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1.

SAFE FOOD, FAIR FOOD FOR CAMBODIA

Final workshop

Workshop proceedings

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Safe food, fair food for Cambodia
Project final workshop

Workshop proceedings
21–22 June 2021
Phnom Penh, Cambodia

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Contents

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We acknowledge the support of the CGIAR Research Program on Agriculture for Nutrition and Health to this project.

Acronyms

ASF	Animal source foods
BBU	Battambang University
CDC	Department of Communicable Disease Control, Ministry of Health, Cambodia
DDG	Deputy director general
DG	Director general
FAO	Food and Agriculture Organization of the United Nations
FSTWG	Multi-sectoral Technical Working Group for Food Safety
GDAHP	General Directorate of Animal Health and Production
ILRI	International Livestock Research Institute
ITC	Institute of Technology of Cambodia
LDC	Livestock Development for Community Livelihood
LMICs	Low- and middle-income countries
LSIL	Feed the Future Livestock Systems Innovation Lab
MISTI	Ministry of Industry, Science, Technology and Innovation, Cambodia
NAHPRI	National Animal Health and Production Research Institute
NIPH	National Institute of Public Health
NTS	Non-typhoidal *Salmonella*
RUA	Royal University of Agriculture
SFFF	Safe Food, Fair Food
SLU	Swedish University of Agricultural Sciences
USAID	United States Agency for International Development
WHO	World Health Organization

Introduction

Background
Animal source foods (ASF) are an important part of the cuisine in Cambodia with pork, fish, and poultry products widely consumed. Most livestock products are produced by smallholders, many of them women, and sold in traditional, wet markets where women also predominate as retailers. In recent years, Cambodia has seen growing food safety concerns.

The overall aim of the Safe Food, Fair Food (SFFF) for Cambodia project is to reduce the burden of foodborne disease in informal, emerging formal, and niche markets and to target small and medium scale producers. The project has five objectives with associated activities, outputs, and outcomes. To reach these objectives, it is necessary to build capacity to better understand what food safety risks are, how to manage food safety and how to communicate it effectively among stakeholders including the government, private sector, academia, donors, and the media.

Objectives
The workshop aims:

- To share key findings and recommendations from the SFFF Cambodia project,
- To discuss the policy implications of the project and project intervention scaling-up opportunities,
- And, to discuss with relevant stakeholders the food safety challenges and how to address them.

Participants

- Core members from project partner institutions: General Directorate of Animal Health and Production (GDAHP), Livestock Development for Community Livelihood (LDC), Department of Communicable Disease Control (DCDC), National Institute of Public Health (NIPH)
- Representatives of the Livestock Systems Innovation Lab (LSIL)
- The United States Agency for International Development (USAID), University of Florida, International Livestock Research Institute (ILRI), and representatives from 25 provinces
- Representatives from partners linked to the project: Royal University of Agriculture (RUA), Battambang University (BBU), Institute of Technology of Cambodia (ITC), Ministry of Industry, Science, Technology and Innovation (MISTI), Swedish University of Agricultural Sciences (SLU), Food and Agriculture Organization of the United Nations (FAO), World Health Organization (WHO)
- Members of the taskforce and Technical Food Safety Working Group
- Representatives from other partners

Date and location

- Location: Meeting Hall of GDAHP and NAHPRI, and Zoom link
- Date: 21–22 June 2021
- Co-organized by: ILRI and NAHPRI
- Funded by: USAID LSIL through University of Florida

Workshop program

Time	Activities	Person in charge
Day 1: Project achievement reporting		
13:30	• Registration for in person participants • Getting online in zoom and greetings	• NAHPRI and LDC • Chi Nguyen, Hanh Le, ILRI
14:00-14:20	Opening remarks • LSIL • ILRI • GDAHP	***Tum Sothyra, NAHPRI*** • Gbola Adesogan, Director, LSIL • Dieter Schillinger, Deputy Director General (& Fred Unger, Regional representative, ILRI • H.E Tan Phannara, Director General, GDAHP
14:20-14:30	Objectives of the workshop Introduction of participants	Sothyra Tum, NAHPRI
Session 1: Reporting key results and recommendations from the SFFF Cambodia project		
14:30-14:45	Invited talk 1: Risk ranking to support priority setting of food safety policy at the national level - experiences from the TARTARE project in Ethiopia	Arie Havelaar, University of Florida
14:45-15:45	Project achievement reporting	***Hung Nguyen, ILRI***
	• Overview of project (5mn)	Hung Nguyen, ILRI
	• Multi-pathogen survey in markets (15 mn)	Rortana Chea, NAHPRI
	• Household survey (10 mn)	Chhay Ty, LDC
	• Quantitative microbial risk assessment of salmonellosis (15 mins)	Sinh Dang, ILRI
	• Cost of illness (10 mins)	Teng Srey, CDC
	Short Q&A (5 mns)	All
15:45-16:00	*Tea break*	
16:00-16:45	Nutrition study (10 mins)	Candice Duong, Emory University
	Parasite study (10 mins)	Fred Unger, ILRI
	M&E and Theory of Change of SFFF (10 mins)	Fred Unger, ILRI
	Cross-cutting activities: Gender, capacity building, communication (10 mins)	Hung Nguyen, ILRI
	Q&A (5mns)	
16:45-17:15	Discussion and wrap up	Tum Sothyra, NAHPRI
Day 2: Innovation, Policy and Scaling		
13:45-14:00	• Registration for in-person participants • Getting online in zoom and greetings	• NAHPRI and LDC • Chi Nguyen, Hanh Le, ILRI
14:00-14:05	*Recap day 1*	Johanna Lindahl, ILRI
14:05-14:20	Invited talk 2: Innovation technology for food safety	Rob Readnour, Mountain Group Partners

