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Assoc. Professor Achyut Adhikari, PhD

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Compost, raw manure, irrigation water, fresh produce, UVC light treatment, antimicrobials, Weibull model, stress response, chlorine dioxide, peroxyacetic acid, vegetable filter strips, sprouts, pecans, die-off rate, ,

Dr. Ana Allende, PhD

Spanish Scientific Research Council, Madrid, Spain

Fresh produce, Pre-harvest, E. coli, Salmonella, Listeria, Irrigation water, Survival, Inactivation, Risk assessment, water management

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Functional genomics of stress response, Listeria monocytogenes, E. coli O157, 7, STEC, gene expression, microarrays, Q-PCR, subtyping of pathogens, thermal inactivation of Salmonella, molecular methods for pathogen detection, chemical and physical pathogen inactivation methods, food antimicrobials and growth inhibition of L. monocytogenes on RTE foods, survival and adaptation of enteric pathogens in fresh produce and low moisture foods (wheat, flour).

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Campbell Soup Company, Camden, New Jersey, United States of America

Escherichia coli, Listeria monocytogenes, Salmonella, Enterococcus faecium, low moisture foods (nuts, baked goods), low water activity foods, process validation, thermal inactivation, thermal processing (low acid and acidified canned foods), raw dough, wheat flour, fruit juice spoilage (Alicyclobacillus)

Professor Arun Bhunia, BVSc, PhD

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Immunological, cytotoxicity or cytopathogenicity assays, microbial pathogenesis, virulence, Microbiology, Probiotics

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University of Wyoming, Laramie, Wyoming, United States of America

Ecology of Foodborne Pathogens, Food Safety Microbiology, Rapid and Molecular Microbial Detection, Antimicrobial Resistance, Microbial Source Tracking, Single Cell Methods, Control of Foodborne

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Dr. Burton Blais

Bacterial foodborne pathogens, detection, identification, characterization, molecular, genomics, immunoassay, PCR, WGS, method validation

Dr. Declan Bolton

Escherichia coli O157, 7 and non-O157 verocytotoxigenic Escherichia coli (STEC - ecology, epidemiology, transmission, virulence factors and control on the farm and during meat processing, Salmonella – epidemiology, pathogenicity, antibiotic resistance, stress response and gene expression, Campylobacter – epidemiology in poultry, pigs and humans, antibiotic resistance including the molecular basis of multiple resistances and on-farm and processing control including chemical decontamination, Yersinia enterocolitica and pigs, Clostridium estertheticum and Clostridium gasigenes and blown pack spoilage of vacuum packaged meat, beef, pork, lamb, poultry, broilers, fish, HACCP, prerequisites, GMP, GHP, biosecurity

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USDA - ARS - US Meat Animal Research Center, Meat Safety and Quality Research Unit, Clay Center, Nebraska, United States of America

Beef, Pork, Lamb, Post-harvest intervention, Sanitation, E. coli O157, 7, Salmonella, Shiga toxin-producing E. coli (STEC), Listeria, Biofilm, Surrogate bacteria, PCR, Antigen detection, WGS, Metagenomics

Dr. Julie Brassard

Foodborne viruses in horticultural and animal production, Virus detection by concentration and molecular methods, Viral surrogates, Farm-to-table control strategies, Thermal and non-thermal virus inactivation strategies, Virome (NGS), Foodborne virus outbreaks

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USDA Agricultural Research Service, Raleigh, North Carolina, United States of America

Acid and general stress resistance in *E. coli, Salmonella* and *Listeria*, lactic acid bacteria, produce, fermented foods (kimchi, pickles, sauerkraut), preservatives, food spoilage, modeling of thermal and other inactivation kinetics, competitive exclusion

Dr. Robert l. Buchanan

Microbial food safety, Psychrotrophs, Predictive microbiology, Risk assessment, Microbiological criteria, HACCP, Molds/mycotoxins

Dr. Laurel Burall, Ph.D.

Center for Food Safety and Applied Nutrition, College Park, Maryland, United States of America

Persistence, environmental stress, listeriosis and Listeria monocytogenes, specifically looking into identification of contaminated foods and environmental samples and, enumeration of the levels of contamination to better inform risk analyses, environmental response, *L. monocytogenes* genomic diversity, pathogen detection, persistence, genomics, and transcriptomics

Professor Francis Butler, PhD

University College Dublin, Dublin, Ireland

Microbial quantitative risk assessment, Pathogens in the food chain, Next generation sequencing, Characterizing microbial distributions, Predictive microbiology, ,

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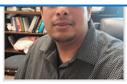

Dr. Govindaraj Dev Kumar, PhD

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E. coli, Salmonella, Listeria, STEC, antimicrobial resistance, sanitizers, antimicrobials, bacterial stress, gene manipulation, recombinant DNA technology, pathogenicity, survival, cross-contamination and control of foodborne bacterial pathogens in the environment, on produce, meats and in low moisture foods, bacterial physiology, bacterial genetics, environmental monitoring, biochemical/ immunological and molecular assays for detection and characterization of foodborne pathogens, Food Safety Microbiology

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Salmonella, E. coli, Poultry processing, Post-harvest food safety, Biofilms, Thermal inactivation of pathogens, Environmental sampling, RTE foods, Antimicrobials (sodium hypochlorite, peroxyacetic acid, organic acids, medium chain fatty acids, sodium bisulfate, bacteriophage), Microbial pathogen mitigation in fats and oils, Mold (Aspergillus flavus, Fusarium graminearum), Animal feed, Control of molds using antimicrobials, Pet food, Challenge studies in food and animal feed, Conventional microbiological methods, PCR

Dr. Francisco Diez, PhD

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Pre-harvest food safety, organic produce, Listeria, fresh Hispanic cheese, acid resistance and stress response, *Bacillus anthracis* inactivation, ecology of STEC, fresh produce, bacteriophages, colicinogenic *E. coli*, *Salmonella* in low moisture foods, Low water activity foods, wheat and wheat flour treatments *Clostridium difficile* in meats, plant-pathogen interaction, blue light treatment as antimicrobial intervention, E. coli O157, 7 in cattle

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E. coli O157, non-O157 Shiga toxin-producing E. coli (STEC), L. monocytogenes, Control, Antimicrobials, Decontamination treatments, Beef, Thermal inactivation in non-intact beef, Ready-to-eat meat and poultry products, Pre-harvest and post-harvest, Inoculum preparation, Prevalence of pathogens, Meat-associated spoilage and pathogenic bacteria, Salmonella, Poultry, Pork

Dr. Gregory Gharst

Campylobacter, Proficiency testing, Allergens, Peanut proteins

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University of the Aegean, Department of Food Science and Nutrition, Myrina, Greece

Bacterial attachment and biofilms, Microbial stress response, Microbial interactions, Quorum sensing, Disinfection, Fermented foods, Pathogen detection, Identification and quantification, Listeria, Salmonella, Lactococcus

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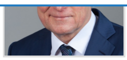

Dr. Leon Gorris, PhD

Nijmegen, Netherlands

Microbiological Food Safety, Food Safety Assurance, Food Safety Control, Food Safety Management Systems, Food Safety Management, food safety risk assessment, MRA, QMRA, qualitative MRA, quantitative MRA, MRA, predictive microbiology, risk assessment, risk management, risk communication, Food microbiology, Food safety

