Chapter 5

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The present study entitled “Safety of Street Vended Foods in Kochi” is an attempt to gain an overview of the functioning of the street food sector in Kochi. Data regarding demographic profile of street food vendors, vending units, foods sold hygiene status of food handlers, waste disposal practices were obtained by a detailed field survey of 200 street food vendors. A rapid assessment survey was conducted among one hundred street food consumers to gather data on their demographic information, street food purchase and consumption pattern, nutrient contribution and perception regarding street food hygiene and sanitation.

In order to find out the nutritive value of common street foods, selected vendors were interrogated and the proportion of various raw
materials used for the preparation of fifty popular and frequently available foods were collected. The nutrient composition of these street vended foods belonging to seven categories namely deep fried and steamed snacks, main dishes, vegetarian and non vegetarian side dishes, main meal and chaats was computed. The organoleptic qualities of ten foods with respect to appearance, texture, flavour and taste collected from the street food outlets were evaluated and compared with the same dishes prepared in the laboratory by rating them on a five point hedonic scale. A taste panel consisting of ten members were engaged for judging the products.

The ingredients used for the preparation of street foods were categorised into major food groups. Two common ingredients from each of the food groups such as cereals, pulses, spices, miscellaneous items and one ingredient each from milk and fats and oil were collected from fifteen vendors and tested for the presence of adulterants.

Microbiological quality of street foods was tested by collecting food samples from the vendors. Thirty six street vended foods namely steamed and shallow fried main dishes, vegetarian and non vegetarian side dishes prepared by combination methods of cooking and vegetarian and non-vegetarian deep fried dishes were assayed for Total Plate Count, Total coliforms, faecal coliforms and presence or absence of E. coli. Microbiological assay of beverages, chaats, chutneys and snacks for food borne pathogens were also carried out. Two beverages and snacks, one chaat and chutney were selected for this and the samples collected from nine different vendors were assayed for Total coliform, Escherichia coli, Staphylococcus aureus, Vibrio and Salmonella species in cfu/g.
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Five samples each of water and ice were collected from the street food outlets and assayed for Total coliforms, *Escherichia coli*, *Staphylococcus aureus* in cfu/g/ml and the presence or absence of two pathogens, namely *Vibrio* and *Salmonella*. Ten swabs were collected from ten street food outlets from where the beverage and food samples were procured and assayed bacteriologically. Swabs were collected from five sites namely vendors hands, utensils, cutting board, knife and napkin and assayed for the presence or absence of two common food borne pathogens, namely *Staphylococcus aureus* and *Escherichia coli*. Six foods namely beverages (2), coconut chutney (1), chaat (1) and snacks (2) were subjected to hazard analysis to identify the source of contamination and HACCP flow diagram was developed. From the HACCP protocol, the common hazards were identified and Critical Control Points (CCPs) were established.

In order to positively influence the personal hygiene and handling techniques of the food handlers, a food safety education module was developed. It consisted of a documentary on general aspects of street food vending in the city and a food safety kit. A food safety training program was conducted in order to educate street food handlers on the importance of personal hygiene, cross contamination, environmental sanitation and other aspects of food safety. Pre and post training knowledge levels of the participants were assessed by administering a set of twenty questions and the scores were compared to evaluate the impact of the intervention. A SWOT analysis of street food service was performed in the study locale to get a holistic picture of the sector.
The major findings of the present study are summarized below:

5.1 Characteristics of street food vendors and street food outlets

- Street food vendors were mostly men (90%) and 68% had attained education up to secondary level. Forty six per cent of the vendors were into street food vending for more than ten years.

- The vending facilities ranged from mobile carts (55%) to fixed stalls (45%). Approximately half (54%) of the units had the license issued from the Kochi Corporation. Thus, unlicensed street food outlets (46 %) were also functioning in the city. Kerosene and LPG were the fuels used by the vendors. A wide variety of foods like beverages, snacks, main dishes, side dishes, chaats and main meal were vended at the street food outlets.