14:20-14:50	Innovation in food safety: • Intervention RCT at market and Communication (30mns) • Q&A	Tum Sothyra, NAHPRI
14:50-15:00	Sharing by partner institutions	FAO/WHO representatives
15:00-16:00	General discussion on food safety innovation and scaling up • Project reflection • Taskforce and scaling-up opportunities • Structured discussion: What we know and what is missing?	***Tum Sothyra, NAHPRI*** • Delia Grace, ILRI/University of Greenwich • Hung Nguyen, ILRI • Tum Sothyra, NAHPRI
16:00-16:10	*Tea break*	
16:10-16:35	Food safety innovation and scaling up • What we know and what is missing?	Tum Sothyra, NAHPRI and Hung Nguyen, ILRI
16:35-16:40	Launch of project products • Policy brief • Video, guideline, handbook, etc. • Papers	***Hung Nguyen, ILRI***
16:40-16:50	Wrap-up and closing	Dieter Schillinger, DDG ILRI H.E Tan Phannara, DG GDAHP

Day 1: Guest lecture and reporting on project key achievements

Risk ranking to support priority setting of food safety policy at the national level - experiences from the TARTARE project in Ethiopia

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Abstract

The Assessment and Management of Risk from Non-typhoidal *Salmonella*, Diarrheagenic *Escherichia coli* and *Campylobacter* in Raw Beef and Dairy in Ethiopia (TARTARE) is a research study aiming to reduce morbidity and mortality from foodborne diseases in Ethiopia. One of the goals of this project is to provide a risk-based framework for determining where resources should be allocated nationally to effectively reduce the risk of foodborne disease that can be applied to all pathogens and foods using Ethiopia as a model. FAO has defined two key steps towards a risk-based framework. *Risk ranking* is the systematic analysis and ordering of foodborne hazards and/or foods in terms of the likelihood and severity of adverse impacts on human health in a target population *Risk prioritization* also includes other types of impact such as social, economic, and political consequences.

As a first step towards risk ranking in Ethiopia, a scoping workshop was organized in March 2020 connecting government stakeholders and technical advisors from the 16 federal agencies engaged in food safety, giving them the opportunity to work towards the identification of a shared set of priority hazards. The emphasis was on ownership by the agencies and full participation from all food safety stakeholders. The approach was based on recent guidance from FAO. The scoping workshop defined the *purpose of the ranking*, drafted a *statement of concern* and a *statement of purpose and objectives*. Subsequently, a selection was made of hazards to be ranked. The list of hazards was generated by first considering WHO global estimates of burden of foodborne disease, and then the list was expanded to include hazards identified by the stakeholders. With the permission of the Ethiopian authorities, data for Ethiopia were extracted from the WHO database and presented to the Ethiopian stakeholders.

Foodborne disease burden can be quantified using many different metrics, and risk ranking should be based on those metrics that are deemed most important by the stakeholders. To facilitate the selection of metrics, and subsequently hazards, a data dashboard was developed using the R Shiny platform. The dashboard was initially populated with simulated data to stimulate the stakeholders to focus on selection of the metrics without confounding by specific considerations about the hazards. Out of the possible risk metrics from the FERG analysis, the most meaningful to the Ethiopian government decision-makers are the rates (per 100,000 person years) of incidence, mortality, years of life lost, and disability adjusted life years, as well as the case-fatality ratio.

The stakeholders also identified additional hazards that they considered important to be included in the risk ranking process. These included different groups of hazards (pathogens causing viral diarrhea, bacterial toxins, pathogens causing invasive infections, helminths, mycotoxins, natural toxins, processing contaminants, adulterants, agro-chemicals and drug/antibiotic residues. There are no disease burden estimates for these hazards for Ethiopia. Nevertheless, the goal is to include approximate estimates of the disease burden in the data dashboard, using literature data complemented with expert opinion and appropriate uncertainty margins. The dashboard will then be fully populated with specific estimates for Ethiopia and will be presented to the stakeholders as a decision support tool. Once a selection of priority hazards has been made, the next goal is risk prioritization involving stakeholders from other segments of society (industry, consumers, NGOs, etc.).

Acknowledgments
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Safe Food Fair Food Cambodia proposal

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Abstract

In 2017, LSIL awarded ILRI and partners a grant to research solutions for food safety in traditional, wet markets in Cambodia. The original principal investigator and co-principal investigators are the authors of this abstract and their backgrounds cover the areas of epidemiology, biology, nutrition, gender, governmental *research* and non-governmental development. This, along with other awards made by LSIL, broke with tradition in having a novel focus on the contribution of livestock and animal source food to human health and nutrition. After four years of implementation, the last two during the coronavirus disease 2019 (COVID-19) pandemic, we take this opportunity to look at the original proposal, and more briefly, how this translated into implementation.

