In common sense, the phenomenon of population concentration in specific ruins such as Neukdo Island or in specific areas such as the southern coast is not easily accepted. In addition, the traces of high-intensity labor as mentioned above are not easily understood. A more complex explanation of what the purpose of the labor was is likely to be needed.

One of the approaches to the problem will be a review of the differential aspects of manual labor after stratification. In addition, it seems necessary to approach the problem of the predominance of rice consumption produced through aquaculture, a type of intensive agricultural method, from a similar direction.

Ⅴ. CONCLUSION

Based on the analysis of remains, various attempts to restore prehistoric Korean diets and diseases were summarized, and limitations as a systematic source of information, as well as contributing or contributing to understanding social and cultural changes, were examined.

Human data, an important research subject in natural science fields such as biological anthropology, paleopathology, and collective genetics, meets archaeology and reveals the high population and funeral rituals of the past, directly helping to restore the past social culture such as life, culture, social organization, and customs of the old people.

While fully acknowledging its status as archaeological data, it is rare in the world to systematically and comprehensively apply the results of analysis of harmful data to various archaeological tasks in the society. This is especially true in Korea, where the soil is fundamentally poor in the preservation of organic matter, and the entire country has already been actively developed. It is difficult to expect a dramatic improvement in the future.

A framework, for example, a biological model that systematically combines biological and cultural information is required to overcome the fragmentation of such data even a little and to absorb the analysis results that provide specific information that was previously unexpected in the archaeological explanation. Biological archaeology's approach is based on such a framework. Biological archaeology is no longer unfamiliar to Korean academia. There is also a fairly tangible movement to actively implement its methods and orientations. The emergence of legal and administrative measures and research organizations is also accelerating their activities.

This paper and the collection that was based on it were written with the expectation that the current movement will be guided in a more productive direction. Although such an attempt may not immediately provide specific and novel conclusions, a comprehensive examination of the existing achievements will be able to suggest a starting point for future research.

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