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Sustainability of K-Food: focused on the change in the health values of K-Food

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Abstract

The importance of culture and interest in K-culture due to the development of online Mediterraneania such as social media have increased curiosity about K-Food, which contains Korean traditions and cultures. It will be necessary to establish the identity and value of K-Food in order to continue it, which is in global attention. Therefore, this study reviewed the definition, tradition, and health values of K-Food from the past to the present for the sustainability of K-Food in the global era. K-Food has been constantly influenced by geography, climate, religion, ideology, and neighboring countries throughout Korea's 5,000-year history, but has maintained Korea's unique and creative dietary habits and traditions. K-Food is an individual Korean dish, bapsang, constituting K-diet, and K-diet is a concept that combines K-Food and K-culture. Korean traditional fermented food, one of the K-Foods, and Korean dietary patterns have been reported to improve body weight, gastrointestinal health, diabetes, hypertension, dyslipidemia, and cognitive function. In addition, K-Food has a similar dietary pattern and nutritional value to the healthy Mediterranean diet. In conclusion, the sustainability of K-Food in the era of globalization requires continuous education to preserve traditions and culture, scientific research on health functions, and localization research so that it can be easily applied in other countries.

Keywords Korean diet, K-Food, K-diet, Traditional food, *Kimchi*, *Jang*, Sustainability, Fermented food

Introduction

For Korean traditional food (K-Food), Original birth, science and philosophy are deeply studied in this issue, because Korean food is curious and interesting by many peoples even foreigners [1]. According to the report on big data analysis on the culture and industry of global Korean food, while interest and response to K-Food have been gradually increasing, the supply and demand of YouTube video content for K-Food have increased significantly since the COVID-19 pandemic declaration in the second half of 2020 [2]. In other words, the number of YouTube videos and export products related to K-Food, such as traditional K-Food including *kimchi*, *galbi* (ribs dish), *bulgogi* (grilled meat dish), and *tteokbokki* (stir-fried rice cake) and trendy K-Food including Korean chicken, *gogigui* (Korean barbeque), *dalgona* coffee (frothy coffee drink), and Korean-style *ramyeon* (instant noodle), have increased overall [2, 3]. This seems to be due to increased use of online shopping using online media, social media such as YouTube and Twitter, and Netflix viewing in a non-face-to-face society due to lockdown and social distancing caused by COVID-19 [2, 4]. For instance, foreign YouTubers who shoot *mukbang* (social eating) using K-Food along with interest in *mukbang* culture, a distinctive content of Korea, gained popularity [5]. Furthermore, the new *Hallyu* (Korean wave) of K-culture, such as K-pop, K-movie, and K-drama, has increased attention on K-Food such as *tteokbokki* eaten by K-pop stars, Korean-style *ramyeon* in dramas and movies, and *dalgona* (sugar honeycomb toffee) [2, 3, 6].

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Along with the healthy value of K-Food, interest in K-culture has led to increased opportunities for K-Food to enter global markets such as the USA, China, Japan, India, and Europe, and expansion of scale [3, 6]. In this situation, in order for K-Food to be continuously maintained in the global market, steady efforts and strategies will be required, such as preserving K-Food, a Korean tradition, and culture, and proving its health value. Therefore, in order to establish the value and culture of K-Food in the global era, this review tried to identify the direction for the sustainability of K-Food by examining the health benefits and nutritional value of K-Food from the past to the present.