Like many Asian countries, Cambodia has a rich tradition of tasty and nutritious foods. ASF are an important part of the cuisine with pork, fish, and poultry products widely consumed. The great majority of livestock products are produced by smallholders, many of them women, and sold in traditional, wet markets, where women also predominate as retailers. Again, as is common in Asia, recent decades have seen growing concern over the issue of food safety. And, as is common in all low and middle income countries (LMICs), in 2017 there was very little reliable evidence on the health burden of foodborne disease or how to manage food safety in traditional markets, known to be responsible for the majority of foodborne illness in LMICs.

The proposal therefore had two major objectives. The first was to generate evidence on the health and economic burden of foodborne disease in ASF value chains important to the poor and to women and the second was to pilot a market-based approach to improving food safety that built on successfully implemented projects in Africa, India and Vietnam. Initiating a national task force on food safety and developing a theory of change for scale and sustainability were key elements to support long-term impacts. Alongside this was a component on nutrition while gender and capacity building were cross-cutting activities.

In order to generate evidence a number of tools were proposed. These included: food safety situational analysis, systematic literature review, risk ranking, multi-hazard pathogen survey, quantitative microbial risk assessment, cost of illness assessment, nutrition assessment, focus group discussion, gender assessment, a randomised controlled trial of a market-based intervention and theory of change development. All of these were successfully implemented, and the project was able to support additional activities, often leveraging additional funding, such as a Japanese encephalitis and parasitic sero-prevalence studies in pigs, system effects modelling, a food safety system performance evaluation for Asia, contributions to a colloquium on pigs. In addition, we trained several PhD, MSc and veterinary students both in Cambodia and USA who benefited from project data to write their thesis.

Many internal and external changes occurred during the lifetime of the project, not least the COVID-19 pandemic. However, looking back to the status quo of 2017, we can see a wealth of new, trans-disciplinary, evidence on foodborne disease in Cambodia generated and disseminated as well as a successfully trialled, low-cost approach to improving food safety in informal markets. If evidence can be applied and the approach can be scaled, substantial health and economic benefits will accrue to the people of Cambodia.

Prevalence of *Salmonella* spp. and *Staphylococcus aureus* in chicken meat and pork from Cambodian markets

Rortana Chea[1,2,3*], Hung Nguyen-Viet[2], Sothyra Tum[1], Fred Unger[2], Sofia Boqvist[3], Sinh Dang-Xuan[2,4], Sok Koam[1], Delia Grace[2,5], Kristina Osbjer[6,8], Theng Heng[1], Seng Sarim[1], Or Phirum[1], Roeurn Sophia[1], and Johanna F. Lindahl[2,7,8*]

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Abstract

Salmonella spp. and *Staphylococcus aureus* are two of the most common foodborne bacteria in animal-source foods (ASF) that cause illness worldwide. This study aimed to determine the prevalence of *Salmonella* spp. and *S. aureus* in chicken meat and pork in markets in Cambodia. Sampling was done in 52 traditional markets and 6 supermarkets in 25 provinces of Cambodia between October 2018 and August 2019. In total, 532 samples were obtained: chicken meat and pork (n = 408, 204 of each) and chicken and pork cutting board swabs (n = 124, 62 of each). All samples were analyzed for the presence of *Salmonella* spp. and *S. aureus*; colony-forming units per gram (CFU/g) of coagulase-positive *Staphylococci* (CPS) were counted, and a subset of samples was also analyzed for the most probable number (MPN, n = 136) of *Salmonella*. The overall prevalence of *Salmonella* spp. and *S. aureus* were 42.1% (224/532) and 29.1% (155/532), respectively, with 14.7% (78/532) of samples containing both bacteria. The prevalence of *Salmonella* spp. in chicken meat was 42.6%, on chicken cutting board it was 41.9%, on pork it was 45.1%, and on pork cutting board 30.6%. Chicken meat had a significantly (p-value < 0.05) higher prevalence of *S. aureus*, 38.2%, than chicken cutting board, 17.7%, pork 28.9%, and pork cutting board, 11.3%. Mean MPN-*Salmonella* was 10.6 MPN/g in chicken and 11.1 MPN/g in pork samples. Average Log CFU/g of CPS in chicken and pork samples were 2.6 and 2.5, respectively. The results indicate that chicken meat and pork in Cambodia were highly contaminated with *Salmonella* spp. and *S. aureus*, posing risks to consumers' health. Urgent interventions are necessary to improve hygiene for safer meat in Cambodian markets.