- Food preparation was done at the vending location itself by 57 per cent of the vendors and 38 per cent prepared the food at home. A small proportion (5%) of them used to purchase prepared foods from others and outsourced it. The vendors had limited access to potable water and 71 per cent brought water to the vending site from home. A majority of the vendors (84%) served the food by hand. Seventy eight per cent of the vendors repetitively washed the cooking and serving utensils in still water stored in a receptacle.
The cooking oils used were palm oil (75%), refined sunflower oil (15%) or coconut oil (10%). The oil for frying was heated repeatedly by 82% of the vendors.

Average time gap between preparation and vending of foods varied from one to six hours with a majority holding the food for four to five hours after preparation. Cooked foods were held uniformly at ambient temperature as there was no facility for low temperature storage. Majority of the vendors used to purchase ingredients required for the preparations on a daily basis.

Majority of the vendors (77%) rarely washed their hands before preparing food. The dress of 69 per cent of the vendors was rated average and 20 per cent of the vendors were visibly dirty. Frequent contacts with body surfaces were observed among 66 per cent of the vendors. Nearly half (54%) of the vendors cut their hair neatly and combed it well. The use of a separate hand towel was rated poor in 68 per cent of the outlets.

The provision of litter bin and frequency of cleaning the unit were found to be very poor in 66 per cent of the outlets. Only 14 per cent of the vendors followed satisfactory insect, pest or rodent control measures. The absence of stagnant water in the vicinity of the outlet was observed to be satisfactory in 71 per cent of the vending locations. The cleanliness of the surrounding area was found to be very poor in 74 per cent of the outlets.
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- The practice of washing utensils before cooking was rated average in 74 per cent of the outlets. Only 23 per cent of the vendors cleaned the cutting board and knife satisfactorily. Only 29 per cent of the vendors kept a separate cutting board and knife to cut vegetarian and non-vegetarian ingredients and 23 per cent dried the napkins used in the vending unit in an excellent manner.

- On the spot observation revealed that none of the vendors used aprons, head gear, and gloves. The use of hand towels was inadequate among all vendors. None of the vendors washed hands frequently. The ingredients were not washed before use by 92 per cent of the vendors. Cooked foods were exposed to dust and flies in 94 per cent of the outlets. None of the outlets had a proper garbage disposal facility.

\subsection*{5.2 Characteristics of street food consumers}

- Among the consumers of street foods 85 per cent were male and included different categories namely business class (15\%), salaried employees (35\%), labourers (10\%) and students (40\%). Sixty five per cent of the consumers were unmarried.

- The criteria for selection of street food outlets were location of the outlet (43 \%), variety of food served (32\%), cleanliness of the outlet (18\%) and the crowd at the outlet (7\%). The factors that were cited for preference of street foods included convenience (33\%), taste and variety (32\%) and economic nature (18\%).
Thirty five per cent of the consumers rated the overall cleanliness of the outlet as excellent while 21 per cent rated it as very poor. The hygiene of the vendors was rated excellent by 26 per cent of the consumers while 23 per cent rated it as very poor.

The street foods consumed by the male and female consumers provided on an average 15 to 18 per cent of energy, 13 to 16 per cent of protein, 58 to 68 per cent of fat, eight per cent calcium and 10-12 per cent of iron recommended per head per day.

5.3 Nutrient composition and organoleptic attributes of street vended versus laboratory prepared foods

- One serving of deep fried snacks provided 145.7 - 258.6 Kcal of energy, 1.7 to 7.8 g protein, 8.2 to 14.7 g fat, 3.95-45.4 mg calcium and 0.44-1.3 mg of iron.

- Three steamed snacks namely ela ada, kozhukatta and vattayappam provided 151.7 - 183.4 Kcals of energy ,1.85 to 2.4 g of protein, 4.3 to 7.4 g of fat, 4.6 -11.5 mg calcium and 0.4-1.13 mg of iron per serving.

- The nutrient composition of eleven main dishes varied from 207 - 433.8 Kcal, 1.5 to 8.9 g of protein and 0.28 to 25.5 g of fat. The calcium and iron content of these preparations were in the range of 6.0 to 65 mg and 0.4 to 3.2 mg per serving.
Nine vegetarian dishes contributed 80.0-154.5 Kcal of energy, 1.05 to 5.25 g protein 3.3 to 11.9 g of fat, 9.1 to 47.6 mg calcium and 0.6 to 1.22 milligrams of iron per serving.