Characteristics of K-Food

In addition to the recent book and the papers [1, 7], the 'Standard Korean Language Dictionary(*pyojun-guke-odaesajeon*)' defines Korean food (*Hansik*) as "Korea's unique food or meal" [8]. However, many people are vague about the definition and characteristics of K-Food since K-Food has been constantly changing in the flow of history. The reason for this is that although there is the traditional food in K-Food, there is foreign food that has come into Korea and become Koreanized, or conversely, there is food that has been localized by going overseas. In addition, K-Food has 'emotions' that transcend the concept of simple food. Koreans also express their emotions through '*bap*' when they say hello, welcome, happy, thankful, or on the other hand, when they are upset or angry. Namely, when Koreans meet close friends and ask for their regards, they say, 'Have you had *bap*?' or express their gratitude with the expression, 'I'll buy you a *bap* later.' This means that K-Food also expresses *jeong* (情; similar to caring or affection) the unique sentiment of Koreans [1]. Also, the word '*jipbap* (home-cooked meals)' has a special meaning for Koreans and longing that reminds of 'mom's *sonmat* (comfort food)' because mothers prepared family meals in the past. Therefore, some food and nutrition scholars in Korea had expanded on the current definition of K-Food by considering various aspects such as the preservation of tradition, health, and culture, and they arranged the definition and characteristics of K-Food in the 'Seoul Declaration of Korean Diet' in 2016 [9]. In other words, K-Food is defined as "an individual single food constituting K-diet, and K-diet is a carefully prepared *bapsang* (table set) with *bap*, *guk*, *kimchi*, and various *banchan* on one table" [9, 10]. K-diet is a concept that combines K-Food and K-culture, often referred to as Korean cuisine, Korean diet, or traditional Korean food [10].

Additionally, the Seoul Declaration lists the characteristics of K-Food as follows [10]: 'The *bap* (rice) is the staple food, vegetables and seaweed are consumed a lot, and the intake rate of legumes and fish is higher than that of red meat. Medicinal herbs, sesame seeds, perilla oil, or fermented food like *jang* is typically utilized to season *banchan* (side dish) [10, 11]. In addition, a variety of seasonal ingredients are used, and fewer deep-frying recipes are applied. These characteristics are similar to the requirements of a healthy diet recommended by the World Health Organization (WHO). The WHO recognized the importance of diet as a factor of disease risk in a situation where the mortality rate from non-communicable diseases is rising globally [12]. A goal to encourage a healthy diet was offered as one way to solve this issue [12]. In other words, a balanced energy intake, reduced intake of saturated and trans-unsaturated fatty acids, low intake of sugar and salt, and high intake of fruits, vegetables, legumes, and whole grains are recommended [12]. Cena and Aldor (2020) also cite the Mediterranean diet, Dietary Approaches to Stop Hypertension (DASH), Mediterranean-DASH Intervention for Neurodegenerative Delay (MIND), Nordic, and traditional Asian diets, including Korean, as diets similar to the WHO's diet goals [13]. The characteristics of these diets were also found to contain higher plant food, including fresh fruits, vegetables, and whole grains, and lower animal foods, compared to Western diets [13]. Above all, the Mediterranean diet, which was first described in a study in seven countries in the 1950s, is known to be related to a low incidence of cardiovascular disease and is hence accepted worldwide as a healing food [14]. The Mediterranean diet is today known as the traditional dietary behavior of Mediterranean countries such as Greece and Southern Italy [14, 15]. The Mediterranean diet was recognized by the United Nations Educational, Scientific and Cultural Organization (UNESCO) not only for its value, but also for its cultural identities, such as a way of life and a meal eaten together, and was listed as an Intangible Cultural Heritage of Humanity in 2010 [14, 15]. Comparing the intake of food and nutrients in the Mediterranean diet and K-diet, these exhibited similar qualities, although there were some differences in food and nutrient consumption [16] (Fig. 1). In summary, the K-diet had a high carbohydrate ratio, while the Mediterranean diet had a high-fat ratio [16, 17]. This seems to be because rice is the staple food in K-diet, and olive oil is used a lot in the Mediterranean diet. While the Mediterranean diet consists of raw or oven-cooked vegetables like salads and fermented animal food like yogurt and cheese, K-diet mainly consists of cooked vegetables and fermented plant food like *kimchi* and *jang*. Additionally, the K-diet appeared to have a lower consumption of saturated fat due to a higher intake of vegetables, fish, and seafood as well as less meat than the Mediterranean diet,

	Korean Diet (K-diet)	Mediterranean Diet (Med diet)
Example of diet		
Energy intake	1,976 kcal/day	1,815 kcal/day
Ratio of energy intake (carbohydrate : protein : fat)	65:15:20	45:15~20:30~40
Saturated fat intake from energy intake	6.3 %/day	11.8 %/day
Calcium	496.9 mg/day	1,062 mg/day
Meat	42 kg/year	91 kg/year
Fish	51 kg/year	25 kg/year
Vegetables	223 kg/year	178 kg/year
Legumes	34 g/day	8.5 g/day
Milk	29 kg/year	247 kg/year