Keywords: animal-source food; Cambodian traditional market; food safety; livestock product; *Salmonella* species; *S. aureus*; wet market

Citation: Rortana, C.; Nguyen-Viet, H.; Tum, S.; Unger, F.; Boqvist, S.; Dang-Xuan, S.; Koam, S.; Grace, D.; Osbjer, K.; Heng, T.; et al. Prevalence of *Salmonella* spp. and *Staphylococcus aureus* in chicken meat and pork from Cambodian markets. *Pathogens* 2021, 10, 556. https://doi.org/ 10.3390/pathogens10050556

Pork and animal source food consumption and food safety risk perception in Phnom Penh, Cambodia

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Introduction

ASF are important in human diet as they provide proteins and essential nutrient elements to people. In Cambodia, pork is one of the most important ASF but studies on risks related to pork consumption is limited. The risk-based approach can provide information on the risk linked to food consumption and propose measures to mitigate this risk. This study aimed to analyse the patterns of pork and other ASF consumption, understand consumers' perception of food safety and how it relates to food purchasing decisions and consumption in Phnom Penh, Cambodia.

Materials and methods

Seven districts in Phnom Penh were selected based on SFFF Cambodia project selection criteria that focused on population density and socio-economic profile. A total of 202 randomly selected household representatives were interviewed. Seven focus group discussions were conducted, one in each district.

Results

The results show that pork was more widely consumed than other ASF such as beef, chicken or fishes in both rural and peri-urban/urban areas. Pork price was acceptable, and its year-round availability and broad accessibility were recorded. The most frequently consumed pork meat was fried, boiled and dried pork. Raw pork and fermented pork were consumed but less frequently. Majority of respondents reported that they used same knife (74.3%) and cutting board (69.8%) when preparing pork and other foods such as vegetables. Pork was purchased mainly from wet markets (45.9%), street vendors (28.6%) and mobile vendors (21.1%). More than 80% of the respondents believed that supermarkets and organic shops were cleaner and safer to buy pork than wet markets and mobile/street vendors. Respondents selected stalls to buy pork based on cleanliness, truth of personal relationship, accessibility, and price.
The most important concerns in food safety included imported food, food additive, followed by pesticides, cancer causing chemicals and preservatives. Bacterial hazards were less concerned compared to chemical hazards.

Discussion and conclusions

The study shows the diversity in ASF consumption in Phnom Penh and pork as the most consumed meats. Food preference was more driven by cleanness and accessibility than by food safety. Mobile and street vendors are available and easy to access are the main sources of purchasing pork even though they were considered as less clean and less safe. It indicates that perception of food environment -which consists of food availability, accessibility and convenience- and food safety is closely linked.
While most of the known burden of foodborne diseases is caused by biological hazards, people were mainly concerned about food additive, pesticides, chemicals and preservatives. Inappropriate practice of raw pork consumption or using same knife and cutting board while cooking could increase the risks of foodborne disease. This study provides information on pork and ASF consumption and food safety perception in Phnom Penh. The findings are useful for food safety risk assessment and to propose risk management measure such as education campaign to raise awareness and motivate action to improve food safety in the community.

Quantitative microbial risk assessment of salmonellosis through chicken and pork salad consumption in Cambodia

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Abstract

This study aimed to estimate the risk of acquiring salmonellosis after consuming contaminated pork and chicken salad using a quantitative microbial risk assessment. A total of 204 chicken meat and 204 pork samples were collected from 52 traditional markets in 25 provinces for *Salmonella* analyses. Information on preparing and cooking chicken and pork salad was gathered from 93 households in 4 provinces of Cambodia. Four salad cooking scenarios at household were simulated to assess the occurrence and levels of *Salmonella* cross-contamination from raw chicken carcasses via kitchen utensils and hands to ready-to-eat chicken salad. Monte Carlo simulation was performed using @Risk for 10,000 iterations. Annual incidence rates of salmonellosis from consuming chicken salad, pork salad and mixtures of chicken and pork salads were estimated at 11.2% (90% CI: 0.0–35.1), 4.0% (90% CI: 0.0–21.3), and 14.5% (90%CI: 0.0–33.5), respectively. The factors with the highest influence on the estimate were cross-contamination while preparing the chicken salad, followed by the prevalence of *Salmonella* on chicken at the market. A wide confidence interval in the incidence estimate was mainly due to the variability in the degree of reduction in bacteria concentration by cooking, and chicken and pork consumption patterns. The risk of salmonellosis due to chicken and pork salad consumption appears to be high. Control measures may include improving the safety of retailed chicken and pork at markets and improving hygiene practices and equipment during salad preparation at household.

Keywords: consumption, Cambodia, QMRA, chicken, pork, salmonellosis

Salmonella cross-contamination during handling and preparation of chicken salad in Cambodian households

Rortana Chea[1,2,3,*], Hung Nguyen-Viet[2,4], Sothyra Tum[1], Fred Unger[2], Johanna F. Lindahl[2,5,6], Delia Grace[2,7] , Chhay Ty[8], Sok Koam[1], Theng Heng[1], Or Phirum[1], and Sinh Dang-Xuan[2,9*]