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Dr. Lisa Gorski

E. coli O157, 7, Salmonella, Campylobacter and Listeria monocytogenes, produce, plants, pre-harvest and food processing surfaces, inter-relatedness of bacterial species, ecological interactions, adaptation, biofilms, phenotypic characterization, genomic analyses, gene expression and regulation, cell surface biochemistry, soil microbiology, pathogen recovery/enrichment, real-time PCR

Dr. Sara Gragg, PhD

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Salmonella, E. coli O157, 7, STEC, Pre-harvest transmission and intervention strategies, Cattle, Swine, Poultry (lymph nodes, feedlots), post-harvest processing of beef, pork, and poultry, pre-harvest and post-harvest safety of fresh produce (leafy greens)

Dr. Elizabeth Grasso, PhD

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Survival and thermal inactivation in low moisture/low water activity foods (nuts, spices, flours), Salmonella, E. coli, Listeria, Enterococcus faecium, growth, process validation, surrogates, cleaning and sanitizing low moisture facilities, extrusion, baking, microbial transfer, produce, dairy

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treatment), Food regulations, FSMA, Acidified and low-acid canned foods, Baking validations, Antimicrobial interventions, Post-harvest meat (acids, antimicrobials)

Dr. Allison C. Lacombe

Fresh produce, Blueberries, Almonds, Lettuce, Cranberry, Non-thermal inactivation including cold plasma, Irradiation, High intensity pulsed light, Norovirus, E. coli O157, 7, Salmonella, Listeria monocytogenes

Dr. Elisabetta Lambertini, PhD

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Pathogen ecology, viruses, Salmonella, E. coli, predictive microbiology, zoonotic, food, water, irrigation, farm, virulence, sampling, qPCR, low water activity, spatial models, transfer, disinfection, preharvest and postharvest pathogen ecology in produce crops, farming practices, quantitative microbial risk assessment (QMRA), risk assessment, decision analysis, environmental fate and transport, exposure science, food safety, food systems

Dr. Keith A. Lampel

Methods of microbial detection in foods, Shigella, PCR methods, Microarrays, Molecular sequencing, WGS

Ing. Alexandre Leclercq, MSc

Institut Pasteur, Paris, France

Listeria, Yersinia, E. coli O157, Enterobacter (Cronobacter) sakazakii, Hepatitis A, Norovirus, Standardization, ISO, CEN, Method validation, MLVA, MLST, PFGE, PCR, Genomic, European regulation, Infant formula, Phage, Chromogenic media, CRISPR, Accreditation, Bioterrorism

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Transmissible spongiform encephalopathies (TSEs), Detection of animal proteins in feed, Detection of central nervous system tissue in food, Risk analysis of TSE-related issues, rendering animal products, inactivation of TSE agents in food/feed, use of new animal drugs in animal feed, nanotechnology applications for food

Dr. Matthew Moore, PhD

University of Massachusetts Amherst, Department of Food Science, Amherst, Massachusetts, United States of America

Food microbiology, Food and environmental virology, Norovirus, eukaryotic virus-bacteria interactions, Gut microbiome, Portable detection and sequencing platforms, Viral inactivation strategies and therapeutics, Viral concentration techniques, Microbiome, Mycotoxin, Biosensor

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Dr. Hudaa Neetoo, PhD

University of Mauritius, Reduit, Mauritius

Fresh produce, sprouts, poultry, histamine, thermal and non-thermal processing (high pressure), antimicrobials, nisin, packaging, *Listeria, Salmonella, E. coli, Vibrio, norovirus*, food and water microbiology, food processing, climate change and food safety, mycotoxins, histamine, seafood

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Dr. Brendan Niemira

Food irradiation, Cold plasma technology, High-intensity pulsed light, Microbial ecology of foods and food-contact surfaces, Biofilms, Persistence, Antimicrobial interventions, CSLM and digital image analysis, Non-thermal processes, Fresh and fresh-cut fruits and vegetables, Plant pathology and physiology

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Antimicrobial resistance, Molecular detection of enteric viruses (Hepatitis E) and foodborne pathogens (Listeria), epidemiology and control of Listeria, genomics, microbiome, NGS/WGS sequencing, risk assessment

Dr. Dojin Ryu, PhD

University of Idaho, Moscow, Idaho, United States of America

Molds and mycotoxins including occurrence, impact of postharvest processing/treatment, toxicology, and risk assessment, mycotoxin detection including HPLC and ELISA, food safety education

Prof. Dr. Anderson Sant'Ana, PhD

UNICAMP - University of Campinas, SAO PAULO, Brazil

Predictive microbiology, predictive modeling, risk analysis, quantitative microbial risk assessment, challenge tests, foodborne pathogens (Salmonella, Listeria, Bacillus cereus, Clostridium perfringens, Clostridium botulinum), probiotics, spoilage microorganisms(Alicyclobacillus, Clostridium, Bacillus, fungi), effects of processing on the microbial quality and safety of foods, GC-MS, HPLC, MS-MS and molecular tools

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Dr. Charles Santerre, PhD

Clemson University, Clemson, South Carolina, United States of America

Food toxicology (mercury, trace elements, PCBs, PBDE's, among others in seafood), Measurement and bioavailability, Seafood safety, Bisphenol A in packaging, Pesticide analytical methods including SPME, GC/MS, ELISA, effects of cooking on chemical contaminants, Melamine, Risk assessment, Ag Policy

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Pathogenic E. coli, STEC, PCR detection, Pathogenicity islands, Toxins, Recombinant protein expression, Shiga toxin-encoding bacteriophages, Subtilase, DNA sequencing, Bacteriophages, EHEC, Shiga toxin

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Dr. Keith Schneider

E. coli, Salmonella, Shigella, Fresh produce (lettuce, tomatoes), Packinghouses, Soil amendments, Aquaculture

Dr. Harry Schonberger, PhD

Virginia Polytechnic Institute and State University, Blacksburg, Virginia, United States of America

Food safety education, Farms/farmers, Farmers markets, Cooperative extension, Qualitative methods, Food donation, Food recovery, produce safety, food handler observational studies, surveys, and focus groups, consumer behavior, food preservation, Retail food handling, Cooperative Extension volunteers

Dr. Heidi Schwartz-Zimmermann, PhD

University of Natural Resources and Life Sciences Vienna, Wien, Austria

Mycotoxins, Mycotoxin biomarkers, HPLC, Mass spectrometry Mycotoxins and mycotoxin biomarkers, Metabolomics

Dr. Kun-Ho Seo

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Food engineering, Thermal and non-thermal food processing and preservation technologies, Dairy products, Food shelf-life, Food quality attributes, Functional properties, Physical properties, Modeling process optimization, Probiotics, Prebiotics, Lactic acid bacteria , ,

Dr. Manan Sharma

E. coli O157, 7 survival in leafy greens, produce, soil, manure, compost, and irrigation water, impact of modified atmosphere packaging on *E. coli virulence*, stress response (rpoS) of E. coli and *Salmonella* on leafy greens, sand filters and zero-valent iron for recovery of *E. coli* and *Salmonella* from irrigation water, shiga-toxin and other virulence factors in EHEC, virulence factors, lytic bacteriophages for control of foodborne pathogens in lettuce and melons, adaptation of enteric pathogens to non-host environmental conditions, Produce safety Soil amendments, Manure, Heat treated poultry pellets, Water filtration

Assoc. Professor Cangliang Shen, PhD

West Virginia University Division of Animal and Nutritional Sciences, Morgantown, West Virginia, United States of America

Natural antimicrobials (hops), *Enterococcus, Salmonella, Campylobacter, Listeria*, sanitizers for poultry, eggs and fresh produce, stress adaptation, farm market safety, postharvest sanitizing procedures for reducing food safety risks on poultry meat products and fresh produce, which including thermal and or nonthermal process, antimicrobial treatments and outreach related survey studies in very small to small local communities, thermal inactivation, egg, surrogate bacteria, extension survey.