Fig. 1 Comparison of intake of food and nutrient from traditional Korean and traditional Mediterranean diets. The K-diet had a high carbohydrate ratio, while the Mediterranean diet had a high-fat ratio [16, 17]

despite the high consumption of vegetable fat from olive oil in the Mediterranean diet. As such, K-diet has the potential as a healthy diet that is as good as the Mediterranean diet and may become a better meal with a high intake of fermented food, vegetables, fish, and shellfish. However, calcium intake was lower in the K-diet than in the Mediterranean diet, which seems to be due to lower milk intake in the K-diet. Therefore, calcium supplementation will be needed for the K-diet to become a more well-balanced healthy diet.

Health-beneficial effects of Korean traditional fermented food

Fermented food is one of the indispensable components of K-Food. In particular, *kimchi* and *jang* are fermented food that is well known around the world, and exports of *kimchi* and *jang* in 2021 are steadily increasing to about $160 million and $82 million (*gochujang* $53 million, *ganjang* $19 million, and *doenjang* $11 million), respectively (Fig. 2) [18].

The reason seems that K-Food such as *tteokbokki* and *bibimbap* gained popularity as they were introduced on global video platforms, and consumption increased as their health benefits became known. Therefore, research on the health functionality of K-Food has been steadily conducted to establish itself as a global health food like the Mediterranean diet.

Not only *kimchi*, known as Korea's representative fermented vegetable food but also lactic acid bacteria derived from *kimchi* have been studied a lot [19]. Kim et al. [19] confirmed a total of 149 studies on the health functionality of *kimchi* and *kimchi*-derived lactic acid bacteria from 1995 to 2017. *Kimchi*, its extracts, and *kimchi*-derived functional ingredients have been reported to have various results such as anti-oxidant, anti-mutagenic, lipid-inhibiting effects, anti-hypertensive, anti-inflammatory, immune enhancement, improvement in obesity and blood glucose levels, and protective effects on the skin in cell and animal models [19, 20]. In addition, *kimchi* and its derived functional ingredients prevented cancer development in various cancer cells such as stomach,

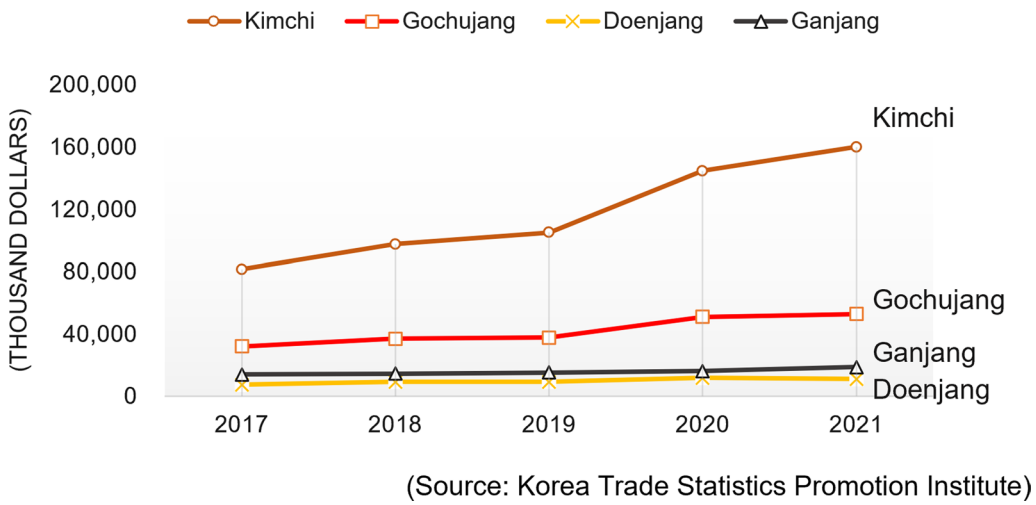


Fig. 2 Changes in exports of typical Korean traditional fermented foods. Export of kimchi is increased steadily even with COVID-19