The energy, protein and fat content of the non vegetarian side dish ranged from 132.6 to 178.0 Kcal, 7.4 to 18.1 g and 5.5 to 11.8 g per serving respectively. The calcium and iron content of the preparations were in the range of 17.5-112.8 and 0.49 -1.74 mg/serving.

The nutrient composition of a combination of main and side dishes sold at the street food outlets provided 322.4 to 611.8 Kcal of energy, 5.8 to 36.9 g of fat, 6.0 to 20.5 g of protein, 26.1 to 127.0 mg calcium and 0.11 to 3.24 mg iron per serving.

Three chaats namely pani puri, bhel puri and samosa chaat provided 180.4 – 369.2 Kcals of energy, 3.8 to 7.2 g of protein, 5.8 to 16.4 g of fat, 36.3 -101.2 mg calcium and 2.4-6.1 mg of iron per serving.

On comparing the organoleptic attributes of street vended main dishes, snacks, vegetarian and non vegetarian side dishes and chaat with the same foods prepared in the laboratory, all street vended items were found to have better acceptance except for sambar and egg curry.
5.4 Adulterants detected in ingredients used by street food vendors

- The quality of ingredients used for the preparation of various food items with respect to adulterants indicated that 13.3 to 26.7 per cent of cereals, 67 per cent of pulses (red gram dhal), 13.3 to 20 per cent of chilli and turmeric powder, 60 per cent of milk samples and 20 to 26.7 per cent of oil samples collected from various locations were adulterated. Damaged grains, insect and rodent hair, dust and pebbles in rice, chalk and resultant flour in refined wheat flour, non permitted colours in chilli and turmeric powder, mineral oil and rancidity in fats were the important adulterants detected in different foods. However adulterants were not detected in salt and sugar samples.

5.5 Microbiological quality of street foods

- Four main dishes namely appam, idiappam, idli and puttu prepared by steaming had a Total Plate Count (TPC) in the range of log 3 to log 6 cfu/g. Sixty three per cent of steamed dishes indicated the presence of faecal coliforms and *Escherichia coli*.

- In the case of shallow fried main dishes namely chapathi and parotta the Total Plate Count was in the range of $5.8 \times 10^3$ and $6.2 \times 10^5$ cfu/g. All the four samples indicated the presence of total coliforms which varied from $7.0 \times 10^1$ to $9.6 \times 10^1$ cfu/g. *E.coli* was present in 75 per cent of the shallow fried main dishes.
The deep fried vegetarian snacks namely undampori, pathiri, onion bajji had a TPC in the range of $3.8 \times 10^3$ to $5.7 \times 10^3$ cfu/g. Among the six samples tested only one sample of pathiri indicated the presence of faecal coliforms and *E.coli*.

Deep fried non vegetarian snacks namely fish fry, egg bajji and chicken fry had TPC in the range of $10^3$ to $10^6$ cfu/g. One sample of chicken fry had a TPC that was Too Numerous To Count (TNMC) and a high coliform count of $1.1 \times 10^3$ cfu/g and fifty per cent of the deep fried non vegetarian dishes indicated the presence of faecal coliforms and *E.coli*.

Three vegetarian side dishes namely sambar, kadala curry and vegetable kurma indicated a TPC of Too low to count (TLTC) and $2.5 \times 10^3$ cfu/g and faecal coliforms in the range of $2.5 \times 10^1$ to $3.1 \times 10^1$ cfu/g with the presence of *E.coli* in both the samples of sambar. Kadala curry had a Total Plate Count in the range of log 4 and log 6 for the two samples with no faecal coliforms. Both the samples of vegetable kurma had a TPC that was Too Numerous to Count (TNMC >$10^7$ cfu/g) and one sample indicated the presence of *E.coli*. Overall three of the six samples assayed indicated the presence of *E.coli*.

Non vegetarian side dishes namely fish, egg and beef curry indicated high TPC for both samples of egg and beef curries in the range Too Numerous To Count($>10^7$ cfu/g). The fish curry had a TPC in the range of log 2 and log 5 for the two samples. One sample of egg curry had faecal coliforms in the range of
1.2 × 10^3 cfu/g and a sample of beef curry indicated the presence of faecal coliforms in the range of 5.3 × 10^1 cfu/g. *E.coli* was present in 33.3 per cent of the non vegetarian side dishes.

