ABSTRACT. We reviewed records of all outbreaks of food-borne illnesses due to schoollunch in Japan from 1987 through 1996 to determine the risk factors causing these outbreaks. Major hazards in 269 outbreaks were Salmonella spp., Campylobacter jejuni, Escherichia coli and Staphylococcus aureus. Foods including uncooked or partially cooked items, salad or egg products presented a high risk in 62 outbreaks with confirmed food sources. Contaminated food items were involved in 29 incidents (46.8%); storage of foods for an extended period before serving in 29 incidents (46.8%), inadequate cooking and cross contamination in 21 incidents (33.9%) each; infected employees in nine incidents (14.5%).—KEY WORDS: outbreak, risk factor, schoollunch.

RISK FACTORS IN CAUSING OUTBREAKS OF FOOD-BORNE ILLNESS ORIGINATING IN SCHOOLLUNCH FACILITIES IN JAPAN

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Many outbreaks resulting from such mass catering facilities as those in elementary and nursery schools have been reported in Japan. Groups who are at high risk for developing serious complications from food-borne illnesses are children, the elderly, and individuals with compromised immune systems.

The schoollunch program in Japan has been operated since 1954. It has a unique system in which the same menu may be prepared from the same materials for the whole school or all schools in an area, providing an opportunity for many children to be infected simultaneously. Individual school kitchens or schoollunch centers are responsible for the final preparations and distribution of the meals. Between May and December 1996, there were 11,826 cases and 12 deaths from Escherichia coli O157:H7 infection. The major sources of infection were schoollunches served at elementary and nursery schools (nine incidents; 9,845 patients) and meals at old people’s homes (3 incidents; 123 patients) [5].

The Ministry of Health and Welfare (M.H.W.) is considering applying the Hazard Analysis and Critical Control Point (HACCP) concept to strengthen prevention of food-borne illness. This approach may be easier to implement in the schoollunch program than in other catering industries, because the schoollunch programs are supported by the national government and most facilities have similar structures and designs.

Our study of the risk factors related to the outbreaks in schoollunch programs provides basic information for formulating an effective program based on the HACCP concept.

When an outbreak of food-borne illness occurs, the local public health center is responsible to conduct epidemiological studies and laboratory tests needed to determine the causes of infection. Those results are reported to M.H.W. through the head office of the local government. We reviewed reports of outbreaks originating in schoollunches from 1987 through 1996 analyzing for pathogenic agents, food sources and causative factors.

From 1987 through 1996, there were 344,471 confirmed or suspected cases of food-borne illnesses reported by local governments to M.H.W. [1]. These reports include 269 incidents with 71,045 patients, in schools and nursery schools. Major hazards identified were Campylobacter jejuni (45 incidents, 7,299 patients); Salmonella spp. (44 incidents, 14,283 patients); E. coli (35 incidents, 20,614 patients); Staphylococcus aureus (32 incidents, 2,846 patients); Clostridium perfringens (18 incidents, 3,828 patients); Bacillus cereus (13 incidents, 4,388 patients); Vibrio parahaemolyticus (seven incidents, 299 patients); histamine (two incidents, 33 patients); unknown (73 incidents, 17,455 patients), representing the major microbiological and chemical hazards of food preparation in catering facilities (Fig. 1).

Investigations confirmed the pathogenic agents, food sources and causative factors in 62 outbreaks of these incidents.

Salmonella spp.: The food sources and causative factors of 20 outbreaks of salmonellosis were confirmed; 18 of these involved S. Enteritidis. Most incidents were related to egg products or salad including cooked or partially cooked foods. Inadequate heating was a factor of 10 incidents (47.6%), contaminated raw materials in nine incidents (42.9%), cross contamination in eight incidents (38.1%) and storage for too long before serving in eight incidents (38.1%) (Table 1).

Staphylococcus aureus: Fourteen incidents were confirmed to involve S. aureus as the causative agent. Foods involved were primarily rice products, noodles, salad and egg product, with cooked food stored for too long time before serving in nine incidents (64.3%), cross contamination, contaminated raw materials and infected kitchen employees each in four incidents (28.6%) (Table 1).

Escherichia coli: Twelve outbreaks of E. coli infection were confirmed for their food sources and causative factors, and four serotypes were involved in these incidents; six
were caused by E. coli O157:H7; three by E. coli O25; two by E. coli O169:H41; and one by E. coli O126. Foods implicated were salad, sauce, radish sprouts, noodles and water. The causative factors were contaminated raw materials in seven incidents (58.3%), inadequate heating, cross contamination and excessive storage time before
serving each in two (16.6%), and an infected kitchen employee in one (8.3%) (Table 1).