lung, colon, breast, liver, and uterine cancer cells, as well as in animal models with solid cancer, cancer cell administration, and chemically induced cancer [19, 20]. In addition to preclinical investigations, clinical trials have also shown the health benefits of *kimchi* [20]. In one of the clinical trials related to *kimchi* intake, healthy young men in Korea were given 210 g/day of *kimchi* for 28 days along with regular meals excluding probiotics [21]. As a result, it was found to improve lipid profile and adiponectin levels, which are obesity-related indicators, in serum, as well as inflammatory markers, harmful enzyme activity, and gut microflora in the colon [21]. The intake of 210 g/day of *kimchi* for 12 weeks also reduced levels of serum inflammatory cytokine and improved clinical symptoms in subjects with irritable bowel syndrome (IBS) [22]. In addition, the intake of *kimchi* reduced blood pressure and insulin resistance in prediabetic subjects [23] and was reported to improve fasting blood glucose and serum lipid levels in healthy young adults [24].

According to reports by Moon et al. [25], there were about 159 studies on the health functionality of *jang*, a major Korean seasoning, from 1995 to 2017. According to pre-clinical studies using cellular and animal models, various *kanjang* (fermented *kanjang*, brewed *kanjang*, mixed *kanjang*), their extracts, and *kanjang*-derived substances showed improvement in intestinal inflammation, anti-hypertension, immune enhancement, anti-inflammatory, anti-oxidant, and anti-thrombotic effects [21]. *Doenjang* and *gochujang* have also been demonstrated to inhibit the growth of various cancer cells, including those that cause stomach, colon, lung, and liver cancer, as well as improve the growth of high blood pressure, thrombogenesis, inflammation, obesity, diabetes, oxidative stress, and bacteria in pre-clinical studies [25]. *Cheongkukjang* has been studied more than other *jang* [25]. Many studies in cells and animals had reported that *cheongkukjang* and its derived substances improved inflammation, allergic reactions such as asthma and atopic dermatitis, death of pancreatic beta and hippocampus cells, obesity, diabetes, oxidative stress, nerve damage, osteoporosis, and thrombosis [25]. Among clinical studies related to *jang* intake, *gochujang,* and *doenjang* revealed anti-obesity effects in overweight/obesity subjects with a polymorphism of peroxisome proliferator activator receptor γ2 (PPARγ2), an obesity-related gene [26, 27]. Additionally, in overweight and obese adults, consumption of traditional and commercial *gochujang* showed a preventive effect on obesity [28], and intake of *cheonggukjang* altered the body composition and the arteriosclerosis index [29]. High consumption of fermented food like *doenjang*, *cheonggukjang*, *kimchi*, seafood fermented food, and *makgeolli* (Korean traditional alcoholic beverage) was linked to a low prevalence of Alzheimer's disease in adults over the age of 19 in a cross-sectional study using data from the Korea National Health and Nutrition Examination Survey (KNHANES) [30].

Recently, attention to immune-boosting food has increased due to the pandemic of COVID-19, and it is estimated that the low mortality rate of COVID-19 in countries such as East Asia is attributable to the intake of fermented food [31]. In particular, traditional Korean fermented food such as *kimchi*, *cheonggukjang*, and *doenjang* has been reported to have antiviral effects against respiratory viruses by stimulating the immune response, suggesting a potential beneficial effect on COVID-19 [32]. As a result, research on the health efficacy of traditional Korean fermented food has been ongoing to this day, and Korean traditional fermented food is

progressively becoming recognized as healthy meal across the world.

Misconceptions about Korean traditional fermented food: Korean Paradox

However, despite the steady demonstration of the health functionality of fermented food such as *kimchi* and *jang*, many people have begun to doubt the health benefits due to a large amount of salt added during the preparation of these traditional fermented foods.