Dr. Ellen Shumaker, PhD

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Food safety education and training (consumers, food handlers), food safety risk communication and messaging, safe food handling knowledge, attitudes, and behaviors, food safety culture, survey and observational research, mixed methods research, observation, consumer behavior, risk communication, kitchens

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Dr. Sujata Sirsat, PhD

University of Houston, Houston, Texas, United States of America

Food safety education, Food safety training, Food safety observations, Restaurant food safety, Retail food safety, Farmers market food safety, Controlled environmental agriculture, Produce safety, Agriculture, Food safety disparities, Beer safety and quality, Cross contamination, pre and post-harvest safety, Hydroponics, Controlled environmental agriculture, Food safety disparities, ,

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Dr. Derike Smiley, PhD

US Food and Drug Administration, Jefferson, Arkansas, United States of America

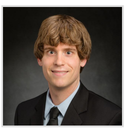
Listeria monocytogenes, Salmonella, Clostridium, method validation, PCR, molecular biology, antibody, ELISA, ELFA, immuno-fluorescence, regulatory, enrichment, antibody capture, immuno-magnetic, foodborne pathogens, analytical microbiology, bacterial recovery, bacterial detection, aptamers, sequencing

Dr. Abigail Snyder

Wet and dry sanitation, mold, food spoilage, fungal spoilage, process validation, bacteriocins, fruit, juice, *E. coli*, food safety training, microbial genomics

Dr. Yoonseok Song

Package integrity, Active packaging, Inspection, and testing, Chemical migration of indirect food additives/contaminants/degradation products, plastics, indirect additives, recycling, active, ,



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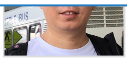

Dr. Jun Wang, PhD

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Microbial risk assessment, predictive microbiology, bacteriophage, atmospheric cold plasma, plasma-activated water, electrolyzed water, UVC-LEDs, non-thermal sterilization, dairy and meat product, biofilms, mathematical modeling, RT-PCR, LAMP

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E. coli, Listeria monocytogenes, Salmonella, bacteriophage, fresh produce, poultry, dairy, genomics, transcriptomics, microbiome

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Chemometrics, modeling, LC-MS, GC-MS, ICP-MS, EMA, VOC, seafood, economically motivated adulteration (EMA), food fraud, volatile organic compounds (VOC), heavy metals, pesticides, animal drugs, mycotoxins, and seafood decomposition

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Microbiological safety of minimally processed vegetables (alfalfa sprouts, tomatoes), interaction of human pathogens with vegetables, non-thermal intervention technologies (UV, biocontrol, bacteriophages), produce sanitizers, HACCP, pathogen diagnostics (biosensors, immunoassays), microbial source tracking (DNA typing)

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response, microbial modelling, risk analyses, risk assessment, sampling plans, dose-response, food safety management, exposure assessment, quantitative microbiology

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MINI-REVIEW

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Research Paper

Food Traceability Systems, Consumers' Risk Perception, and Purchase Intention: Evidence from the "4-label-1-Q" Approach in Taiwan

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ABSTRACT

Many food safety issues have arisen in Taiwan during the past decade. Therefore, in 2016, the Taiwan government proposed the "five rings of food safety" policy to comprehensively protect consumer food supply. Among these policies, the "4-labels-1-Q" approach was adopted to ensure the selection of foods with traceable labels for retrospective study. Hence, this study investigated the association between the degree of familiarity with the 4-labels-1-Q food traceability system and risk perceptions and also investigated whether a consumer's purchase intention toward fresh foods with food labels changed after viewing an educational film on food labels. This study defined subjects as the main food purchasers for their families; 290 valid questionnaire interviews were administered and educational films shown in Tainan markets and stores. Results showed that knowledge about labels significantly affected risk perception for labeling. Age, educational level, and degree of risk perception influenced purchase intention. Results also showed that after viewing the video, subjects' label knowledge and purchase intention increased significantly. However, after adjustment for age, educational level, income, and purchase places, the effect of film education on risk perception was insignificant, especially for those who had lower educational levels, including those older than 65 years. Public trust can be boosted through label education among age groups using different channels and methods, and encouraging the sale of labeled foods in traditional markets would be a useful strategy. Age, educational level, income, and risk perception of participants significantly affected purchase intention. This study can be a reference for designing risk communication strategies and promoting traceable agricultural products.

HIGHLIGHTS

- Knowledge about labels significantly affected the risk perception for labeling.
- Understanding labeling had a slight effect on participants' risk perceptions.
- Risk perception influenced purchase intention.
- Label knowledge and purchase intentions increased after film education.
- Education about labeling is needed to improve trust in the elderly.

Key words: Food label; Food safety; Food traceability system; Purchase intention; Risk perception

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Over the past few years, as many countries have faced food safety issues, they have started to establish their own food traceability systems. France implemented food registration in 1969 and established a food traceability system in 1998. Likewise, the United Kingdom established a food traceability system in 1996, following the outbreak of bovine spongiform encephalopathy (mad cow disease). Additionally, the European Union published the European Commission's White Paper on Food Safety in 2002, which specified that information should be made available from upstream to downstream. They also specified that raw materials should be provided within 4 h of occurrence during any food safety incident *(25)*.

Taiwan has had many food safety issues in the past decade, such as contamination with phthalate plasticizers or with fuels derived from agricultural waste, e.g., from oil meals and waste cooking oils *(5, 46, 48)*. As a result, the Food and Drug Administration, Taiwan (FDA Taiwan) and food safety experts made several legislative amendments, thereby strengthening public understanding of basic food safety concepts. To improve food safety management methods and establish consumer confidence, the government of Taiwan proposed the "five rings of food safety" policy in June 2016, which focused on (i) exercising control at the source; (ii) reestablishing production management

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histories; (iii) boosting the government's inspection capabilities; (iv) imposing heavier responsibilities on producers and manufacturers; and (v) encouraging and creating oversight platforms. This policy ensured that every step, from farm to table, meets environmental and safety standards.

To address the second strategy in Taiwan's five rings of food safety policy ("re-establish production management histories") preferential selection of foods with traceable labels has been promoted in children's lunches since 2016. This policy encourages schools to select foods with traceable labels for retrospective study, those that meet the requirements of Certified Agricultural Standards, Certified Agricultural Standards organic, and good agricultural practices, including those with Taiwan Traceability Agricultural labels or Taiwan Agricultural Products Production Traceability QR codes, hereafter referred to as "4-labels-1-Q." However, in the general population, traceable labels are not yet well-known.

One study suggested that risk perception regarding food safety was based on both subjective consciousness and knowledge of risk *(33)*. Another study found that risk perceptions help explain consumer purchasing behaviors because consumers seek to maximize utility and avoid possible losses *(27)*. However, many external and internal factors can affect an individual's risk perception, and these factors integrate to become a psychological feeling. Risk perception has also been shown to be susceptible to fear of the unknown, which leads to risk-avoiding behaviors *(7, 12, 37)*. Thus, risk perception is multidimensional, with ties to psychology, sociology, economics, etc.; a deep knowledge of customer risk perceptions requires a comprehensive understanding of consumer attitudes toward food safety *(17)*. Notably, Mitra et al. *(28)* categorized food safety risk perception approaches as physics, quality, money, time, social, and psychological. This study also explored the phenomena caused by multidimensional risk perception.