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Abstract

Non-typhoidal *Salmonella* (NTS) is a common foodborne pathogen that causes gastroenteritis in humans. NTS in animal-source foods, such as chicken meat or pork, can cross-contaminate ready-to-eat foods. This experimental study aimed to assess the occurrence and level of *Salmonella* cross-contamination from raw chicken carcasses via kitchen utensils and hands to ready-to-eat chicken salad during preparation. 12 focus group discussions were conducted in four Cambodian provinces to collect information on salad preparation and handling. Four different scenarios of preparing and cooking salad found in Cambodian households were imitated in the laboratory using chicken carcasses that were artificially inoculated with *Salmonella*. Scenario 1 started with washing and preparing vegetables first, followed by the raw and boiled chicken using the same cutting board, knife, and hands to prepare the salad, while *Scenario 2* had the same order as scenario 1 but used a separate cutting board and knife. *Scenario 3* started with washing and cutting raw chicken carcasses before washing and cutting vegetables; then boiled chicken and vegetables were prepared and mixed using the same cutting board, knife, and hands. Scenario 4 had the same sequence as Scenario 3 but used a separate cutting board and knife Most households (86%, 80/93) reported that they washed chicken carcasses before washing and preparing vegetables. Almost all (97%, 90/93) households used the same knife and cutting board to prepare raw vegetables, chicken carcasses and boiled chicken. After washing twice, *Salmonella* spp. was isolated from 32 out of 36 raw chicken carcasses (88.9%, 95% CI: 73.0–96.4). Two out of 18 (11.1%, 95% CI: 1.9–36.1) vegetable samples were cross-contaminated with *Salmonella*. *Salmonella* cross-contaminated the cutting board, knives, and hands when used to cut raw chicken and after washing once at a proportion of 66.7% (12/18), 50.0% (9/18), and 22.2% (8/36), respectively, and the cross-contamination was significantly higher on cutting boards than that on knives or hands (p-value < 0.05). The cross-contamination between the food items, utensils and surfaces and ready-to-eat chicken salad in the scenarios 1, 2, 3, and 4 was 77.8% (7/9), 11.1% (1/9), 22.2% (2/9) and 0% (0/9), respectively. There was a significantly higher *Salmonella* cross-contamination probability in Scenario 1 (using the same cutting board, knives, and hands) compared to the other three scenarios. These results indicate how different hygiene practices can foster or reduce cross-contamination during preparation of food and provide models for quantitative risk assessments, as well as evidence for improving food safety awareness and practices in home kitchens.

Keywords: Bacterial cross-contamination, Cambodia, food safety, hygiene practices, *Salmonella*

Cost of hospitalization for foodborne diarrhoea in the capital city of Cambodia

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Abstract

A cost-of-illness assessment was conducted with data from 266 cases of foodborne illness in Phnom Penh and Siem Reap collected from four types of health care facilities (national, regional and provincial hospitals, and community health centers). Among the 266 foodborne disease cases reported; the main diagnoses were 65 cases of food poisoning (24.4%), 198 cases of acute diarrhea (74.4%), two cases of typhoid (0.8%), and one case of chronic diarrhea (0.4%). While the proportion of acute diarrhea cases is by far the largest in this survey, no information exists from the hospital records to help determine whether these were transmitted via food or which hazards were responsible. On average, the cost of foodborne illness was USD $62.76 per case, but cost varied by type of health care facilities that the patient attended. Per episode of hospitalization, the cost of illness was USD $185.88 at the national hospital, USD $65.07 at a regional hospital, USD $24.16 at a provincial hospital and USD $7.57 at a community health center.

Keywords: foodborne illness; food safety, cost of illness, Cambodia

Perceived neighbourhood food access is associated with low consumption of animal-flesh food, fruits and vegetables among mothers and young children in peri-urban Cambodia

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Abstract

Urban food environment research in Southeast Asia has largely focused on dietary outcomes related to overnutrition while overlooking the problem of inadequate diet and undernutrition among mothers and young children. Few studies have incorporated food safety in urban food environment assessments. This study assessed if mothers' perceived food access, which incorporated their food safety perception, was associated with their own and their children's consumption of animal-flesh food, fruits and vegetables in low-income peri-urban regions of Cambodia. A cross-sectional survey of 198 mothers of young children between 6 and 24 months old was conducted in peri-urban districts of Phnom Penh and Siem Reap, Cambodia. We measured perceived neighbourhood food access, including six dimensions of food availability, affordability, convenience, quality, safety and desirability. Associations were determined using multivariate logistic regressions. Over 25% of the mothers and 40% of the children reported low consumption (less than once a day) of either animal-flesh food or fruits and vegetables. Mothers' dissatisfaction with food access was associated with their low consumption of fruits and vegetables (OR 7.6; 95% CI: 3.22-18.02) and animal-flesh food (OR 5.63; 95% CI: 2.54-12.46), and with their children's low consumption of fruits and vegetables (OR 5.14; 95% CI: 2.69-9.83) and animal-flesh food (OR 4.34; 95% CI: 2.20-8.60). We demonstrated that, in urban-poor settings, women's perceived food access was an important predictor of their own and their young children's nutrient-rich food consumption. Future work is needed to confirm our findings and examine the role of neighbourhood food environments on the dual burden of undernutrition and overnutrition.

