
**FOOD AND NUTRITION
AT RISK IN AMERICA:
FOOD INSECURITY,
BIOTECHNOLOGY, FOOD SAFETY,
AND BIOTERRORISM**

Sari Edelstein, PhD, RD
Department of Nutrition
Simmons College

Bonnie L. Gerald, PhD, DTR
Department of Nutrition and Food Systems
University of Southern Mississippi

Tamara M. Crutchley Bushell, PhD
Department of Microbiology
University of Alabama at Birmingham

Craig Gundersen, PhD
Human Development and Family Studies Department
Iowa State University

With Preface by: Alison Harmon, PhD, RD, LN
Health and Human Development
Montana State University



JONES AND BARTLETT PUBLISHERS

Sudbury, Massachusetts

BOSTON TORONTO LONDON SINGAPORE

World Headquarters

Jones and Bartlett Publishers
40 Tall Pine Drive
Sudbury, MA 01776
978-443-5000
info@jbpub.com
www.jbpub.com

Jones and Bartlett Publishers
Canada
6339 Ormindale Way
Mississauga, Ontario L5V 1J2
Canada

Jones and Bartlett Publishers
International
Barb House, Barb Mews
London W6 7PA
United Kingdom

Jones and Bartlett's books and products are available through most bookstores and online booksellers. To contact Jones and Bartlett Publishers directly, call 800-832-0034, fax 978-443-8000, or visit our website www.jbpub.com.

Substantial discounts on bulk quantities of Jones and Bartlett's publications are available to corporations, professional associations, and other qualified organizations. For details and specific discount information, contact the special sales department at Jones and Bartlett via the above contact information or send an email to specialsales@jbpub.com.

Copyright © 2009 by Jones and Bartlett Publishers, LLC

All rights reserved. No part of the material protected by this copyright may be reproduced or utilized in any form, electronic or mechanical, including photocopying, recording, or by any information storage and retrieval system, without written permission from the copyright owner.

This publication is designed to provide accurate and authoritative information in regard to the Subject Matter covered. It is sold with the understanding that the publisher is not engaged in rendering legal, accounting, or other professional service. If legal advice or other expert assistance is required, the service of a competent professional person should be sought.

Production Credits

Publisher: Michael Brown
Production Director: Amy Rose
Associate Editor: Katey Birtcher
Production Editor: Tracey Chapman
Marketing Manager: Sophie Fleck
Manufacturing and Inventory Control
Supervisor: Amy Bacus

Composition: Auburn Associates, Inc.
Cover Design: Brian Moore
Cover Image: © Matthew Collingwood/
Shutterstock, Inc.; © Elena Elisseeva/
Shutterstock, Inc.; © Kang Khoon
Seang/Shutterstock, Inc.
Printing and Binding: Malloy, Inc.
Cover Printing: Malloy, Inc.

Library of Congress Cataloging-in-Publication Data

Food and nutrition at risk in America: food insecurity, biotechnology, food safety, and bioterrorism / Sari Edelstein ... [et al].

p.; cm.

Includes bibliographical references and index.

ISBN-13: 978-0-7637-5408-2 (pbk.)

ISBN-10: 0-7637-5408-0 (pbk.)

1. Food—United States—Safety measures. 2. Food contamination—United States. 3. Food—Biotechnology. 4. Foodborne diseases—United States. 5. Bioterrorism. I. Edelstein, Sari.

[DNLM: 1. Food Industry—United States. 2. Safety Management—United States. 3. Bioterrorism—United States. 4. Food Contamination—United States. 5. Food Supply—economics—United States. 6. Food, Genetically Modified—United States. 7. Hunger—United States. WA 695 F68621 2009] RA601.F655 2009 363.19'26—dc22

2008006663

6048

Printed in the United States of America

12 11 10 09 08 10 9 8 7 6 5 4 3 2 1

DEDICATION

To my husband, Marc, and my children, Staci, Jodi, and Sebastien.
Sari Edelstein

*To my husband Mike, my parents Peter and Charlotte Hackes,
and my brother Lee Miller.*
Bonnie Gerald