Likewise, food safety perceptions can be divided into "consumer subject" and "product object." Consumer subject is an individual's awareness of food safety, in which food safety knowledge is influenced by individual differences due to external factors. Liu et al. *(22, 23)* found that gender, educational level, income, and occupation all influence consumers. Factors that influence the risk perception of product objects include food ingredients, producer brands, and food labels. Thus, the above studies found that when consumers made decisions in purchasing food, they not only conducted brand benefit assessments in their subconscious behavior but they also checked product manufacturing labels and nutrients according to individual health needs. The food label on product packaging, therefore, becomes the first consideration as consumers decide to purchase products.

Alternatively, a study suggested that purchase intention was an effective indicator of purchase behavior *(13)*. More recently, purchase intention has been defined as the likelihood that a consumer will purchase a certain product *(36)*. Another study divided the main factors driving consumer purchase of organic foods into the following categories: health orientation, environmental, price, and self-value orientation *(39)*. Risk perception, labeling, and attitude have also been noted to affect consumers' purchase intentions *(30)*.

Based on the above premises, this study explored the relationship between the degree of familiarity with food labels on fresh foods and the risk perception of the participants. We further investigated whether food traceability systems can ultimately affect purchase intentions and whether giving information on food traceable labels to participants can drive the purchase of foods.

MATERIALS AND METHODS

Ethics statements. The Human Ethics Committee of the National Cheng Kung University Hospital approved the study protocol and the way informed consent was obtained (B-ER-107-320).

Research design. The study was conducted in the city of Tainan in southwest Taiwan. The flowchart is shown as Figure 1. The city was divided into three districts according to population density: $<$1,000, 1,000 to 5,000, and $>$5,000 people per km^2. The plan at the outset was to complete 100 questionnaire interviews in each district.

Questionnaire design. A questionnaire was developed to assess the impacts of label knowledge and risk perception on purchase intention among primary family food purchasers in Tainan. All participants signed a consent form before their inclusion in the questionnaire-based face-to-face interview.

The questionnaire had five parts: (i) demographic characteristics (gender, age, occupation, etc.); (ii) knowledge of traceable food labels (4-labels-1-Q) (see Supplemental Material, File 1); (iii) risk perceptions of fresh foods (physical risk, performance risk, financial risk, etc.); (iv) short education about label information (educational film); and (v) purchase intention toward traceable fresh foods, including the willingness to pay for food products with a label.

In part iv, an educational film made by the authors to introduce the 4-label-1-Q approach was shown to the participants (3 min, 46 s) after they had responded to basic questions relevant to demographic characteristics, knowledge of traceable food labels, and fresh food safety risk perception. Next, questions relevant to purchase intention toward traceable fresh foods were asked again after they saw the short educational film. The film was shown to participants in a simple and familiar way using a tablet computer, and the features of each label were subsequently compared, after which the participants understood more about traceable food labels.

All questions were answered using a 5-point Likert scale or multiple-choice methods. Points 1 to 5 in the Likert scale corresponded to "strongly disagree," "disagree," "neither agree nor disagree," "agree," and "strongly agree," respectively. The priority sequence represented the importance of food price, food quality, eco-friendliness, health considerations, appearance, and brand. Purchase intention was assessed using mainly vegetables, meat, and white rice in addition to the different labels and corresponding prices in markets and stores. "What label and price of fresh foods do you intend to choose?" was asked (see Supplemental File 2). Also assessed were consumer risk perception, in addition to their willingness to accept food products with additives *(49),* and consumer willingness to accept milk proposed to have come from cloned cows *(4)*.

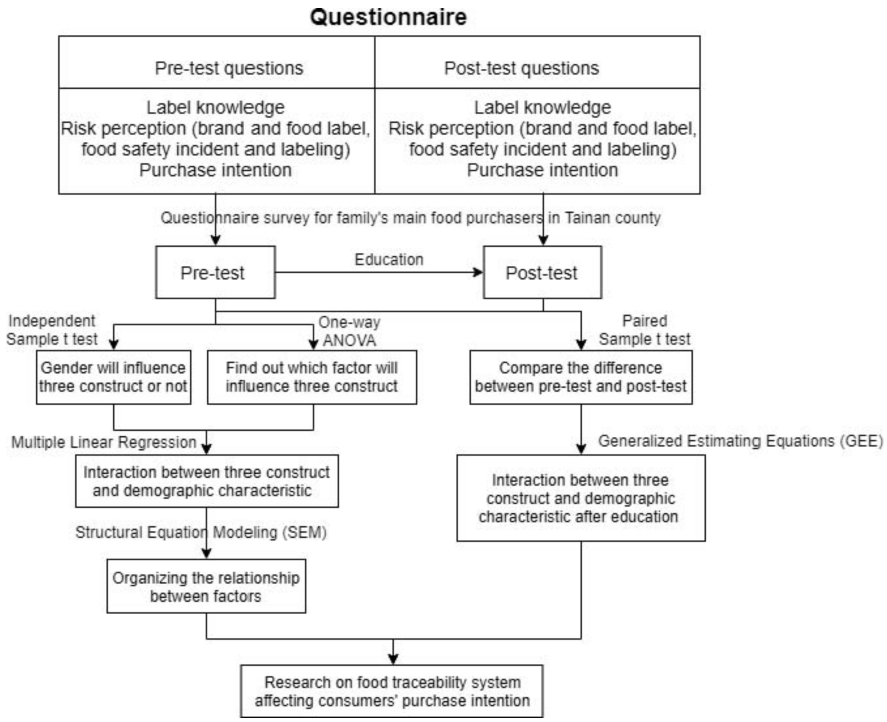

FIGURE 1. *Flow chart of the study design.*

Data collection. In each administrative region, traditional markets, hypermarkets, supermarkets, and convenience stores were selected. The reviewer randomly asked individuals who arrived at these markets and stores to participate in this study if they responded that they were the main food purchasers for their families. This phase was conducted from December 2018 to February 2019.

Before the formal use of this research questionnaire, its reliability was pretested by inviting main food purchasers from 14 families to complete it. Based on analysis of these results, Cronbach's α value of each construct was >0.7, thereby indicating an acceptable level of reliability.

Data analyses. Subsequently, factor analysis was conducted, and the cumulative percentage explained variation (58.82%) was extracted and classified according to the questionnaire responses. Three new constructs were then renamed as "label knowledge," "risk perception" (labeling or brand), and "purchase intention" based on the results of the factor analysis (see Supplemental File 3).

Afterward, Cronbach's α method was used to test the reliability of participant responses regarding food label knowledge, risk perception, and purchase intention, to understand the correlations among these constructs. The questions were mainly answered using the 5-point Likert scale, which allowed the mean and standard deviation to be calculated for each variable; a higher score indicated greater emphasis on a given variable. Furthermore, Student's t test and one-way analysis of variance were used to test differences in label knowledge, risk perception, and purchase intention between males and females and among participants living in different districts. A paired sample t test was also conducted to determine whether there was significant change in the three constructs after the educational film on food labeling had been presented to participants. Additionally, we assessed whether this educational intervention improved each participant's purchase intention. Then, multiple linear regression and structural equation modeling were used to explore the relationships among the constructs and examine the degree of influence of various pathways. In addition to linking a manifest variable (question) with a latent variable (construct) and considering the correlation between the two, structural equation modeling can use path analysis to establish a causal relationship between latent variables *(35)*. All analyses were conducted using SPSS statistical software (version 24, IBM Corp., Armonk, NY).