The WHO suggests a daily sodium intake of less than 2,000 mg (5 g of salt) because it has been known to be correlated with various chronic disorders such as cardiovascular and kidney disease [33]. Sodium intake in Korea was 3,220 mg in 2021, higher than the WHO's recommendation [18]. As *kimchi* and *jang* were pointed out as the main sources of sodium intake for Koreans, some began to say that they would be harmful to health. However, this is because they overlooked other bioactive components in fermented food and focused only on one aspect of sodium levels. A similar example is the French Paradox. The French Paradox refers to a phenomenon in which the French have lower heart disease than other countries, even though they consume high fat, and is cited as the reason for the high intake of red wine [34]. Although red wine is an alcoholic beverage with an alcohol content of 16%, its moderate consumption prevents cardiovascular disease due to polyphenols such as resveratrol [35]. Likewise, Koreans enjoy salty, spicy, and stimulating food, but live slimmer and longer, which can be attributed to the high intake of traditional fermented food [36, 37]. In other words, traditional fermented food has a high salt content, but they have various health functions due to the phytochemicals, lactic acid bacteria, and other bioactive substances produced during the fermentation process. This can also be called Korean Paradox [36, 37]. Many studies are currently being conducted to prove Korean Paradox. When Sprague–Dawley rats were given salt water and *doenjang* orally at 8% salinity to evaluate the effect on blood pressure, the *doenjang* intake group had considerably lower blood pressure than the salt intake group [38]. Therefore, it was suggested that *doenjang* consumption was not a direct cause of increased blood pressure [38]. Recent studies showed that the amount of sodium consumption is not closed related with human longevity by observing the cohorts following the last 10 years about Korean 200,000 peoples [39].

Additionally, when mice with colitis were given salt at the same concentration as the salt content in *gochujang* and *gochujang*, it was found that *gochujang* generally alleviated colitis compared to the salt group [40]. The reason was presumed to be due to isoflavone contained in *gochujang* [40]. In a study that analyzed the relationship between *kimchi* intake and hypertension by gender based on the KNHANES performed by Korea Centers for Disease Control and Prevention, high consumption of *kimchi* was not associated with an increase in the prevalence of high blood pressure [37]. For that reason, it was assumed that *kimchi* would help neutralize the effect of sodium on blood pressure levels because it has a high potassium content as well as sodium [37]. Furthermore, the ripe *kimchi* alleviated the increase in systolic blood pressure and the excretion of proteinuria brought on by kidney damage when salt and ripe *kimchi* were added to the diet and fed to salt-sensitive rats [41]. However, there have been conflicting studies as it was observed that the risk of hypertension increased only in obese men as the intake of watery *kimchi* increased [42]. Therefore, a multidisciplinary study related to the salt content in fermented food and various metabolites produced through fermentation will be required, which will be a way to solve questions about the health functionality of K-Food.

Healthy dietary patterns consisting of K-Food

In addition to K-Food itself, dietary patterns that have positive benefits on health are also found in the K-diet composed of K-Food. K-Food consists not only of fermented food, but also of rice, vegetables, and seaweed-based food. Based on this, studies have been conducted to compare rice-based meals, a traditional Korean meal, with wheat-based meals, a representative of Western meals, and to derive a healthy plant-based diet from K-diet. Taking a few examples, in a 12-week intervention trial comparing a rice-based meal, a typical K-Food meal, and a wheat-based meal, a representative western meal, the rice-based breakfast resulted in lower body fat accumulation and positive effects on cognitive function in Korean adolescents [43]. A prospective cohort study based on health examination subjects among Korean adults from 2004 to 2013 found that "prudent" and "white rice" patterns decreased the risk of dyslipidemia, whereas "wheat-based meals and meat" pattern meals increased the risk of dyslipidemia [44]. Women aged 50–60 years were divided into a control group that consumed the westernized K-diet and a K-diet group that consumed a traditional K-diet for 2 weeks. As a result, the traditional K-diet intake improved diabetes and its related metabolic conditions [45], elevated anti-inflammatory IL-10 in plasma, and reduced the level of pro-inflammatory nuclear factor-kappa B (NF-κB) [46]. In addition, it has been shown that the traditional K-diet along with the Mediterranean diet can lower the risk of cardiovascular disease in adults with type 2 diabetes [47]. Studies on plant-based K-Food have indicated that plant-based diets prevented hypertension [48], improved dyslipidemia [49],