To my husband, Christian.
Tamara M. Crutchley Bushell

To my wife, Lisa, and my children, Diego, Faith, and Van.
Craig Gundersen

*Thanks to: Mike Brown, Katey Birtcher, Tracey Chapman,
and Dawn Browder.*

CONTENTS

List of Tables	xi
List of Figures	xiii
Foreword	xv
Chapter 1: Is America at Risk?	1
<i>Sari Edelstein, PhD, RD</i>	
Food Safety	2
Biotechnology and Genetically Modified Foods	5
Food Insecurity	6
Agro/Bioterrorism	7
Section One: Food Safety and Biotechnology	13
Chapter 2: Foodborne Illness-Causing Pathogens	15
<i>Bonnie L. Gerald, PhD, DTR</i>	
Types of Pathogens: Bacteria	18
Bacterial Infection: <i>Listeria monocytogenes</i>	18
Bacterial Infection: <i>Salmonella</i> spp.	19
Bacterial Infection: <i>Shigella</i> spp.	19
Bacterial Infection: <i>Streptococcus pyogenes</i>	20
Bacterial Infection: <i>Yersinia enterocolitica</i>	20
Bacterial Intoxication: <i>Clostridium botulinum</i>	21
Bacterial Intoxication: <i>Clostridium perfringens</i>	21
Bacterial Intoxication: <i>Bacillus cereus</i>	22
Bacterial Intoxication: <i>Staphylococcus aureus</i>	22
Bacterial Intoxication: <i>Escherichia coli</i>	23
Bacterial Infection: <i>Campylobacter jejuni</i>	23
Bacterial Intoxication: <i>Vibrio vulnificus</i> , <i>Vibrio parahaemolyticus</i>	24
Types of Pathogens: Viruses	25
Viral Gastroenteritis: <i>Norovirus</i>	25
Viral Gastroenteritis: <i>Rotavirus</i>	26
Viral Infections: Hepatitis A Virus (HAV)	26
Types of Pathogens: Parasites	27
Parasitic Roundworms: <i>Trichinella spiralis</i>	27

	Parasitic Roundworms: <i>Anisakis simplex</i> and <i>Pseudoterranova decipiens</i>	28
	Parasitic Protozoa: <i>Giardia lamblia</i>	28
	Parasitic Protozoa: <i>Cryptosporidium parvum</i>	29
	Parasitic Protozoa: <i>Cyclospora cayetanensis</i>	29
	Parasitic Protozoa: <i>Toxoplasma gondii</i>	30
	Emerging Pathogens	32
	Emerging Pathogens: Prions	32
	Emerging Pathogens: Avian Influenza	34
	Emerging Pathogens: Brainerd Diarrhea	34
	Resources	35
Chapter 3:	Safety Issues in the US Food System	41
	<i>Bonnie L. Gerald, PhD, DTR</i>	
	The Food System: Climate	42
	The Food System: Soil	43
	The Food System: Water	43
	The Food System: Animals and Fish	44
	The Food System: Plants	46
	The Food System: Fungi	47
	Gastrointestinal Irritants	47
	Neurotoxins	47
	Protoplasm	48
	Disulfiram-Like Intoxications	48
	Aflatoxin	49
	Yeasts and Molds	49
	The Food System: Raw Ingredient to Food	50
	Harvesting	50
	Processing	51
	Transport and Distribution	51
	Receiving and Storage	52
	Food Production and Service	52
Chapter 4:	Food Safety Regulations and Programs	57
	<i>Bonnie L. Gerald, PhD, DTR</i>	
	Traditional Inspection and Recalls	59
	Recalls	60
	Food Safety Controls	61
	Food Safety Management Systems	62
	Import Regulations	64
	Private Food Standards	65