RESULTS

Sample characteristics. In this study, 38 markets were visited, and 304 questionnaires were obtained. Of the 304 questionnaires obtained, 290 were valid, giving an effective questionnaire rate of 95.4%. Participants were mainly female (89.7%), with a high proportion of homemakers (36.6%) and fewer blue-collar (14.8%) and service industry (13.8%) workers. As for interview locations, 54.1% of the participants were recruited from traditional markets, 33.2% from supermarkets, and 12% from hypermarkets or convenience stores. Results showed that the population density of the area was negatively related to the age of participants but was unrelated to their educational level (Table 1). The degree of risk perception increased with an increase in household income up to a monthly income of USD 2,580, above which there was no further increase in risk perception. Additionally, participants from the traditional market had less familiarity with labeling and lower risk perception than those in the other purchase places.

Association among label knowledge, risk perception, and purchase intention of traceable foods. Label knowledge, risk perception, and purchase intention of participants significantly differed among age groups, educational levels, and purchase places (Table 2). Risk perception associated with labeling was significantly affected as well by educational level and label knowledge ($P < 0.05$). Risk perception associated with brands was

TABLE 1. *Descriptive analysis of the food traceability system questionnaires from 290 participants*

Category	No. (%)
Gender	
Male	30 (10.3)
Female	14 (100)
Age (yr)	
21–30	34 (11.7)
31–40	58 (20.0)
41–50	68 (23.4)
51–65	107 (36.9)
Older than 65	23 (7.9)
Occupation	
Student	7 (2.4)
Pubic servant	28 (9.7)
Worker	43 (14.8)
Business and financial operations	26 (9.0)
Service industry	39 (13.4)
Freelancer	17 (5.9)
Housewife	106 (36.6)
Retired	23 (7.9)
Other	1 (0.3)
Education level	
Elementary school	20 (6.9)
Junior high school	27 (9.3)
Senior high school	78 (26.9)
Bachelor's degree or equivalent	136 (46.9)
Post bachelor's degree	28 (9.7)
Income (New Taiwan Dollars [NTD])	
None	71 (24.5)
<20,000	44 (15.2)
20,000–40,000	109 (37.6)
40,000–60,000	43 (14.8)
60,000–80,000	18 (6.2)
>80,000	4 (1.4)
Marital status	
Never married	50 (17.2)
Married with no children	35 (12.1)
Married with minor children	72 (24.8)
Married with adult children	125 (43.1)
Divorced	6 (2.1)
Widowed	2 (0.7)
Purchase place	
Traditional market	158 (54.1)
Supermarket	97 (33.2)
Hypermarket	21 (7.2)
Convenience store	14 (4.8)

(marginally) significantly related to age, and label knowledge was assessed through multiple regression analysis (Table 3). The regression model also showed a significant association among participant purchase intention, educational level, and degree of risk perception associated with labeling ($P < 0.05$). Also, structural equation modeling showed a significantly positive relationship among label knowledge, risk perception, and purchase intention (Fig. 2). Thus, purchase intention was positively correlated with label knowledge and was also affected by risk perception, whereas the degree of label knowledge also slightly affected the participants' risk perceptions.

Changes in risk perception and purchase intention after label education. Viewing a short film on food labeling significantly increased participants' label knowledge and purchase intentions but slightly decreased their risk perceptions, although this change was not statistically significant (Table 4). Concerning label knowledge, approximately 70% of the participants changed their answer, and 47.9% improved their label knowledge assessment responses after label education (data not shown). Furthermore, the purchase intention of the participants increased by more than 50% after label education.

Results showed that purchase intention was influenced by age, educational level, label knowledge, risk perception, and film education; among these, film education was most influential, followed by gender and educational level (Table 5). Pretest results showed that only education level and risk perception affected purchase intention at the start of the study. After film education, label education and income became significant factors.

Most influential factor in selecting traceable agro-products. Among the six influencing factors (i.e., price, quality, eco-friendliness, health benefit, appearance, and brand), health benefit was the most important factor, followed by product quality. Appearance and product price were the least important factors for the participants in selecting fresh foods (Fig. 3).

DISCUSSION

Relationship of demographic characteristics with label knowledge, risk perception, and purchase intention. This study found that label knowledge, risk perception, and purchase intention differed significantly according to age groups, education levels, and purchase places. In particular, younger participants had a greater knowledge of traceable labels, presumably due to their greater use of the internet and social media. Increased education levels correlated with greater understanding of label information. These observations agree with those of Henderson et al. *(18),* who reported that age and education level were significantly associated with trust in food factors, especially in young people who found the media least trustworthy. Findings also implied that participants with a higher income were more capable of avoiding risks. However, an intervention through purchase promotions for healthy choices in low-income urban areas was shown to improve intentions in making healthy food choices via shelf labeling *(14)*. A nationwide survey using the random parameter logit model was used to evaluate the influence of food labeled "genetically modified" on U.S. consumers' willingness to pay for these products *(30)*. Likewise, another study examined consumer willingness to accept milk based on whether or not it was represented to come from cloned cows. The survey revealed a low level of knowledge,

TABLE 2. *Differences in scores relevant to label knowledge, risk perception, and purchase intention by different demographic data*[a]

	n	Label knowledge	Risk perception: labeling	Risk perception: brand	Purchase intention
Age group (yr)					
21–30	34	17.1 (2.58)*[b]	26 (2.83)*	12.7 (2.04)*	7.94 (2.44)*
31–40	58	17.4 (2.17)	26.9 (2.71)	13 (1.65)	8.74 (2.27)
41–50	68	16.9 (2.20)	25.6 (2.84)	12 (1.79)	8.07 (2.93)
51–65	107	16.5 (2.34)	25.5 (2.91)	12.2 (1.52)	7.68 (2.94)
Older than 65	23	15.0 (2.98)	23 (3.83)	11.2 (1.96)	5.78 (2.75)
Purchase place					
Traditional market	158	16.2 (2.47)*	25.2 (3.12)*	12.1 (1.79)	7.24 (3)*
Supermarket	97	17.3 (2.27)	26.3 (2.83)	12.6 (1.7)	8.51 (2.43)
Hypermarket	21	17.4 (2.11)	26.7 (3.15)	12.8 (1.83)	8.29 (2.45)
Convenience store	14	17.6 (1.74)	26.9 (2.43)	12.5 (1.4)	9.86 (1.61)
Educational level					
Elementary school	20	14.85 (2.91)*	23.1 (4.04)*	11.5 (1.1)*	5.05 (2.72)*
Junior high school	27	16.59 (2.1)	24.9 (2.55)	12.4 (1.5)	6.19 (3.13)
Senior high school	78	16.42 (2.2)	25.1 (3)	11.9 (1.87)	7.97 (2.68)
Bachelor's degree or equivalent	136	17.12 (2.5)	26.5 (2.83)	12.6 (1.74)	8.39 (2.6)
Post bachelor's degree	28	16.93 (1.9)	26.5 (2.44)	12.9 (1.74)	8.71 (2.29)

[a] Mean and standard deviation (in parentheses).
[b] * $P < 0.05$ by chi-square test.

including neutral opinions about animal cloning; this suggests that providing appropriate education and information can easily shape consumer opinion to either support or oppose cloning technologies *(4)*. Labeling was found to be an important factor influencing consumer willingness to accept a food choice. Thus, labeling and packaging was proposed to contribute to consumer perception and purchase intention toward functional milks *(1)*. These parameters were in addition to price and brand, which strongly affected consumer behavior patterns in selecting meats in shops *(11)*. Additionally, it has been suggested that individual characteristics and educational levels were significantly associated with consumer risk perception scores *(19, 34),* including their purchase intentions *(19)*. Likewise, brand was an important factor influencing risk perception *(22)*. Shih and Hsu *(39)* found that as incomes increased, the awareness of risk among food workers also increased.