*Campylobacter jejuni*: *C. jejuni* was identified in eight outbreaks associated with consumption of meat or poultry products, egg product, salad or water. Causative factors involved were inadequate heating in six incidents (75.0%), and cross contamination and use of contaminated well water each in one incident (12.5%) (Table 1).

*Others*: Four outbreaks of *Clostridium perfringens* gastroenteritis were associated with meat products and salad. Food handling risks identified in these outbreaks included inadequate heating in two incidents, cross contamination and contaminated raw materials each in one incident. An outbreak of *B. cereus* food poisoning was caused by cross contamination, and this pathogen was detected from cooked rice in laboratory investigations. One outbreak of *V. parahaemolyticus* gastroenteritis was associated with consumption of a fish product and involved contaminated raw materials, excessive storage time and inadequate heating. Two incidents of histamine poisoning were related to contaminated fish products (Table 1).

To summarize the risk factor in food poisoning, 29 incidents (46.8%) were caused by contaminated raw materials; 29 (46.8%) by excessive storage time between preparation and serving; 21 (33.9%) by insufficient cooking; 21 (33.9%) by cross contamination; and nine (14.5%) by infected kitchen employee.

This study has revealed a variety of major hazards in schoollunch preparations involved in outbreaks from 1987 through 1996. In 269 outbreaks, the pathogenic agents confirmed were *Salmonella* spp., *C. jejuni, E. coli, S. aureus, Cl. perfringens, V. parahaemolyticus, B. cereus and histamine*. However 73 (27.1%) of them were not confirmed for their pathogenic agents. One of the reasons may be that M.H.W. had not recommended the local governments to conduct isolation of small round structured virus (SRSV) from fecal samples before 1997.

Investigations confirmed pathogenic agents, food sauces and causative factors in 62 incidents (23.0%). An ongoing contribution to the difficulty in pinpointing the exact food responsible was the fact that teachers usually encourage children to eat all of the meal. Therefore, most of the food items are consumed, making it very hard to single out the precise source of infection in epidemiological studies.

Outbreaks of salmonellosis often resulted from consumption of partially cooked egg products or salad. Egg products must be prepared with strict time and temperature control; raw and partially cooked egg should not be in contact with other food, equipment or kitchen utensils.

Outbreaks of *S. aureus* food poisoning involved primarily rice products, noodles, salad and egg products. High carbohydrate cooked food should be stored at a low temperature, separated from other uncooked food, since contamination of various foods with *S. aureus* were reported [6, 7]. Kitchen employees should often be checked for their health to prevent contamination form their infected wounds.

Outbreaks of *E. coli* infection involved various kinds of food, such as vegetable, salad, sauce, water, etc. Raw meat and fresh materials must be separated from cooked foods; the chlorine concentration of well water must be checked periodically. Radish sprouts are regarded as a high-risk food for *E. coli* O157:H7 and Salmonella infection [4, 5].

*C. jejuni* food poisoning outbreaks were caused by meat and poultry products, egg products, salad and well water. Control of cooking time and temperature for meat and poultry is also essential to prevent such occurrences.

This study confirmed uncooked or partially cooked food items such as egg products and salad carry a particularly high risk. If such foods had not been included in the menus we studied, food-borne illness outbreaks would have been less frequent. Since *Salmonella* contamination of eggs cannot be prevented on production level in the farm [2], eggs should be cooked at carefully controlled temperature for a sufficient period. Raw radish sprouts have also been identified as a high risk food: they should not be included in the schoollunch menus before an effective method of controlling microbiological contamination of radish sprouts is developed.

Incidents caused by contaminated raw materials or undercooking can easily be controlled by application of strictly controlled time and temperature for cooking as defined in the HACCP system. An appropriate control of cooking time and temperature can be applied and is essential to prevent or eliminate food safety hazard or to reduce it to an acceptable level. Cross contamination, excessive storage time at room temperature before serving, and negligence of regular health and hygiene check of kitchen employees can be prevented by hygienic practices recommended in the Codex Alimentarius guidelines [3].

Schoolchildren are involved in high risk groups for foodborne illnesses and they should receive nutritional control in the family. If implementation is hindered due to limitation in both manpower and funds, high risk foods such as raw and partially cooked food should be eliminated from the menus of schoollunches.

REFERENCES