- Approximately 60 per cent of the main dishes, one third of the snacks and two thirds of the side dishes were found to be positive for *E.coli*, indicative of faecal contamination.

- Pathogenic bacteria like *E.coli*, *Staphylococcus aureus*, *Salmonella* and *Vibrio* were detected in carrot and watermelon juices. Overall, it was observed that 44.4 and 33.3 per cent samples of carrot and watermelon juice indicated the presence of *E.coli*. The presence of *S.aureus* was observed in 88.8 and 77.7 per cent of carrot and watermelon juice. *Salmonella* and *Vibrio* were detected in 33.3 and 66.6 per cent samples of the carrot and watermelon juices respectively.

- Bhel puri samples collected from all of the nine street food outlets were found to be contaminated with *Vibrio* while *Salmonella* was not present in any of the samples. *Staphylococcus aureus* was detected in 77.78 per cent of bhel puri samples while *E.coli* was noticed only in 33.33 per cent of the samples.

- In the case of coconut chutney 55.56 per cent of the samples indicated coliforms and *E.coli* was detected in 44.44 per cent samples. *S.aureus* was present in 66.67 per cent of the samples. None of the samples indicated the presence of *Salmonella*. The presence of *Vibrio* was detected in 77.78 per cent samples with counts in the range 1 × 10^2 to 4 × 10^3 cfu/g.
The bacteriological quality of samosa indicated that 77.78 per cent of the samples were contaminated with *S.aureus* with a count in the range of $0.5 \times 10^1$ to $3.2 \times 10^3$ cfu/g. The presence of *Vibrio* was observed in 33.33 per cent of samples. *E.coli* and *Salmonella* were not detected in any of the samples.

In the case of kozhukatta *E.coli* and *Salmonella* were not detected in any of the samples. 55.56 per cent of the samples tested positive for *S.aureus* with a count in the range of $1.5 \times 10^1$ to $3.5 \times 10^7$ cfu/g. The presence of *Vibrio* was indicated in 88.89 per cent of samples with counts in the range of $1.0 \times 10^1$ to $3.0 \times 10^3$ cfu/g.

### 5.6 Hazard Analysis and Critical Control Point (HACCP) evaluation

- The microbiological assay of water samples collected from five different street vending locations indicated the presence of total coliforms in 60 per cent samples and *E.coli* in 40 per cent of the samples. *Staphylococcus aureus* was also noticed in 40 per cent of the samples of water while *Salmonella* and *Vibrio* were not detected in any of the water samples assayed.

- Ice used at the street vending outlets indicated the presence of coliforms and *E.coli* in all the samples tested. Eighty per cent samples had *S.aureus* in the range of log two and log seven cfu/g. *Salmonella* was not detected in any of the ice samples while 40 per cent samples tested were found to be positive for *Vibrio*. 

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The swabs collected from the vendor’s hands, utensils, cutting board, knives and hand napkin and assayed for the presence or absence of *E. coli* and *S. auerus* indicated the presence of *S. aureus* in all the swabs. *E. coli* was also present in 60 per cent of the swabs.

The hazards identified in the preparation of beverages included contamination from main ingredients, water and ice used for the preparation. Contamination from the equipment used for the preparation and from the food handler was also identified as hazards.

The major hazards for cooked foods were identified as high initial contamination of raw foods, cross contamination between raw and cooked foods, handling cooked foods with bare hands and holding foods at ambient temperature for long hours. Earlier studies report that these situations can lead to contamination, survival or growth of food borne pathogens during storage.

The Critical Control Points (CCPs) for street vended foods included source of ingredients, preparation of the foods in an unhygienic environment, improper cooking, manipulation of foods after cooking and holding cooked foods for long hours in open surroundings at ambient temperature.
5.7 Food safety education and SWOT analysis

- Prior to the administration of educational intervention the food safety education module developed by the investigator was evaluated by experts and the rating scores were high for all the parameters considered. The food safety education was conducted for fifty street food vendors and the impact assessment indicated a statistically significant improvement in the food safety knowledge of the vendors.