Relationships among label knowledge, risk perception, and purchase intention. Our research found that purchase intention was significantly influenced by the risk perception for labeling and was marginally influenced by label knowledge. Another study reported that consumer knowledge was significantly and positively correlated with purchase intention in the health care product market *(2)*. Furthermore, an investigation that assessed consumer attitudes toward processed meat showed a positive preference for natural meat over that with chemical additives based on risk consideration *(19)*. An evaluation of the influence of labels on purchase intention of wine consumers *(9)* in making healthy food choices *(14)* based on a product's nutritional information showed no shift in adults' purchase intentions *(15)*. A study in Belgium additionally reported that pleasure value, symbolic value, risk importance, and risk probability were important factors in the selection of fresh meat *(40)*.

TABLE 3. *Associations among purchase intention, label knowledge, risk perception, and demographic variables by multiple linear regression analysis*[a]

Dependent variable	Independent variable	β coefficient	*P* value
Label knowledge ($R^2 = 0.326$)	Age	−0.014	0.229
	Education level	−0.003	0.952
	Income	<0.0001	0.455
Risk perception: labeling ($R^2 = 0.353$)	Education level	0.026	<0.001**
	Label knowledge	0.467	<0.001**
Risk perception: brand ($R^2 = 0.207$)	Age	−0.013	0.056
	Label knowledge	0.461	<0.001**
Purchase intention ($R^2 = 0.201$)	Education level	0.115	<0.001**
	Label knowledge	0.336	0.101
	Risk perception: labeling	0.798	<0.001**

[a] The results were given by stepwise regression models.
[b] ** $P < 0.001$.

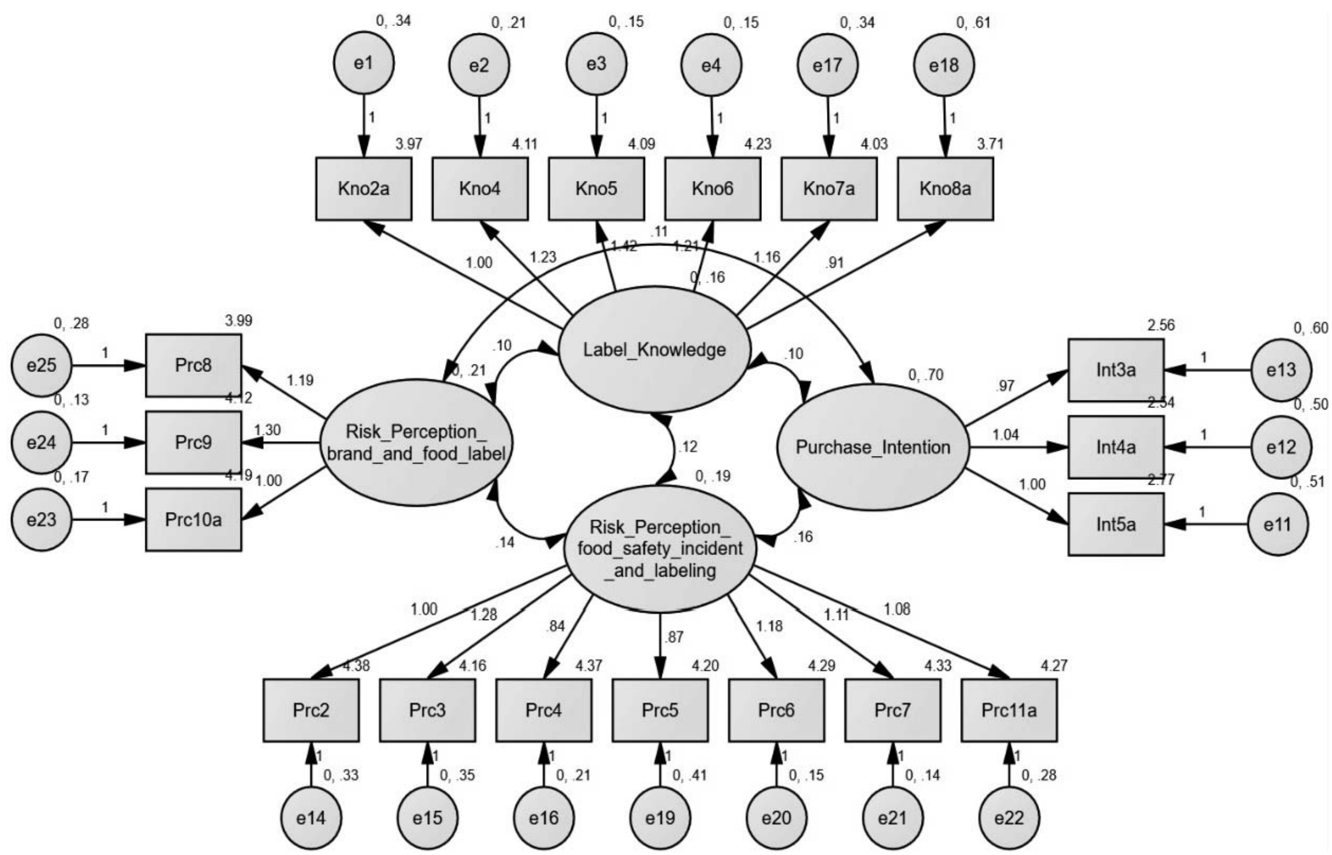

FIGURE 2. *The structural equation model of pretest study.*

Influencing factors in food selection. Consumers' levels of nutritional knowledge influence their selection of processed foods *(43)*. Likewise, studies have shown that misuse of food labeling information causes consumers to become vulnerable, misleading them to have positive attitudes toward particular foods in Singapore *(42)*. A study that recruited participants through Facebook showed that consumers recognized healthier products by looking over their nutritional fact tables; however, these consumers cared more about global quality levels than the nutritional values of the products they purchased *(43)*. A study of college students showed that star-based labeling gave healthy foods greater visibility. Nevertheless, nutrition label instructions and labels did not affect purchase intentions *(24)*. Similarly, the above study reported food labeling as an obvious factor that influences consumers' selection of foods. However, the influence of labels on purchase intention varied by age, as reported also in our study.

TABLE 4. *Pretest and posttest differences after label education*

	Pretest	Posttest	Mean difference	SD	*P* value
Label knowledge	4.29	5.01	0.109	1.86	<0.001*[a]
Risk perception	8.46	8.41	0.07	1.15	0.477
Purchase intention	7.86	9.27	0.141	2.40	<0.001*

[a] * $P < 0.001$.

One study explored how media communication affected consumers' food safety recognition and consumer behavior *(22)*. Another study found that TV and radio programs were important media for sharing knowledge of food safety with consumers in Turkey *(8)*. Significant covariation has been observed among attitudes, knowledge, information perception, food labeling, behavior, and subjective norms in several studies *(3, 10, 26, 28, 32, 44, 45)*. Furthermore, knowledge and attitudes toward food safety should focus on improving producers' control of

TABLE 5. *Associations among purchase intention, label knowledge, and risk perception after label education by generalized estimating equation analysis*

Purchase intention	β	SD	*P* value
(Constant)	1.705	1.554	0.273
Education—no vs. yes	−1.332	0.163	<0.001**[a]
Gender	0.827	0.439	0.060
Age	−0.011	0.012	0.384
Occupation	0.014	0.055	0.802
Education level	0.106	0.046	0.021*
Income	<0.001	<0.001	0.037*
Marital status	0.083	0.117	0.476
Purchase place	0.265	0.157	0.091
Label knowledge	0.110	0.072	0.124
Risk perception—labeling	0.102	0.046	0.027*
Risk perception—brand	0.066	0.083	0.428

[a] * $P < 0.05$; ** $P < 0.001$.

