

# Enterohemorrhagic *Escherichia coli* (EHEC) infection and beef consumption in Japan

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## Abstract:

There were some infection events occurred associated with the consumption of beef in Japan over the last decade. After the first bovine spongiform encephalopathy (BSE) case found in the United States, the Japanese government imposed a ban on U.S. beef imports in December 2003. The ban was lifted in December 2005, but the amounts of U.S. beef imports were still smaller compared with those before the ban. In April 2011, enterohemorrhagic *Escherichia coli* (EHEC) O111 and O157 outbreak occurred associated with the consumption of raw beef in Japan. This incidence triggered to set new standard for preparing raw beef in October 2011, and serving raw beef liver has banned since July 2012. The aim of this study was to evaluate the relationship between EHEC infection and beef consumption in Japan, by using the statistical and epidemiological data from 2000 to 2013.

In 2004 and 2005, importing U.S. beef was almost stopped and then, the amount of U.S. beef imports were gradually increased but were not recovered to the level before the ban. The amounts of the total imported beef and domestic beef were almost constant during this period. On the other hand, the number of food-borne EHEC patients and cases, and the total number of EHEC patients (not only foodborne cases) were fluctuated but relatively constant from 2000 to 2013. It is thought that the U.S. beef might not have a great effect on the situation of EHEC infection in Japan, and it is too early to estimate whether the new standard for raw beef preparation or the ban of raw beef liver is effective or not.

**Keywords:** Enterohemorrhagic *Escherichia coli* (EHEC), beef consumption, Japan, US

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## 1. Introduction

There were occurred some events concerning with enterohemorrhagic *Escherichia coli* (EHEC) infection and beef consumption in Japan over the last decade. The aim of this study was to evaluate the relationship between EHEC infection and beef consumption in Japan, by using the statistical and epidemiological data from 2000 to 2013. Previously, we reported the relationship between U.S. beef imports and EHEC infection from 2000 to 2006, elsewhere [1].

## 2. Materials and Methods

The amounts of total beef consumption (domestic + imported), the amount of domestic beef,

and the amount of imported beef were cited from “Chikusanbutsuryutsutoukei (Statistics on Livestock Products Marketing) [2]” and “Shokunikuryutsutoukei (Statistics on Meat Products Marketing) [3]” provided by the Ministry of Agriculture, Forestry and Fisheries. The amount of U.S. beef imports and the amount of Australian beef imports were cited from “Boekitoukei (Foreign Trade Statistics) [4]” provided by the Ministry of Finance. The amounts of beef were expressed as portion meat weight.

The number of food-borne EHEC cases and patients and the summary of food-borne EHEC cases were cited from “Shokuchudokuhasseijoukyo (Investigation on Food Poisoning) [5]” and “Shokuchudokuhasseijirei (Summary on Food Poisoning Cases) [6]” provided by the Ministry of

Health, Labour and Welfare. The number of EHEC patients with symptoms (not only food-borne cases) was cited from the Infectious Agents Surveillance Report [7] provided by the National Institute of Health Sciences.

### 3. Results

#### 3.1. Beef consumption in Japan

Fig. 1 shows the amounts of total beef consumption (domestic + imported), domestic beef, imported beef, U.S. beef imports, and Australian beef imports. The amounts of total beef consumption decreased in 2001, because of bovine spongiform encephalopathy (BSE) problems in Europe and Japan. (The first BSE case was found in Chiba, Japan in September 2001.) Then, the first BSE case was found in the United States in December 2003, and the Japanese government imposed a ban on U.S. beef imports immediately thereafter. The ban was lifted in December 2005, but in January 2006, the spine, a region whose removal was required as a material designated at risk of containing infectious agent of BSE, was found in imported U.S. beef and the ban was imposed again. The ban was lifted again in July 2006, but the amounts of U.S. beef imports were still smaller, although recovered gradually, compared with those before the ban. On the other hand, the amount of domestic beef production has been stable around 350 kilo tons from 2000 to 2013, and the amount of imported beef and total beef consumption have been stable around 500 kilo ton and 800 - 900 kilo ton, respectively from 2002 to 2013.