- To prevent the contamination of the food from the food handler and the equipment, the use of an alcohol based hand rub solution and chlorine based surface disinfectant was demonstrated to the vendors and the trial samples were distributed during the food safety training. Care was taken to equip them to prepare the two disinfectants by themselves and the instructions to prepare the same were included in the training manual distributed to the vendors.

- The strengths of the street food sector were low capital investment, reduced dependency on hired services, participation of family members in running the business, traditional skill-based trade, high acceptability levels of the products vended, employment generation for youth belonging to low socio economic strata, assured profit and regular income, local market based trade and flexibility in work scheduling and selection of vending site and the foods to be vended.
The weaknesses of street food vending sector were the sub-standard infrastructural facilities of the food vending outlets with inadequate work space and storage provisions and lack of basic amenities for promoting safe food services, deficiencies in hygiene behavior of the vendors, lack of rules, regulations and standards for quality check and control over the operation of street food vending outlets, poor investment capacity of the vendors, lack of technical knowledge, skills and facilities for safe disposal of garbage and waste water and lack of awareness of the food vendors on food safety.

The opportunities identified were the policy support and rising social concern for the street food vending sector, institutionalisation of street food vending in the state by creating street food parks, efforts to establish Standard Operating Procedures (SOPs) and recognition of street food vendors as a working class contributing to food security. Fund availability for R&D work, and capacity building of the food vendors for entrepreneurship building creates opportunities for empowering the workers.

The threats identified were the high risk operations of the vendors in a sub standard work environment coupled with lack of knowledge and concern for hygiene in food handling. There is a growing risk of spread of food and water borne diseases among the consumers who frequently consume foods
from these outlets. A rapid proliferation of unlicensed street food outlets without any quality control over the food service is a threat that needs to be addressed by the stake holders.

To conclude, the informal trade in street food vending is male dominated and for a majority of them it is the main source of employment. A low level of compliance with regard to hygienic practices was evident in the street food vending practices. The environment in which the vendors operated was not conducive for the production of safe food. Although the street foods made a contribution to the food security of the population in the study region, the presence of adulterants in the ingredients and the microbiological quality of the foods vended at the outlets is a matter of concern. The findings of the study reinforce the concerns of many studies in India, which indicated that the majority of street food vendors lack appropriate knowledge and expertise in the application of food hygiene and safe food handling practices. Thus, food safety education for street food vendors along with reinforcement of food code continues to remain a hallmark in improving the quality of street vended foods.

The rapid rate of urbanisation has brought about with it a considerable expansion in street food vending. The sector has both positive and negative impact in the current scenario. Street foods are convenient, cheap, easily available and a source of income to many poor people who would otherwise have not found gainful employment. They play an inevitable role in the food security of urban population. Street foods contribute to the uniqueness and cultural identity of local cuisines.
Street foods are increasingly important as a fast and economical meal option. They offer the convenience of a cooked meal without the purchase of ingredients and concern regarding the preparation of the food to migrant, floating and working population.

Food borne diseases are a composite result of a mosaic of causes and are commonly associated with bacterial species like *E. coli*, *Salmonella* and *Staphylococcus aureus*. The reporting and surveillance of food borne diseases are grossly neglected and the magnitude of the problem has not been understood. Generally, two approaches are used to gauge food safety. The definitive approach involves monitoring the occurrence of food borne diseases in the population through identification of cases by the clinicians. Additionally, science based standards for levels of pathogens are applied under the assumption that products not meeting these standards can cause food borne diseases. Although, such standards for ready to eat foods are still not established by FSSAI the presence of food borne pathogens in high counts in the samples assayed is a matter of concern with respect to food safety which will pose a risk for the occurrence of food borne diseases.

A system of recording the food borne diseases should be established. Although there are not many published studies in this regard, in a case control study to investigate an outbreak of gastroenteritis associated with street food consumption in Tamilnadu, it was observed that the cause of the infection was *Salmonella typhimurium* in coconut chutney and vegetable kurma. The nail cuts and stool samples from the workers indicated the occurrence of the pathogen.
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(Prabhu et al., 2013). The actual scenario with regard to food borne diseases can emerge with inadequate emphasis on surveillance. Health policy makers and educators should promote the sale of healthy traditional street foods and ensure that regulatory measures are enforced to prevent health problems associated with the consumption of street vended foods. Hence, adequate emphasis on regulation, control and inspection of street food outlets is a prime need.