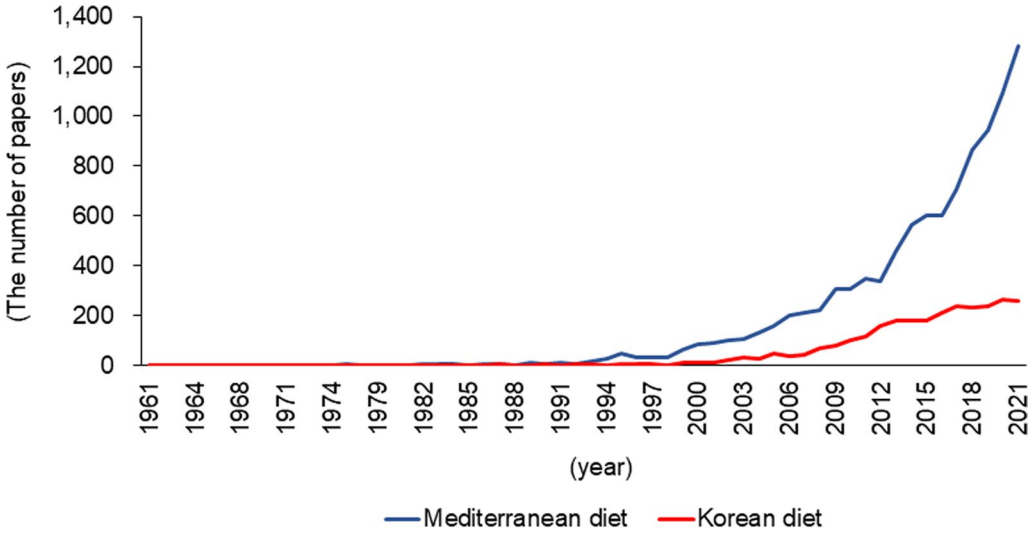
and reduced the mortality rate of Korean adults aged 40 or older when the healthful plant-based diet index was high [50]. K-diet, prepared as K-Food, has been proven to exhibit various health effects through clinical trials. Chung et al. [20] reviewed the healthy functionality of Korean fermented food very comprehensively. As well reported by Kim et al. [1], basically Korean food is very healthful because they found how to make meals to be deliciously without using sugar and frying oils, which are known as very harmful [1].

The need for further extensive research on K-diet

However, scientific research on K-diet is still lacking in both quantity and quality compared to Mediterranean diet. Looking at the difference in the number of published papers on Mediterranean diet and K-diet, there were about 1,200 papers on the Mediterranean diet and about 250 papers on the K-diet on PubMed (https://pubmed.ncbi.nlm.nih.gov/) in 2021, a difference of more than five times (Fig. 3). It can be seen that research is insufficient for K-diet to be recognized as a healthy food worldwide. As a result of searching and analyzing the two diets in PubMed, the range and depth of the clinical research also showed great differences.

In Table 1, a lot of clinical trial data related to the Mediterranean diet have been accumulated, and based on this, meta-analysis and systemic review with high levels of evidence are conducted, but K-Food is still under interventional trial. There are also differences in the research areas and subjects. K-Food is gradually diversifying its research fields, but research on cardiovascular disease, metabolic syndrome, obesity, and diabetes is still the main focus, and studies on changes in the gut microbiome, and improvement in gastritis, colitis, and cognitive function have recently been conducted. On the other hand, the Mediterranean diet has not only been studied on the aforementioned diseases, but also a wide range of studies such as rheumatoid arthritis, neurodegenerative diseases, and aging delay. K-Food has been mainly studied for Koreans and short-term for about 12 weeks, while Mediterranean food has been investigated for diverse population groups in many countries around the world, and large-scale and long-term studies.

Moreover, the K-diet is mainly focused on deriving dietary patterns to prevent diseases only in Korea,



	Mediterranean diet	Korean diet
The year when more than 100 paper was published	Since 2002	Since 2010
Number of published papers in 2021	More than 1,200 papers	More than 250 papers
	The difference in the number of papers by about 5 times	

(Search: https://pubmed.ncbi.nlm.nih.gov/. Accessed 5 June 2022)

Fig. 3 Variations in the number of published papers on the Mediterranean diet and K-diet (keyword: Mediterranean diet, Korean diet)

Table 1 Comparison of scientific-based studies related to clinical research on the Mediterranean diet and K-diet