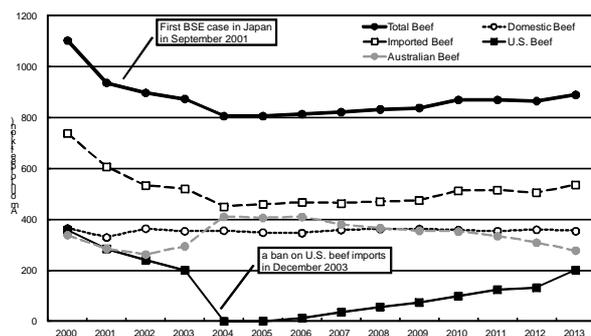


Fig 1. The amounts of domestic and imported beef

#### 3.2. EHEC infection in Japan

Fig. 2 and Fig. 3 show the number of food-borne EHEC cases and patients, respectively. These numbers are reported to the Ministry of Health, Labour and Welfare based on the Food Sanitation Act. On the other hand, Fig. 4 shows the number of EHEC patients with symptoms. This number is reported to the Ministry of Health, Labour and Welfare based on the Infectious Diseases Control Law. The formers are the number of confirmed food-borne EHEC cases and patients, and the latter

is the total number of confirmed EHEC patients with symptoms, but not only food-borne patients.

The number of food-borne EHEC cases was fluctuated from 12 to 27 cases, but relatively constant from 2000 to 2013. The number of food-borne EHEC patients shows the peaks in 2007 and 2011. On the other hand, the total number of EHEC patients with symptoms was also relatively constant around 2500 people from 2000 to 2013.

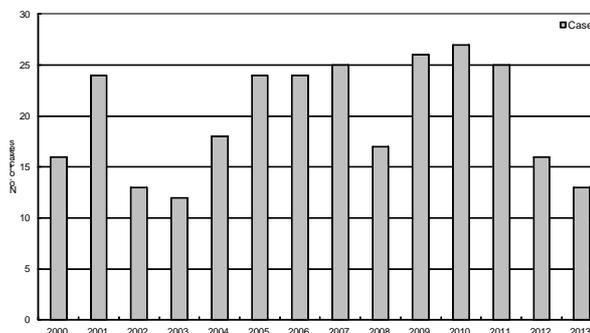


Fig 2. The number of food-borne EHEC cases

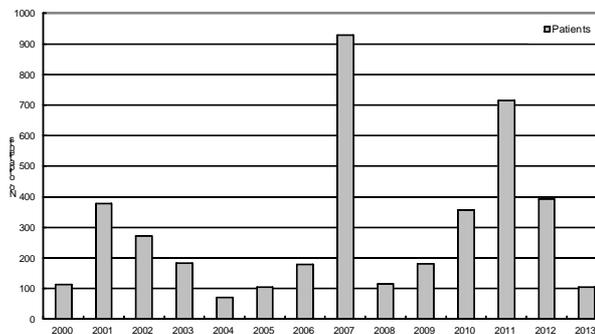


Fig 3. The number of food-borne EHEC patients

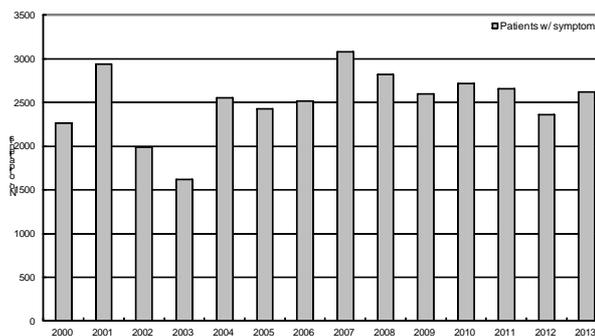


Fig 4. The number of total EHEC patients with symptoms

#### 3.3. Food-borne EHEC cases in Japan

The summaries of foodborne EHEC cases in the past 14 years (2000 - 2013) were shown in Table 1. From 2000 to 2013, 12 to 27 foodborne EHEC cases were reported. The causative foods were unknown in most of the cases, but barbecue, raw beef liver, molding steak and etc. were confirmed or suspected as causative foods in many cases.

#### 3.4. EHEC O111 and O157 outbreak and the new standard for raw beef and ban on raw beef liver in Japan

In April 2011, EHEC O111 and O157 outbreak caused by raw beef consumption occurred at branches of a barbecue restaurant in Kanagawa, Toyama and Fukui Prefectures, Japan. This outbreak involved 181 infected patients, including 34 hemolytic-uremic syndrome (HUS) patients. Among the 34 HUS patients, 21 developed acute encephalopathy and 5 died. The causative dish was yukhoe, Korean-style raw beef dish. From the patients, 2 serotypes of EHEC, that is, O111:H8 and O157:H7, were isolated but EHEC O111 was considered the main causative agent of this outbreak, because the patients showed higher anti-O111 antibody titer.

The Ministry of Health, Labour and Welfare set new standard for preparing raw beef in October 2011 and a ban on serving raw beef liver since July 2012, triggered by this incidence. The most important point of this standard is “meat wrapped under aseptic conditions is heated to 60°C to a depth of 1 cm or more for at least 2 minutes”.