Chapter 5:	Future Food Safety Initiatives and Biotechnology	71
	<i>Bonnie L. Gerald, PhD, DTR</i>	
	Farm-to-Fork System	72
	Transparency	74
	Public and Private Initiatives	75
	Primary Packaging Initiatives	77
	Packaging—Passive	77
	Packaging—Active	79
	Other Food Safety Processing Methods	80
	Edible Coatings	80
	Thermal Processing	81
	Irradiation	81
	Nanotechnology	83
	Biotechnology	83
	National and International Food Safety Initiatives	84
Section Two:	Food Insecurity	91
Chapter 6:	The Measurement of Food Insecurity in the United States	93
	<i>Craig Gundersen, PhD</i>	
	Background	94
	History of the Measurement of Food Insecurity	94
	The Measurement of Food Insecurity	96
	Food Insecurity in the United States	103
	Measuring the Extent, Depth, and Severity of Food Insecurity in the United States	107
Chapter 7:	The Determinants of Food Insecurity in the United States	113
	<i>Craig Gundersen, PhD</i>	
	Characteristics of the Food Insecure in the United States	114
	Determinants of Food Insecurity in the United States	120
	Dynamic Determinants of Food Insecurity	121
	State-Level Determinants of Food Insecurity	121
	Effects of Income and Work Changes on Food Insecurity	123
	Social Capital and Food Insecurity	123
	Food Insecurity among the Homeless	124
	Food Insecurity among Pregnant Women	125
	Determinants of Food Insecurity among the Elderly	127

Chapter 8:	The Consequences of Food Insecurity in the United States	131
	<i>Craig Gundersen, PhD</i>	
	Descriptions of the Differences in Health Outcomes by Food Insecurity Status for Children in the United States	132
	Studies of the Consequences of Food Insecurity in the United States	139
	Dietary Intakes by Food Insecurity Status	139
	Effects of Food Insecurity on Birth Outcomes	140
	Effects of Food Insecurity on Child Health Outcomes	141
	Effects of Food Insecurity on Depression and Anxiety	141
	Food Insecurity and Child Behaviors	142
	Is There a Relationship between Food Insecurity and Childhood Obesity?	142
Chapter 9:	Food Assistance Programs in the United States	149
	<i>Craig Gundersen, PhD</i>	
	Food Stamp Program	150
	History	151
	Eligibility Criteria	152
	Nonparticipation by Eligible Persons	154
	The Special Supplemental Nutrition Program for Women, Infants, and Children (WIC)	155
	History	155
	Eligibility Criteria	156
	Research on the Benefits of WIC	157
	National School Lunch Program	157
	History	158
	Eligibility Criteria	158
	National School Breakfast Program	159
	History	159
	Eligibility Criteria	160
	The Emergency Food Assistance Program (TEFAP)	161
	History	161
	Eligibility Criteria	161
	Section Three: Food and Bioterrorism	167
Chapter 10:	Intentional and Unintentional Contamination of the Food Supply	169
	<i>Tamara M. Crutchley Bushell, PhD</i>	
	Key Vulnerabilities in the Food Supply	170

Recognition of Foodborne Illnesses Associated with Intentional Contamination	174
Cases of Intentional Contamination Involving Food Items in the United States	175
Intentional Acts of Contamination Perpetrated by Two or More Individuals	176
Intentional Acts of Contamination Perpetrated by One Individual	178
Intentional Acts of Contamination by Unknown Perpetrator(s)	180
Naturally Occurring Foodborne Disease in the United States	181
Reporting of Foodborne Disease Outbreaks (FBDOs) in the United States	181
Foodborne Disease Outbreaks (FBDOs) Caused by Unintentional Contamination	184
Foodborne Disease Outbreaks (FBDOs) in the United States Between 1983 and 2006	184
Chapter 11: Key Issues Associated with Foodborne Disease Outbreaks	211
<i>Tamara M. Crutchley Bushell, PhD</i>	
Food Safety Begins on the Farm	214
Significance of Pathogen Carriage in Livestock, Poultry, and Crops	215
Significance of Pathogen Carriage in Crops	217
Antimicrobial Resistance	219
Globalization of the Food Supply	224
Fresh Produce and Globalization	225
Fish/Seafood and Globalization	226
Federal Oversight of Surveillance and Regulatory Control	227
Federal Oversight	228
Regulatory Enforcement Authority	230
Federal Expenditures on Food Safety Activities	231
Surveillance	232
Federal Recall Authority	232
Chapter 12: Principles and Application of the Hazard Analysis and Critical Control Points	243
<i>Tamara M. Crutchley Bushell, PhD</i>	
The Seven HACCP Principles	246
Guidelines for the Application of the HACCP System	249