Keywords: animal-flesh food, Cambodia, consumption, food access, food safety

"Our food may not be very safe, because nowadays everything uses chemicals:" Women's Perceptions of Food Safety and Nutrition in Phnom Penh, Cambodia

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Introduction
There is growing recognition of the importance of foodborne disease as a major health concern. Although 1 in 10 people worldwide will fall ill each year from a foodborne illness, 40% of the deaths resulting from these illnesses will occur in children under 5[1, 2]. To address food safety in animal-source food products purchased in wet markets in urban Cambodia, a multi-level research and intervention project called "Safe Food, Fair Food for Cambodia" is investigating the health and economic burden of foodborne disease in animal source food product value chains and pilot a market-based intervention to reduce the incidence of foodborne disease outbreaks associated with animal-source food products. This qualitative study is a part of the formative research for the larger project.
Women in urban and semi-urban Cambodia are primarily responsible for cooking and childcare, although many also work either in a home-run business (such as growing and selling flowers) or in garment factories. Few studies have examined women's perspective into food safety and nutrition and how it affects their families in this setting. The study objective was to determine women's perception of the risk of food safety and how it relates to diet, health and decision making as part of formative research for a market-based intervention that aims to improve the safety of animal-source foods sold in informal markets.

Materials and methods
In-depth personal interviews with 24 caregivers (mothers and grandmothers) of children under five in Phnom Penh, Cambodia, were conducted and complemented with a second follow-up PhotoVoice interview, which allowed the women to photograph their meals and perceptions of food safety and nutrition. MAXQDA was used to conduct a thematic analysis of the 48 interviews (24 initial personal, 24 follow up PhotoVoice interviews).

Results
A primary food safety concern expressed was that chemicals in animal-source foods, fruits and vegetables may impact the health of their families by causing diarrhea and problems during pregnancy. This fear created a lack of trust in markets, which influenced their food purchasing behaviors and strategies for making the food safer for their families. These mitigation strategies, including food selection and cleaning, vary among the women but are perceived as important to be able to provide their families with what they define as safe meals.

Discussion and conclusions
Interventions that wish to decrease rates of foodborne illness and increase animal source food consumption should also address the belief that the food system has been compromised by the addition of chemicals and pesticides.

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Low prevalence of Cysticercosis and *Trichinella* infection in pigs in rural Cambodia

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Abstract

Cysticercosis and *Trichinella* spp. infection are parasitic zoonoses prevalent among pigs in Southeast Asia, where pork is the most important source of meat. In rural Cambodia, many pigs are raised extensively in family backyards, and information regarding the prevalence in rural small-scale pig production is very limited. This study was conducted in four provinces in north-eastern Cambodia to determine the seroprevalence of porcine cysticercosis and *Trichinella* spp. infection in rural villages, and to identify possible risk factors. Only households with less than 10 pigs above three months old were eligible. In total, 139 households participated, and 242 blood samples were collected. Farmers were interviewed about food and hygiene habits, disease knowledge and practices. The serum samples were analysed by ELISA to determine antigens to *Taenia* spp. cysticerci or antibodies to *Trichinella* spp. muscle larvae. Positivity among the pigs was 11.2% (95% CI 7.5–15.8) for *Taenia* spp. cysts and 2.5% (95% CI 0.9–5.4) for *Trichinella* spp. Cysticerci were more common in the province Preah Vihear ($p < 0.001$) than in the other provinces. Risk factors associated with porcine cysticercosis were management systems for the pigs and access to human faeces ($p < 0.001$). *Trichinella* spp. infection in pigs was more common in the province Ratanakiri ($p = 0.001$). The main risk factor associated with *Trichinella* spp. transmission was feeding pigs with food waste ($p = 0.048$). More men had heard about cysticercosis than women ($p = 0.002$), and men also consumed undercooked pork meat to a greater extent ($p = 0.004$). Although the present study is relatively small, several risk factors could be identified for porcine infection with *Taenia* spp. and *Trichinella* spp., which can be used to guide future interventions to improve both porcine and human health in these provinces.

Keywords*: Taenia solium*; *Taenia asiatica*; *Trichinella* spp.; neglected tropical disease; food safety; parasitic disease; zoonoses

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Using a Theory of Change to support evaluation planning for a food safety intervention in Cambodia

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Background

Theory of Change is becoming widely used in the agri-food sector to evaluate agricultural research for development. However, there is little reflection on the process of using this approach to evaluate interventions aiming to improve food safety. Our objective is to describe the process of using a Theory of Change to map out the potential pathways toward food safety, drawing on the Safe Food Fair Food (SFFF) project in Cambodia as a case study.

Methods

We conducted a full day Theory of Change workshop with 23 SFFF partners, researchers, and policymakers in Cambodia following a six-step process. Participants were randomly assigned into two groups to map out program theories at different levels of change.

Results

One group developed a map outlining systems change toward food safety, which consisted of three interdependent causal pathways: a research capacity development pathway, a value chain development pathway, and a policy pathway. Another group outlined the potential contribution of SFFF to the systems change pathway, focusing on wet market transformation.

Conclusion

Theory of Change analysis enabled the identification of change pathways and the context and assumptions in which change occurs from the perspectives of institutional actors, enabling SFFF to better evaluate food safety interventions.