### 3.5. Raw or undercooked Japanese-style beef dishes

Raw or undercooked Japanese-style beef dishes are explained in this section. The explanation was mainly cited from wikipedia.

“Gyu sashi” means raw beef sashimi (raw beef meat). “Sashimi” is a Japanese delicacy. It consists of very fresh raw meat, most commonly fish, sliced into thin pieces. This is restricted by the above-mentioned new standard for preparing raw beef (Fig.5a).

“Gyu tataki” means raw beef tataki (undercooked beef meat). “Tataki” is a manner of preparing fish or meat in Japanese cuisine. The meat or fish is seared very briefly over a hot flame or pan, briefly marinated in vinegar, sliced thinly and seasoned with ginger (which is ground or pounded into a paste) This is also restricted by the above-mentioned new standard for preparing raw beef (Fig.5b).

“Reba sashi” means beef liver sashimi, raw beef liver. Serving raw beef liver is prohibited at restaurant in Japan now, as mentioned above (Fig.5c).

“Yukhoe” is so-called Korean steak tartare. “Yukhoe” refers to a variety of raw dishes in Korean cuisine, which are usually made from raw ground beef seasoned with various spices or sauces. The beef is thinly julienned with the fat removed, then mixed with seasoning. A raw egg yolk is usually added, either on top of the dish or separately (Fig.5d).

## 4. Discussion

The amount of U.S. beef imports showed drastic changes from 2000 to 2013. It was almost zero in 2004 and 2005 and gradually increased from 2006. On the contrary, the amount of Australian beef showed compensatory changes for the changes of U.S. beef imports, and the amount of total imported beef were almost constant from 2002 to 2013. The amount of domestic beef production was almost stable from 2000 to 2013, and the amount of total beef consumption was also stable from 2002 to 2013.



a) “Gyu sashi”

from <http://shingama.com/hpgen/HPB/entries/51.html>



b) “Gyu tataki”

from <http://www.recipe-blog.jp/profile/16094/blog/1732547>



c) “Reba sashi”

from <http://www.mytokachi.jp/sigejirou/entry/43>



d) “Yukhoe”

from <http://en.wikipedia.org/wiki/Yukhoe>

**Fig 5.** Raw or undercooked Japanese-style beef dishes

The number of foodborne EHEC cases and patients, based on the Food Sanitation Act, are the number of cases and patients when the doctors

diagnose (or suspect) them and report to the local public health centers as food-borne EHEC infection and the bacteria are confirmed. These numbers are thought to be “the tip of the iceberg”. On the other hand, the number of EHEC patients with symptoms, based on the Infectious Diseases Control Law, is the number of patients when the doctors confirm the symptom and the bacteria are isolated. This number is thought to be quite reliable because all the patients that EHEC were isolated from must be reported. The number of foodborne EHEC cases, based on the Food Sanitation Act, fluctuated but relatively constant. The number of foodborne EHEC patients, based on the Food Sanitation Act, showed some peaks but no trends were seen. And the total number of EHEC patients with symptoms was also relatively constant.

Compared to the drastic changes in the U.S. beef imports, the numbers of EHEC patients and cases, regardless of foodborne or not, were relatively constant between 2000 and 2013. It is thought that the U.S. beef might not have a great effect on the situation of EHEC infection in Japan. It was reported that the prevalence of EHEC was 3.49% (61/1750) and that of *E. coli* O157 was 1.14% (20/1750) in the ground beef in the U.S. [8]. On the other hand, the prevalence of *E. coli* O157 were 0.00% in beef meat (0/262) and minced beef (0/82), and 0.61% in beef liver (5/826) between 2005-2010 in Japan (“Shokuchudokukinosenjittaichosa (Surveillance of Food-Poisoning Bacterial Contamination on Food) [9]” by the Ministry of Health, Labour and Welfare).

Before 2011, there were several cases caused or suspected to be caused by raw beef, raw beef liver and yukhoe (Table 1). For these dishes, domestic beef is often used rather than imported beef. So, the numbers of EHEC patients and cases might be related with the amounts of domestic beef production or total beef consumption, rather than the amounts of U.S. beef imports.

In 2012 and 2013, no cases were reported caused by raw beef, raw beef liver and yukhoe (Table 1). The number of foodborne EHEC cases and patients decreased in these 2 years but the total number of EHEC patients with symptoms did not decrease. It is thought to be too early to estimate whether the new standard for raw beef preparation or the ban of raw beef liver is effective or not, and further investigations are needed to apply the proper countermeasures.

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