Division	Mediterranean diet	Korean diet
Differences in data accumulated from clinical trials	• Lots of clinical trial data accumulated • Based on the accumulated clinical data, meta-analysis, and systemic reviews are emerging a lot	• Insufficient clinical trial data •Still working on an intervention study
A field of study	• Much has already been done regarding cardiovascular disease, metabolic syndrome, obesity, diabetes, cognitive function, and gut microbiome changes •In addition, studies in various fields such as rheumatoid arthritis, neurodegenerative diseases, and aging delay are steadily being carried out	• Study fields are gradually diversifying, but studies on cardiovascular disease, metabolic syndrome, obesity, and diabetes are still the main focus • Recently, studies such as gut microbial changes, gastritis, colitis, and cognitive function improvement have been conducted
Subject to clinical trial	• Research is being conducted in many countries around the world • Large-scale studies involving more than 1,000 people	• Studies mainly focused on Koreans
Study period	• There are also long-term studies of more than 1 year	•Short-term studies, usually 12 weeks or so
Steady studies for the application of dietary patterns	• The Mediterranean diet is being tried out in many geographical and cultural areas •Efforts to modify dietary patterns according to changes in food ingredients caused by environmental changes • Studies on the utilization of the Mediterranean diet in other countries	• Research on the derivation of dietary patterns that prevent diseases in Korea is the main focus

Analysis based on PubMed; https://pubmed.ncbi.nlm.nih.gov/

but the Mediterranean diet is further studied to draw healthy and universal dietary patterns by applying ingredients from other countries' mainland to the Mediterranean diet.

Recently, the Nordic diet, based on the traditional diet in Nordic countries, has become increasingly known as a healthy diet [51]. The Nordic diet focuses on getting more calories from plants and more food from the seas, lakes, and wild countryside [52]. The Nordic diet is not yet widely known like the Mediterranean diet, so continuous scientific research on health-promoting effects is attempted. The Nordic diet has shown beneficial effects on weight, stroke, myocardial infarction, type 2 diabetes, and cognitive decline through various clinical trials [53–58]. In particular, the Nordic diet was emphasized on its health benefits while conducting comparative studies with the Mediterranean diet [53, 55, 59]. In addition, clinical studies on the Nordic diet have been conducted in various ways, such as randomized controlled trials, cohort studies, meta-analyses, and systematic review [54–58]. However, the Nordic diet has been mainly targeted at the Nordic population, and longitudinal and large-scale prospective studies are lacking [53–59]. Comparing the number of currently published papers on the K-diet and the Nordic diet, it was found that K-diet was higher (from the PubMed site). However, it is required to accumulate a lot of data on health benefits in various aspects and continuous clinical research in order for the K-diet to be recognized globally and accepted as a healthy dietary habit. Beyond the current Korean-focused and short-term studies, trials on the healthy dietary habits of the K-diet will demand large-scale, long-term, and extensive investigations targeting other nations.

Sustainability of K-Food

Previous paper in this issue, K-Food must have sustainability due to its cultural high value, scientific healthiness, low carbon dioxide production, and diversity of food. Diversity is a powerful factor for human personalized food in the future [1]. Currently, the world has become more active in exchanges because of the development of economic and scientific technology and has been placed in an era of interdependent globalization. K-Food, which is in the trend of globalization, is continuously developing fusion food that localizes food from other countries and Korean-style processed food that are convenient and have an extended shelf life due to the development of the food industry. In this way, K-Food is constantly developing and changing. However, globalization has led to the westernization of Korean dietary life and a decrease in consumption and perception of traditional K-Food.

Like the situation in Korea, Japan also faced a crisis in Japan's traditional dietary cultures due to westernization of diet, and Washoku, Japanese dietary culture to celebrate the New Year) was listed as a UNESCO Intangible Cultural Heritage of Humanity in 2013 as a way to maintain its disappearing tradition [60, 61].