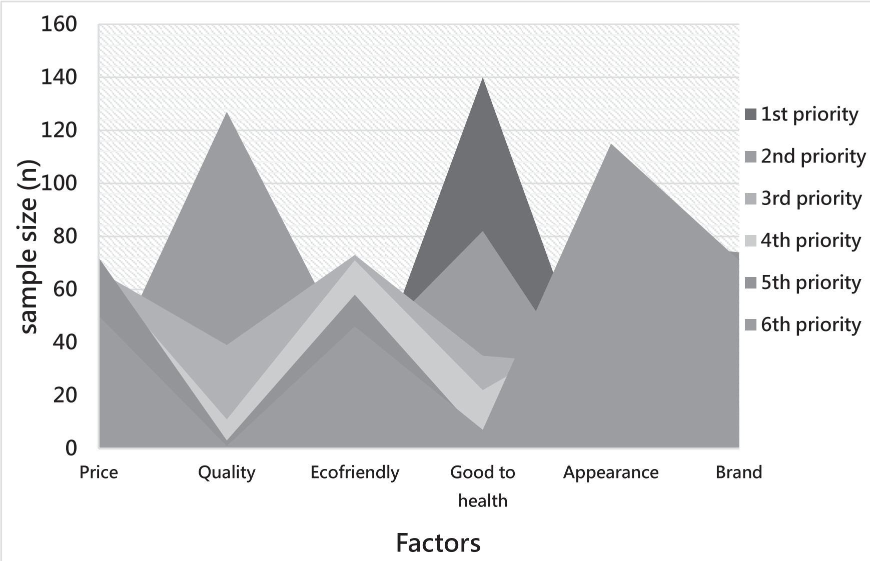

FIGURE 3. *The priority of consumer choice.*

Campylobacter and *Salmonella* in broiler chicken flocks by continuing education *(49)*. This study found risk perception to be a less important factor in the purchase intention of consumers. Based on the purchase behavior findings, we believe that this parameter can be significantly improved after label education, which is consistent with the results of Liu and Lee *(22)*.

Studies have shown that education and the presence of food traceable labels can help consumers select healthy foods *(15, 20, 23)*. Therefore, although many people have now started to pay attention to food safety in the hope of providing themselves and their families with healthier and safer meals, the price of food remains an influential factor in food choices *(6, 21, 47)*. However, this study showed that health benefits and product quality were the most important priorities of consumers. Likewise, a previous review article showed that food quality and safety were central issues that related to consumer perception and demand *(16),* whereas the appearance and price of products were least important. Consequently, consumers should understand the information provided in food labels. Also, as Thomas and Feng *(40)* mentioned, trusted sources of information increased risk perception, thereby causing consumers to adopt good behavior during the COVID-19 pandemic.

Based on the above results, we conclude that efforts should be aimed at consumer education through quality improvement, traceability, labeling, and communication. Our findings are in agreement with current research on the association of purchase intention with label knowledge and risk perception.

We note two limitations in our study: (i) the responses from the questionnaire were affected by the food safety issue and (ii) participants of this study were mainly food purchasers in Tainan. Therefore, although population density was used as a grouping indicator, it still did not represent the subjects of other counties and cities. Hence, it is recommended that future studies expand the research scope, thereby making the results more representative for the Taiwan population.

This study found that film education significantly improved participants' label knowledge and purchase intentions but had less effect on their risk perceptions. Moreover, participants' age, educational level, income, and risk perception significantly affected their purchase intention. An increased understanding of traceable food labels and a higher perception of food risks was found to increase consumer willingness to purchase labeled foods. Therefore, to increase public trust in the food traceability system, a rigorous application of traceable food labels and an increased frequency of irregular sampling are needed. Additionally, the food industry should gradually integrate labels and upload production information to improve the food traceability system. This study successfully used an educational film to improve label knowledge and purchase intention. Development of suitable risk communication strategies to improve labeling knowledge among different age groups, including steps to encourage the sale of labeled foods in traditional markets, would be important strategies in the future.

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SUPPLEMENTAL MATERIAL

Supplemental material associated with this article can be found online at: https://doi.org/10.4315/JFP-21-160.s1

REFERENCES

1. Ares, G., M. Besio, A. Gimenez, and R. Deliza. 2010. Relationship between involvement and functional milk desserts intention to purchase. Influence on attitude towards packaging characteristics. *Appetite* 55:298–304.
2. Ateke, B., and D. James. 2018. Consumer knowledge and purchase intention of healthcare product consumers in Rivers State. *J. Bus. Law Res*. 6:1–7.