Over the past few decades, major changes in the way food is processed, retailed and consumed have emerged with the country’s urbanisation and modernisation. Recognizing the complexity of today’s food safety system, particularly street vended foods, a proactive approach is required to predict where problems might arise rather than detecting them after their occurrence. The required standards for food hygiene among street food vendors need to be clearly defined on a national scale through the collaborative efforts of all stakeholders to serve as a point of departure for local bylaws on food safety. The roles of all stakeholders, including consumers in ensuring food hygiene and safety, food vendors selling cooked foods, raw foods and packaged foods need to be defined unequivocally. Intensive public education on principles of food hygiene and safety for food vendors is also a key necessity. In South Africa, (FAO, 2012) in collaboration with the South African Government created a series of educational programmes to help the street vendors, food inspectors and consumers to ensure that street vended food is hygienic and safe. The vendors were introduced to the idea of greater business and profitability by ensuring safe food through
the implementation of Good Hygiene Practices (GHPs) and Good Manufacturing Practices (GMPs).

In a regional consultation of safe street foods by WHO (2011), FSSAI reported that 60 per cent of the vendors requested free training in aspects of food safety and 80 per cent requested better garbage disposal, sanitation support and clean water supply in addition to hygienic toilets near food vending areas. Therefore, the sector deserves attention from local authorities with respect to planning, investments, regulations and education. Local governments should provide support in the form of adequate infrastructure in street vended outlets. Education should be emphasised as a strategy to improve the safety of street vended foods.

People of all times and cultures have recognised that bad food can make us sick and food safety is a basic human right. The history of food safety is a story that bridges all civilizations together. As early as 500 B.C, Confucius warned against “Sour Rice”. Today, food safety specifically in commercial vended foods in the street food sector is a cause for concern. A scheme aimed at voluntary participation of food service establishments to ensure food safety and training programmes for various stake holders should be envisaged. In view of safeguarding the interests of consumers, the street food industry needs to be supported in every aspect for its economic development, nutritional quality and microbiological safety of foods.
Limitations of the present study

The limitations of the study are listed below:

- The street vended foods can be subjected to exhaustive microbiological assay (for a range of food borne pathogens) to obtain a greater insight into pathogens that are present.

- The study was limited by it being a pioneer one in the state of Kerala with little prior data on the street food vending sector in Kerala.

- In the absence of microbiological guidelines for ready to eat foods in India, the levels of acceptability of the foods could not be established. International standards may not be applicable considering the poor standards of hygiene in which the foods are prepared.

- Detection of other probable additives like colours, preservatives and flavor enhancers in foods that are served by the vendors has not been included in the purview of the study.

- Field-level follow-up to ascertain if the food safety education programme has actually brought about changes in the vendors has not been attempted.

Recommendations for future research

During the course of the present study the following areas were identified where future research can be pursued:

- Development of code of hygiene for preparation and sale of foods in the Indian context, both at state and national level.
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- Research in the design optimization of the vending units with a primary focus on safe food production. The prospects of exploiting solar energy for heating and lighting requirements of the street food vendors may be considered.

- Sensitization programme for food handlers and consumers regarding their roles on compliance with food safety requirements.

- On the job training and capacity building for street food vendors to ensure safe street food vending.

- Identification of key risk behaviors that are major contributors for contamination by other qualitative research methods like Focus Group Discussions (FGDs), participant observation and case study method.

- Research to develop reference microbiological guidelines for street vended foods and risk evaluation by exposure assessment to pathogens.

- Microbiological assay for pathogens like *Yersinia, Pseudomonas, Bacillus cereus, Klebsiella, Leucnostoc*, yeasts and moulds to obtain exhaustive data on quality of street vended foods.

- Training of public health personnel in food safety and hygiene as a fundamental requirement for an effective Food Safety Management System (FSMS) for street food vendors.
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- Testing of other parameters such as, food colours, additives, toxins, trans fats and heavy metal contamination in street vended foods.

- Longitudinal studies among frequent consumers of street foods to obtain an insight into the occurrence of food borne diseases associated with the consumption of street vended foods.