Moreover, Mediterranean countries are experiencing similar situations and are making great efforts to maintain the Mediterranean diet: Education for children and adolescents to preserve the tradition and health

of Mediterranean cuisine, a study of coping with the change of biodiversity in the Mediterranean region by climate change, and a study on the localization to realize Mediterranean diet with food Ingredients produced in non-Mediterranean countries [14, 15]. Therefore, for the sustainability of K-Food, various education will be needed to pass down the K-diet, a unique Korean culture that preserves the traditional dietary lifestyle. K-Food is a part of Korean identity that contains Korean ideology, traditions, culture, and emotions beyond just meals. *Kimchi* is a representative K-Food that is essential to Koreans' *bapsang*, and there is a "*kimjang* culture" in which everyone gathers to make *kimchi* in late fall and early winter for eating during the long and cold winter. Based on these characteristics, the *kimjang* culture was also registered as a UNESCO Intangible Cultural Heritage of Humanity in 2013 [62]. Furthermore, specialties are found in each region of Korea due to variations in geography and climate, and native local food made by applying the unique recipes of the region exists. An example of Korean native local food is *Jeonju* food. *Jeonju*, located in the southwestern region of Korea, is a city with a well-preserved tradition and culture. *Jeonju* food was also designated as a UNESCO Creative City of Gastronomy in 2012 because it is a distinctive food culture that contains *Jeonju*'s abundant ingredients and philosophy [63]. Therefore, maintaining and developing the unique tradition and culture contained in K-Food seems important to establish the value of K-Food in the global era. Furthermore, localization efforts will be needed to understand the dietary behavior of each country and adapt the food ingredients of that country to the K-diet in order for K-Food to become a healthy dietary behavior for people all over the world. The Mediterranean Diet Pyramid has already been constantly updated so that the Mediterranean diet can be implemented and applied to the diet of many countries by substituting food materials produced in non-Mediterranean countries and lost due to climate change [14, 64]. Similar to this, it is necessary to first update the Food Balance Wheels developed to practice a balanced diet in Korea utilizing ingredients used in the K-diet and then to continuously update it using the materials produced in other countries. Moreover, various dietary assessment tools are made to determine whether the Mediterranean diet is followed correctly; Mediterranean Food Pattern, Mediterranean diet score, and Short Mediterranean diet questionnaire [65]. These dietary assessment tools are also frequently modified to reflect changing dietary habits. In the case of the Nordic diet, the Baltic Sea Diet Score and Healthy Nordic Food Index (HNFI) have been developed and updated to assess its compliance [66–68].

However, currently few indicators have been developed to evaluate the dietary patterns of the K-diet, Integrated Korean Dietary Pattern Score [69]. Therefore, it is important to steadily perform studies to develop dietary assessment tools that determine whether a healthy K-diet pattern is maintained. The Food and Agriculture Organization of the United Nations (FAO) states that a sustainable diet is a diet that considers the environment, cultural acceptability, economics, nutrition, safety, and health [70]. So, studies considering these various aspects will be required for K-Food to continue.

Conclusion

The importance of health and the increased use of social media, as well as the rise in interest in K-culture, led to an increase in interest in K-Food. K-Food has maintained Korea's unique tradition despite the long influence of neighboring countries over 5,000 years of history, so K-Food can be said to be a Korean lifestyle and culture that goes beyond one meal; K-Food is similar to Mediterranean food, which was registered on the UNESCO Intangible Cultural Heritage due to its healthy dietary pattern and unique food culture, and better have superior nutritional value. Therefore, K-Food can be referred to as a healthy food comparable to the Mediterranean diet. However, when compared to the Mediterranean diet, research on the health value of K-Food is insufficient both quantitatively and qualitatively. Therefore, accumulating a lot of scientific evidence through continuous research on K-Food is a way to establish itself as a healthy food for people around the world. And continuous efforts and education are needed to maintain the tradition of the K-diet to cope with the westernization of a healthy diet in the midst of globalization. It will also be necessary to update Korea's Food Balance Wheels and develop the dietary assessment tools so that K-diet can be easily applied in other countries. Ongoing study and education on K-Food will be essential for enhancing the brand value of K-Food and for its generalization and sustainability.

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Author contributions
HJM collected data and prepared, reviewed, and edited the manuscript. YSC provided the main concept, reviewed and edited the manuscript, and supervised. All authors read and approved the final manuscript.

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Availability of data and materials
Not applicable on Sustainability of K-Food: Focused on the Change in the Times and Health Values of K-Food.

Declarations

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Not applicable.

Consent for publication
The authors have agreed to the publication of this manuscript.

Competing interests
The authors declare no competing interests.

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