Human Salmonellosis* and One Health

January 2022

Dr Marc Henninger, DVM
Corporate Affairs Manager
France and MENA GSE

*non-typhoidal

Key Messages

- **Salmonellosis** is the **deadliest foodborne disease** globally and is underestimated
- **Eggs** and egg products are a potential **source for human infection**
- If you are an egg producer, there is a **risk for your brand** and your operations

Investing into an integrated *Salmonella* prevention program focused on controlling SE and ST will support a more sustainable business

PM-EG-22-0021

Objectives

- Describe the **impact of *Salmonella*** to humans, producers and the food chain
- Demonstrate how **comprehensive control programs**, including vaccination, can support sustainability of your business

Outline

1. Why is salmonellosis a **global threat** for public health?
2. Which is the best approach to control *Salmonella* and therefore support a **sustainable business**?

PM-EG-22-0021

1. Why is salmonellosis a global threat for public health?

Foodborne Diseases

- **Foodborne diseases** (FBD) have been an issue for all societies **since the beginning of humanity**
- **Lot of people** are at **risk of falling ill** or even **die every year** as a result of **consuming unsafe food**
- **FBD affect economic development,** particularly challenging the tourism, agricultural industries and international food trade

PM-EG-22-0021

Foodborne Diseases (FBD)

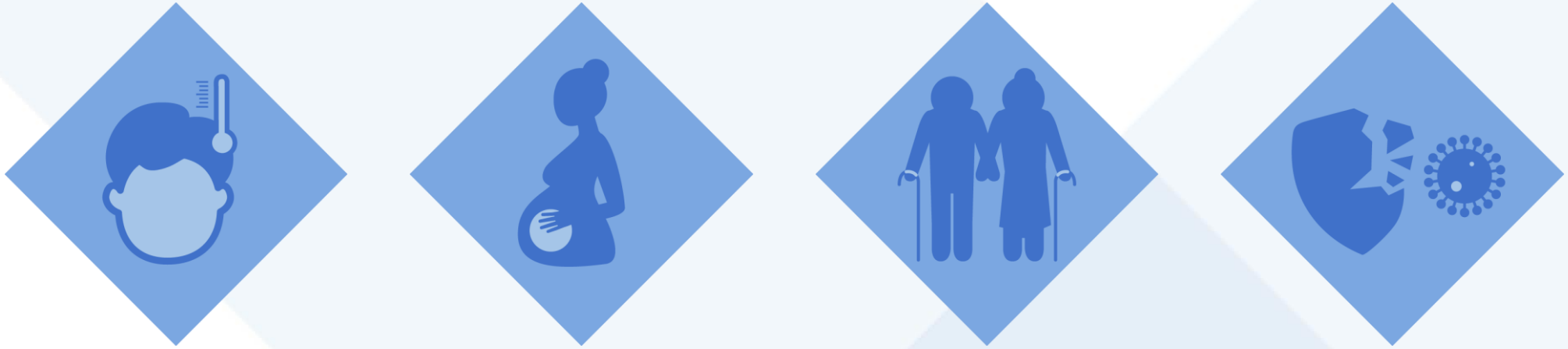
- FBD agents are estimated to cause **600 M illnesses** globally **annually with 420,000 deaths**

- ***Salmonella* causes 59,000 deaths globally**

https://apps.who.int/iris/bitstream/handle/10665/199350/9789241565165_eng.pdf

The Burden of Foodborne Diseases is Substantial

- **FBD affect particularly vulnerable people with weak immune systems**



Children
(40% of the foodborne disease burden is on children under 5 years of age)

Pregnant women

Elderly

Immunocompromised

PM-EG-22-0021

https://apps.who.int/iris/bitstream/handle/10665/199350/9789241565165_eng.pdf

FBD, foodborne disease

Salmonellosis is the Deadliest Foodborne Disease

- ***Salmonella* represents 26% of diarrhoeal deaths**
- Salmonellosis has the highest DALY (1 DALY = 1 healthy life year lost) among all FBD
- New WHO Food Safety Strategy commits to reducing diarrhoeal diseases by 40% by 2030