Day 2: Innovation, policy and scaling

Emerging technologies for food safety: A venture funding perspective

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Abstract
Venture Funding is a private equity investment where investors provide capital to start-up (high risk) companies that they believe have high potential for return to investment. This model has proved successful in advancing technology which is otherwise deemed too risky to develop by other funding methods. Mountain Group Partners is a venture firm in Nashville Tennessee which invests in human and animal health biotech. Food safety is an investment area of focus for Mountain Group Partners. Mountain Group Partners looks at technology solutions for food safety in biosecurity, diagnostics, vaccines, and nutritional supplements. We discuss these technology areas and provide examples of companies with technologies that could apply to food safety solutions.

Good hygiene practices intervention for safer pork in traditional markets in Cambodia: Preliminary results

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Abstract

In low- and middle-income countries, animal-source foods sold in traditional markets contributes to livelihoods and food accessibility. Better hygienic practices in these markets would improve food safety and increase consumers' trust. This study aimed at improving hygiene knowledge and practice of retailers to enable them to sell safer pork in traditional markets in Cambodia. A randomized controlled trial was designed in 12 trial and 12 control markets in six Cambodian provinces. The light-touch and low-cost intervention package, using nudge theory, provided shop equipment and training on good hygienic practices to the trial retailers. Total bacteria count (TBC) and *Salmonella* were used as indicators to assess the improvement of the safety of pork. Knowledge, attitude and practice (KAP) evaluation was also conducted and analyzed. There was a significantly lower overall $\log_{10}$CFU/g TBC and *Salmonella* prevalence in the trial group (6.29 $\log_{10}$CFU/g and 29.0%, respectively) compared to the control group (6.87 $\log_{10}$CFU and 53.3%, respectively). These differences varied across the six provinces, ranging from 0.30–0.95 $\log_{10}$CFU/g and 0–43.6%, respectively. Pork sold by trial retailers in Kampong Cham and Takeo provinces had less bacterial contamination than that sold by their counterparts in the control markets. Modest compliance of pork vendors in cleaning and disinfecting shop equipment and handwashing was observed in the trial group. The KAP scores of trial retailers were significantly improved compared to those of the control group ($p < 0.05$). The light-touch intervention demonstrated an effective improvement of safety of pork at traditional retail markets, with potential for scale. Stronger policy engagement, consumer recognition of vendors practising good hygiene, and frequent monitoring of hygienic practice are necessary to enhance the compliance of retailers with the intervention packages.

Keywords: food safety, good hygiene practice, traditional market, animal-source food, pork

Food safety intervention to improve knowledge, attitude and hygienic practices of pork retailers in traditional markets in Cambodia

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Background

Food safety is a significant concern in low- and middle-income countries. This study evaluated the food safety knowledge, attitude and practice of pork retailers in traditional markets in Cambodia. A randomized controlled trial was carried out among 180 control and 180 trial retailers in six provinces. Trial retailers were trained on good hygienic practices to reduce cross-contamination of retailed pork. A month later, they were interviewed to assess their knowledge, attitude and practice related to food safety. An observational checklist was used to monitor the personal hygiene practices, shop facility and environment. The knowledge, attitude and practice were scored as either correct (1) or wrong (0). A chi-square test was used to compare differences in proportions, with statistically significant level (p-value) set at 0.05.

About 84% of the trial retailers had a good knowledge of safe meat handling compared to the control group (44%). Fifty-seven percent of trial retailers had a good attitude about meat handling, compared to 32% of the control group. Only 2.3% of retailer from the control group demonstrated hygienic meat handling, in contrast to 17% of the trial group. A significant association was observed between the control group and trial group with their knowledge (p<0.001), attitude (p<0.001), and practice (p<0.001) of safe meat handling at the traditional market in Cambodia.

Thus, training of pork retailers in traditional markets resulted in significant improvement of knowledge, attitude and practice of food safety and meat handling. We recommend that this food safety intervention be extended to retailers involved in the sale of other meat products, such as chicken and beef, to help improve safety of animal-source foods sold in traditional markets in Cambodia.

Keywords: knowledge, attitudes, practice; food safety; traditional markets; meat

Food safety taskforce to support food safety management in Cambodia

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In Cambodia, the implementation and institutional arrangements of food safety, based on the farm to table approach, mandates six ministries to share the responsibility for food safety. These are: Health (MoH), Agriculture, Forestry, and Fisheries (MAFF), Commerce (MoC), Industry and Handicraft (MIH), Economic and Finance (MEF), and Tourism (MoT). However, each ministry still manages food safety through separate systems. Even though coordination and information sharing across sectors has been in place, this was still ad-hoc and limited. improve the coordination among ministries, a Multi-sectoral Technical Working Group for Food Safety (FSTWG) was established in 2017 to help ministries set priorities for food safety and to improve policies and communication.

From the consultation, the SFFF Cambodia project team realised that research evidence and technical inputs in food safety are needed for decision making in general and to support the FSTWG in particular. Therefore, the project proposed a taskforce on food safety risk assessment to be able to support the FSTWG. This risk assessment taskforce brought together experts from the six above-mentioned ministries, universities and research institutes working on food safety, and also experts from the international organisations such as FAO and WHO in Cambodia. The aims were to develop the capacity of decisionmakers and national researchers to use risk-based approaches for food safety management.