Logic Sequence for Application of HACCP	250
HACCP and Regulatory Oversight	255
The USDA and HACCP	256
The FDA and HACCP	259
Juice HACCP	259
Seafood HACCP	262
International HACCP Alliance	265
The Food and Agriculture Organization of the United Nations (FAO) and the World Health Organization (WHO)	266
Chapter 13: US Food Safety and Bioterrorism	271
<i>Tamara M. Crutchley Bushell, PhD</i>	
What Government Agencies Are Doing to Improve Food Safety	273
What Academic Institutions Are Doing to Improve Food Safety	283
What the Food Industry Is Doing to Improve Food Safety	289
Index	299

LIST OF TABLES

- Table 1.1 Average Annual Hospitalizations and Deaths for Gastrointestinal Illness by Diagnostic Category, National Hospital Discharge Survey, 1992 to 1996
- Table 1.2 Summary of Inventory for Federal Food Safety Research
- Table 1.3 Percentage of Respondents Identifying Each Pathogen as among the Top Three Causes of Foodborne Illness and Estimated Percentage of Foodborne Illnesses in the United States Actually Caused by Those Pathogens
- Table 2.1 Foods Implicated with Foodborne Illness
- Table 2.2 Foodborne Illnesses
- Table 2.3 Federal Agencies and Web Sites with Food Safety Responsibilities
- Table 4.1 Federal Agency Food Safety Responsibilities
- Table 5.1 Primary Packaging
- Table 5.2 Genetically Modified Food Products: Benefits and Controversies
- Table 6.1 Food Insecurity Questions in the Core Food Security Module
- Table 6.2 Food Insecurity for American Indians and Non-American Indians
- Table 6.3 Food Insecurity for American Indians and Non-American Indians, Households with Incomes Below 185% of the Poverty Line
- Table 10.1 Foodborne Illness Outbreaks

LIST OF FIGURES

- Figure 1.1 Relative Rates Compared with 1996 to 1998 Baseline Period of Laboratory-Diagnosed Cases of Infection with *Campylobacter*, *Escherichia coli* O157, *Listeria*, *Salmonella*, and *Vibrio*, by Year—Foodborne Diseases Active Surveillance Network, United States, 1996 to 2004
- Figure 1.2 Relative Rates Compared with 1996 to 1998 Baseline Period of Laboratory-Diagnosed Cases of Infection with the Five Most Commonly Isolated *Salmonella* Serotypes, by Year—Foodborne Diseases Active Surveillance Network, United States, 1996 to 2004
- Figure 1.3 Traditional Plant Breeding and Modern Plant Breeding (Genetic Engineering)
- Figure 1.4 Top Three Genetically Engineered Crops in the United States (2003)
- Figure 1.5 US Households by Security Status, 2002
- Figure 5.1 Farm to Fork
- Figure 6.1 Food Insecurity Rates, 2001 to 2005
- Figure 6.2 Food Insecurity Rates, Households with Children, 2001 to 2005
- Figure 6.3 Food Insecurity Rates, Households without Children, 2001 to 2005
- Figure 6.4 Food Insecurity Rates, Incomes <200% of the Poverty Line, 2001 to 2005
- Figure 6.5 Food Insecurity Rates, Incomes <200% of the Poverty Line, Households with Children, 2001 to 2005
- Figure 6.6 Food Insecurity Rates, Incomes <200% of the Poverty Line, Households without Children, 2001 to 2005
- Figure 7.1 Food Insecurity Rates by Income Categories
- Figure 7.2 Food Insecurity Rates by Racial Categories
- Figure 7.3 Food Insecurity Rates by Hispanic Categories
- Figure 7.4 Food Insecurity Rates by Marital Status
- Figure 7.5 Food Insecurity Rates by Home Ownership Status
- Figure 7.6 Food Insecurity Rates by Metropolitan Status