3. Balzan, S., L. Fasolato, B. Cardazzo, C. Penon, and E. Novelli. 2017. Genuine and natural: the opinion of teen consumers. *Ital. J. Food Saf*. 6:6183.
4. Britwum, K., and J. Bernard. 2018. A field experiment on consumer willingness to accept milk that may have come from cloned cows. *Food Policy* 74:1–8.
5. Chang, F. C., M. J. Tsai, and C. H. Ko. 2018. Agricultural waste derived fuel from oil meal and waste cooking oil. *Environ. Sci. Pollut. Res. Int*. 25:5223–5230.
6. Chang, T. Z., and A. R. Wildt. 1994. Price, product information, and purchase intention: an empirical study. *Environ. Sci. Pollut. Res. Int*. 22:16–27.
7. Covin, J. G., and M. P. Miles. 1999. Corporate entrepreneurship and the pursuit of competitive advantage. *Entrep. Theory Pract*. 23:47–63.
8. Ergönül, B. 2013. Consumer awareness and perception to food safety: a consumer analysis. *Food Control* 32:461–471.
9. Escandon-Barbosa, D., and J. Rialp-Criado. 2018. The impact of the content of the label on the buying intention of a wine consumer. *Front. Psychol*. 9:2761.
10. Feng, Y., and C. M. Bruhn. 2019. Motivators and barriers to cooking and refrigerator thermometer use among consumers and food workers: a review. *J. Food Prot*. 82:128–150.
11. Font-i-Furnols, M., and L. Guerrero. 2014. Consumer preference, behavior and perception about meat and meat products: an overview. *Meat Sci*. 98:361–371.
12. Frewer, L. J., R. Shepherd, and P. Sparks. 1994. The interrelationship between perceived knowledge, control and risk associated with a range of food-related hazards targeted at the individual, other people and society. *J. Food Saf*. 14:19–40.
13. Ghosh, P., D. Dasgupta, and D. Ghosh. 1990. Retail management, 2nd ed. Dryden Press, Chicago.
14. Gittelsohn, J., H. J. Song, S. Suratkar, M. B. Kumar, E. G. Henry, S. Sharma, M. Mattingly, and J. A. Anliker. 2010. An urban food store intervention positively affects food-related psychosocial variables and food behaviors. *Health Educ. Behav.* 37:390–402.
15. Gorski Findling, M. T., P. M. Werth, A. A. Musicus, M. A. Bragg, D. J. Graham, B. Elbel, and C. A. Roberto. 2018. Comparing five front-of-pack nutrition labels' influence on consumers' perceptions and purchase intentions. *Prev. Med*. 106:114–121.
16. Grunert, K. G. 2005. Food quality and safety: consumer perception and demand. *Eur. Rev. Agric. Econ*. 32:369–391.
17. Hansen, J., L. Holm, L. Frewer, P. Robinson, and P. Sandoe. 2003. Beyond the knowledge deficit: recent research into lay and expert attitudes to food risks. *Appetite* 41:111–121.
18. Henderson, J., J. Coveney, P. R. Ward, and A. W. Taylor. 2011. Farmers are the most trusted part of the Australian food chain: results from a national survey of consumers. *Aust. N. Z. J. Public Health* 35:319–324.
19. Hung, Y., T. M. de Kok, and W. Verbeke. 2016. Consumer attitude and purchase intention towards processed meat products with natural compounds and a reduced level of nitrite. *Meat Sci*. 121:119–126.
20. Khandpur, N., P. de Morais Sato, L. A. Mais, A. P. Bortoletto Martins, C. G. Spinillo, M. T. Garcia, C. F. Urquizar Rojas, and P. C. Jaime. 2018. Are front-of-package warning labels more effective at communicating nutrition information than traffic-light labels? A randomized controlled experiment in a Brazilian sample. *Nutrients* 10:E688. https://doi.org/610.3390/nu10060688
21. Lange, C., P. Combris, S. Issanchou, and P. Schlich. 2015. Impact of information and in-home sensory exposure on liking and willingness to pay: the beginning of Fairtrade labeled coffee in France. *Food Res. Int*. 76:317–324.
22. Liu, H. L., and J. S. Lee. 2014. The effect of media communication on the food safety cognition and the consuming behaviors. Master's thesis. Taiwan.
23. Liu, R., N. H. Hooker, E. Parasidis, and C. T. Simons. 2017. A natural experiment: using immersive technologies to study the impact of "all-natural" labeling on perceived food quality, nutritional content, and liking. *J. Food Sci*. 82:825–833.
24. Lundeberg, P. J., D. J. Graham, and G. S. Mohr. 2018. Comparison of two front-of-package nutrition labeling schemes, and their explanation, on consumers' perception of product healthfulness and food choice. *Appetite* 125:548–556.
25. McEvoy, J. D. 2016. Emerging food safety issues: an EU perspective. *Drug Test. Anal*. 8:511–520.
26. McLean, K. G., D. J. Hanson, S. M. Jervis, and M. A. Drake. 2017. Consumer perception of retail pork bacon attributes using adaptive choice-based conjoint analysis and maximum differential scaling. *J. Food Sci*. 82:2659–2668.
27. Mitchell, V. W. 1990. Consumer perceived risk in the UK food market. *Br. Food J*. 92:16–22.
28. Mitra, K., M. C. Reiss, and L. M. Capella. 1999. An examination of perceived risk, information search and behavioral intentions in search, experience and credence services. *J. Serv. Mark*. 13:208–228.
29. O'Connor, R. J., M. J. Lewis, S. E. Adkison, M. Bansal-Travers, and K. M. Cummings. 2017. Perceptions of "natural" and "additive-free" cigarettes and intentions to purchase. *Health Educ. Behav.* 44:222–226.
30. Onyango, B., R. M. Nayga, and R. Govindasamy. 2016. U.S. consumers' willingness to pay for food labeled "genetically modified." *Agric. Resour. Econ. Rev.* 35:299–310.
31. Pang, S. M., B. C. Tan, and T. C. Lau. 2021. Antecedents of consumers' purchase intention towards organic food: integration of theory of planned behavior and protection motivation theory. *Sustainability* 13:5218.
32. Pao, C. F. L., and Kai-Li. 2014. A study of awareness and labeling of GM foods on consumers' purchase intention: the case of Miaoli County elementary schools' teachers. Master's thesis. Taiwan.
33. Roberto, C. A., M. Shivaram, O. Martinez, C. Boles, J. L. Harris, and K. D. Brownell. 2012. The Smart Choices front-of-package nutrition label. Influence on perceptions and intake of cereal. *Appetite* 58:651–657.
34. Rosati, S., and A. Saba. 2004. The perception of risks associated with food-related hazards and the perceived reliability of sources of information. *Int. J. Food Sci. Technol*. 39:491–500.
35. Sake, F. T., K. Wong, D. J. Bartlett, and B. Saini. 2018. Benzodiazepine use risk: understanding patient specific risk perceptions and medication beliefs. *Res. Social Adm. Pharm*. 15:1317–1325.
36. Schermelleh-Engel, K., H. Moosbrugger, and H. Müller. 2003. Evaluating the fit of structural equation models: tests of significance and descriptive goodness-of-fit measures. *Methods Psychol. Res*. 8:23–74.
37. Schiffman, L. G., and L. L. Kanuk. 2000. Consumer behavior, 7th ed. Prentice Hall, Upper Saddle River, NJ.
38. Shepherd, R., and M. Raats. 1996. Attitude and beliefs in food habits, p. 346–364. *In* H. Meiselman and H. MacFie (ed.), Food choice, acceptance and consumption. Blackie Academic & Professional, London.
39. Shih, Y.-J., and S.-L. Hsu. 2016. A study on food service employee's cognition, attitude, and behavior toward food safety. Master's thesis. Taiwan.
40. Thomas, M. S., and Y. Feng. 2021. Consumer risk perception and trusted sources of food safety information during the COVID-19 pandemic. *Food Control* 108279.
41. Verbeke, W., and I. Vackier. 2004. Profile and effects of consumer involvement in fresh meat. *Meat Sci*. 67:159–168.
42. Vijaykumar, S., M. O. Lwin, J. Chao, and C. Au. 2013. Determinants of food label use among supermarket shoppers: a Singaporean perspective. *J. Nutr. Educ. Behav.* 45:204–212.
43. Viola, G. C., F. Bianchi, E. Croce, and E. Ceretti. 2016. Are food labels effective as a means of health prevention? *J. Public Health Res*. 5:768.
44. Walters, A., and M. Long. 2012. The effect of food label cues on perceptions of quality and purchase intentions among high-involvement consumers with varying levels of nutrition knowledge. *J. Nutr. Educ. Behav.* 44:350–354.

45. Wu, L., Y. Zhong, L. Shan, and W. Qin. 2013. Public risk perception of food additives and food scares. The case in Suzhou, China. *Appetite* 70:90–98.
46. Wu, M. T., C. F. Wu, J. R. Wu, B. H. Chen, E. K. Chen, M. C. Chao, C. K. Liu, and C. K. Ho. 2012. The public health threat of phthalate-tainted foodstuffs in Taiwan: the policies the government implemented and the lessons we learned. *Environ. Int*. 44:75–79.
47. Wu, W. Y., P. C. Huang, and C. S. Fu. 2011. The influence of an online auction's product price and e-retailer reputation on consumers' perception, attitude, and behavioral intention. *Scand. J. Psychol*. 52:290–302.
48. Yen, T. H., D. T. Lin-Tan, and J. L. Lin. 2011. Food safety involving ingestion of foods and beverages prepared with phthalate-plasticizer-containing clouding agents. *J. Formos. Med. Assoc*. 110:671–684.
49. Young, I., A. Rajic, A. Letellier, B. Cox, M. Leslie, B. Sanei, and S. A. McEwen. 2010. Knowledge and attitudes toward food safety and use of good production practices among Canadian broiler chicken producers. *J. Food Prot*. 73:1278–1287.