The main activities included training courses on risk assessment for members of the Task Force and researchers from universities and research institutes. A meeting was organized on 24-25 October 2019 in Siem Reap with key partners of the FSTWG to discuss project progress, terms of refence and membership of the taskforce. It was agreed that SFFF would assist the FSTWG to improve the translation of food safety research findings. A second follow-up meeting was organised on 18 February 2021 in which research results and intervention studies were presented and discussed to formulate policy relevant messages. Unfortunately, due to the COVID-19 pandemic, the planned visit of the taskforce members to Vietnam could not happen. However, experts from Vietnam and Japan shared with the taskforce members relevant experiences of translating research into policies at a taskforce meeting. The taskforce is expected to continue after the project has ended and ILRI is committed to supporting the taskforce. The main activities will focus on how the successful (incentive-based, light-touch) interventions to improve food safety in traditional markets can be scaled up in Cambodia and how the research findings can inform food safety policies.

Japanese encephalitis in small-scale pig farming in rural Cambodia: Pig seroprevalence and farmer awareness

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Abstract

Japanese encephalitis (JE) is endemic in Cambodia, but circulation of JE virus (JEV) among domestic pigs has previously only been studied in the southern part of the country. The main purpose of this study was to determine the seroprevalence of JEV antibodies in smallholder pigs held in rural areas of Kampong Thom, Preah Vihear, Ratanakiri, and Stung Treng provinces, in north-eastern Cambodia. Another purpose was to identify possible associations between serologic status and other factors, such as reproductive disorders, and to investigate the farmers' knowledge of mosquito-borne diseases and use of preventive measures. In October 2019, 139 households were visited throughout the study area, and 242 pigs were sampled for blood. The sera were analysed with ELISA for JEV antibodies. Household representatives were interviewed, and data were recorded for each sampled pig. The apparent seroprevalence was 89.1% in pigs between 3 and 6 months of age, and 100% in pigs over 6 months of age. In total, 93.0% of the pigs tested positive. Province appeared to be the only factor significantly associated with serologic status ($p < 0.001$). Almost all (97.8%) respondents knew that mosquitos could transmit diseases, and 70.5% had heard of JE. However, only one respondent knew that JEV is transmitted to people through mosquito bites. Very few respondents knew that pigs can become infected with JEV, and no one knew that mosquitos transmit the virus. All families used some sort of mosquito protection for themselves, but only 15.1% protected their pigs from mosquito bites. The children were vaccinated against JE in 93 households, while adults only were vaccinated in eight households. The results suggest that JEV transmission is intense in north-eastern Cambodia, and that people's knowledge about the transmission route of JEV and the role of pigs in the transmission cycle is low. Fortunately, people are well aware of mosquito-borne diseases in general and use mosquito protection, and many children are vaccinated against JE. Nonetheless, it is important that national vaccination is continued, and that people -especially in rural areas where pigs are commonly kept—are educated on the ecology and transmission of JEV.

Keywords*:* zoonosis; vector-borne disease; arbovirus; neglected disease; pig farming; Southeast Asia

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11. Rortana Chea, Sothyra Tum, Hung Nguyen-Viet, Sinh Dang-Xuan, Delia Grace, Johanna F. Lindahl, Chhay Ty, Sok Koam, Theng Heng, Or Phirum, Sofia Boqvist, Fred Unger. *Good hygiene practices intervention for safer pork in traditional markets in Cambodia: Preliminary results* (in preparation)

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Presentations

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2. R. Chea, S. Dang, S. Tum, J. Lindahl, D. Grace, S. Koam, T. Khuoch, R. Sophia, and Hung Nguyen-Viet. *Experiment of Salmonella cross-contamination during handling and preparation of chicken salad in Cambodia.* Presented at the Virtual General Meeting, the Feed the Future Innovation Lab for Livestock Systems, 28-30 September 2020.
3. R. Chea, S. Dang, S. Tum, D. Grace, T. Heng, C. Ty, Hung Nguyen-Viet, and F. Unger. *Good hygiene practices intervention for safer pork in traditional markets in Cambodia: a preliminary result.* Presented at the Virtual General Meeting, the Feed the Future Innovation Lab for Livestock Systems, 28-30 September 2020.

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Blog posts

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ILRI INTERNATIONAL LIVESTOCK RESEARCH INSTITUTE	International Livestock Research Institute (ILRI) works with partners worldwide to enhance the roles that livestock play in food security and poverty alleviation, principally in Africa and Asia. ILRI's mission is to improve food and nutritional security and to reduce poverty in developing countries through research for efficient, safe and sustainable use of livestock—ensuring better lives through livestock. www.ilri.org
	National Animal Health and Production Research Institute (NAHPRI) is part of the General Directorate of Animal Health and Production (GDAHP), Ministry of Agriculture, Forestry, and Fisheries (MAFF). The mandate of NAHPRI is to conduct veterinary surveillance and research, investigate disease outbreaks, and consolidate information on all matters pertaining to animal health and production and food safety. It conducts veterinary epidemiological surveys and diagnostic testing.