- Figure 7.7 Food Insecurity Rates by Age of Household Head
- Figure 7.8 Food Insecurity Rates by Employment Status of Household Head
- Figure 7.9 Food Insecurity Rates by Region of Country
- Figure 7.10 Food Insecurity Rates by Education Level of Household Head
- Figure 7.11 Food Insecurity Rates by Presence of Children
- Figure 8.1 Percentage of Children with Asthma by Food Insecurity
- Figure 8.2 Percentage of Children with ADD by Food Insecurity Status
- Figure 8.3 Percentage of Children with a Learning Disability by Food Insecurity Status
- Figure 8.4 Percentage of Children with an Ear Infection by Food Insecurity Status
- Figure 8.5 Percentage of Children with a Headache by Food Insecurity Status
- Figure 8.6 Percentage of Children Missing Five or More Days of School by Food Insecurity Status
- Figure 8.7 Percentage of Children Missing 10 or More Days of School by Food Insecurity Status
- Figure 8.8 Percentage of Overweight Children by Food Insecurity Status
- Figure 8.9 Percentage of At Risk of Overweight or Overweight Children by Food Insecurity Status
- Figure 8.10 Percentage of Children in Excellent Health by Food Insecurity Status
- Figure 8.11 Percentage of Children in Excellent or Very Good Health by Food Insecurity Status
- Figure 8.12 Percentage of Children in Excellent, Very Good, or Good Health by Food Insecurity Status
- Figure 12.1 Logic Sequence for the Application of HACCP
- Figure 12.2 Example of Decision Tree to Identify CCPs

FOREWORD

Food seems simple. It is a necessary part of our lives every single day. When abundant, it is easy to take food for granted, but occasionally we are reminded of its importance and its costs. Questions related to food safety, security, and the implications of new technologies are complex ones. Students of food and nutrition, food science, and public health need to be skilled at considering complex questions. Is our food safe? This is a question that is on the minds of many consumers today. Food safety exists on several levels. Is our food free of pathogens? Is our food free of components that increase our risk for chronic disease? Does our food provide adequate amounts of essential nutrients and contain additional compounds that prevent disease and promote health?

Food dangers arise when food is scarce or when not everyone has safe or socially acceptable ways to access food. We need to strive for food security as families, communities, as a nation, and as a global society. There are different approaches to achieving global food security. Should every small village or community be self-reliant, producing food with limited inputs on a small scale? Or should we specialize and trade for foodstuffs, centralizing and industrializing food production and relying on inexpensive fuel to transport it? These strategies are both employed in the world today, as are many scenarios that fall somewhere in between.

The challenge for those in our food and healthcare systems is in determining where to strike a balance for maximum food safety and food security. When news reports tell of product recalls or foodborne illness outbreaks related to the industrial food system, many consumers start looking for food produced closer to home, by people they know. When midwinter limits the variety of local foods or when convenience is perceived as a necessity, consumers are in turn drawn toward the globally and industrially supplied supermarket.

It is easy to appreciate both the freshness and flavor of local food and the variety and convenience of industrial food. Students and professionals alike will be able to critically evaluate the advantages of

each in view of their costs. The industrial food system, for example, has done much to ensure that we have an abundant and affordable supply of food, thus improving the quality of our lives. Which gains have been worth their costs (i.e., costs for the environment; costs for agricultural communities, culture, and traditions; and costs for our long-term public health)?

Understanding food issues entails understanding trade-offs on both personal and societal levels. When does having immediate food safety compromise our long-term health? Does selecting particular vegetable varieties that are durable for transportation compromise the nutrient density and flavor of the food? What intrinsic qualities of food are lost when they are mass produced? How has the mass production of a few crop varieties in monocultures threatened long-term food security, which is dependent on ecological diversity? How have our agricultural advances made the food system vulnerable to interruption by terrorists? When are sustainability, food safety, and food security at odds?

One of the roles for those charged with responsibilities for our food supply and nutritional status is helping individual clients as well as broader populations understand how to make good food choices. Having choices related to food is a blessing when we understand the power they hold. Our food choices determine, in part, how healthy we will be as individuals. They also can affect our communities and the surrounding landscape. Ultimately our food choices will shape the future food system, its safety, and security. What do we value about food? How do our choices enact those values? Food is not so simple after all. This text will be a tool to help educators train future food and nutrition professionals to critically consider complex questions about food safety, food security, food technology, and the food system as a whole. For those already at work in the field, this book will serve as a valuable reference concerning this most critical issue.

Alison Harmon, PhD, RD, LN
Health and Human Development
Montana State University