World Health Organization

HAZARD	FOODBORNE ILLNESSES	FOODBORNE DEATHS	FOODBORNE YLDS	FOODBORNE YLLS	FOODBORNE DALYS
TOTAL	600 652 361 (417 646 804–962 834 044)	418 608 (305 128–598 419)	5 580 028 (4 780 374–8 195 314)	27 201 701 (19 655 451–38 922 210)	32 841 428 (24 809 085–46 274 735)
Diarrhoeal disease agents	548 595 679 (369 976 912–888 528 014)	230 111 (160 039–322 359)	839 463 (644 924–1 123 907)	16 821 418 (11 700 916–23 579 652)	17 659 226 (12 458 675–24 516 338)
Viruses	124 803 946 (70 311 254–251 352 877)	34 929 (15 916–79 620)	91 357 (51 047–174 130)	2 403 107 (1 102 397–5 387 672)	2 496 078 (1 175 658–5 511 092)
Norovirus	124 803 946 (70 311 254–251 352 877)	34 929 (15 916–79 620)	91 357 (51 047–174 130)	2 403 107 (1 102 397–5 387 672)	2 496 078 (1 175 658–5 511 092)
Bacteria	349 405 380 (223 127 469–590 002 559)	187 285 (131 742–254 037)	685 212 (521 848–921 335)	13 795 606 (9 688 221–18 893 580)	14 490 808 (10 303 551–19 681 271)
Campylobacter spp.	95 613 970 (51 731 379–177 239 714)	21 374 (14 604–32 584)	442 075 (322 192–587 072)	1 689 291 (1 141 055–2 652 483)	2 141 926 (1 535 985–3 137 980)
Enteropathogenic *E. coli*– EPEC	23 797 284 (10 750 919–62 931 604)	37 077 (19 957–61 262)	22 977 (9 662–66 211)	2 908 551 (1 574 520–4 833 325)	2 938 407 (1 587 757–4 865 590)
Enterotoxigenic *E. coli*– ETEC	86 502 735 (49 136 952–151 776 173)	26 170 (14 887–43 523)	70 567 (40 134–119 017)	2 011 635 (1 132 331–3 407 273)	2 084 229 (1 190 704–3 494 201)
Shiga toxin-producing *E. coli*– STEC	1 176 854 (754 108–2 523 007)	128 (55–374)	3 486 (1 741–6 996)	9 454 (4 140–27 208)	12 953 (5 951–33 664)
Non-typhoidal *S. enterica*	78 707 591 (31 843 647–211 154 682)	59 153 (36 341–89 045)	78 306 (35 961–185 179)	3 976 386 (2 410 953–6 180 921)	4 067 929 (2 486 092–6 271 290)
Shigella spp.	51 014 050 (20 405 214–118 927 631)	15 156 (6 839–30 072)	51 613 (21 184–114 267)	1 181 231 (519 372–2 445 834)	1 237 103 (554 204–2 520 126)
Vibrio cholerae	763 451 (310 910–1 567 682)	24 649 (10 304–50 042)	2 721 (1 019–6 020)	1 719 381 (718 642–3 487 195)	1 722 312 (720 029–3 491 997)
Protozoa	67 182 645 (35 794 977–120 556 797)	5 558 (2 593–11 958)	57 536 (30 526–102 608)	432 316 (195 372–960 910)	492 354 (239 400–1 034 790)
Cryptosporidium spp.	8 584 805 (3 897 252–18 531 196)	3 759 (1 520–9 115)	8 155 (3 598–17 355)	287 690 (114 012–711 990)	296 156 (119 456–724 660)
Entamoeba histolytica	28 023 571 (10 261 254–68 567 590)	1 470 (453–5 554)	20 851 (7 431–53 080)	115 740 (32 070–476 144)	138 863 (47 339–503 775)
Giardia spp.	28 236 123 (12 945 655–56 996 454)	0 (0–0)	26 270 (11 462–53 577)	0 (0–0)	26 270 (11 462–53 577)

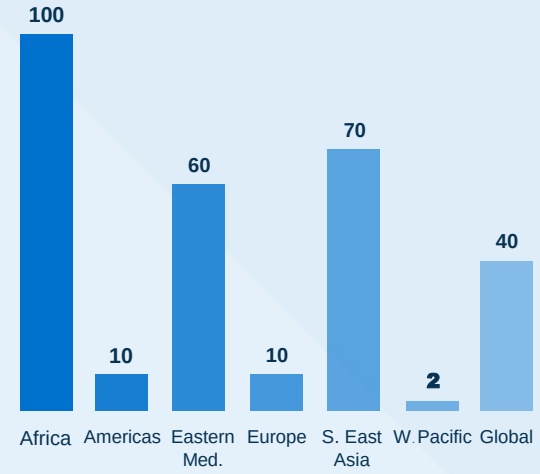
Median global number of foodborne illnesses, deaths, Years Lived with Disability (YLDs),Years of Life Lost (YLLs) and Disability Adjusted Life Years (DALYs), with 95% uncertainty intervals, 2010.

Draft WHO Global strategy for food safety 2022-2030. https://apps.who.int/iris/bitstream/handle/10665/199350/9789241565165_eng.pdf

Global Presence of Salmonellosis

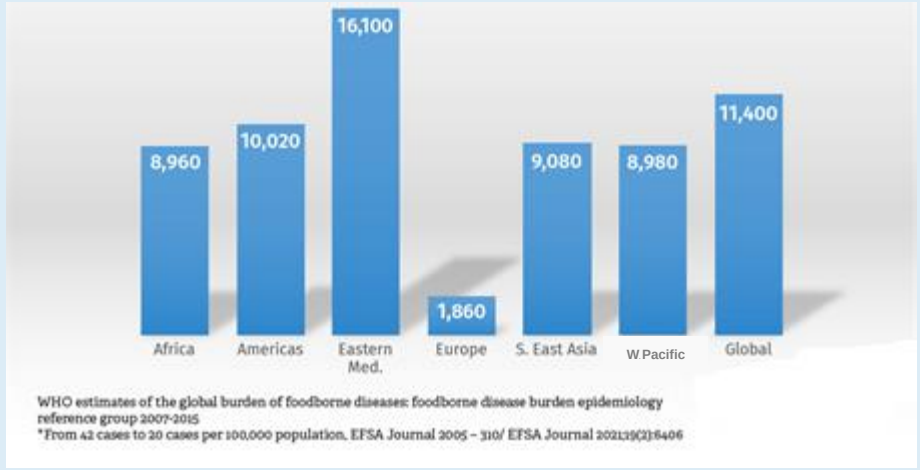
- The WHO* estimates that **11,400 people per 1 million got sick from *Salmonella* in one year**
- **Europe has the lowest rates** with 1,860 cases per 1 million
  - 6 times lower than global average thanks to EU wide *Salmonella* control regulations

***Salmonella* Death estimates per 10 mio Population**



EFSA journal 2021;19(2):6406

***Salmonella* illness estimates per 1 million population**



PM-EG-22-0021

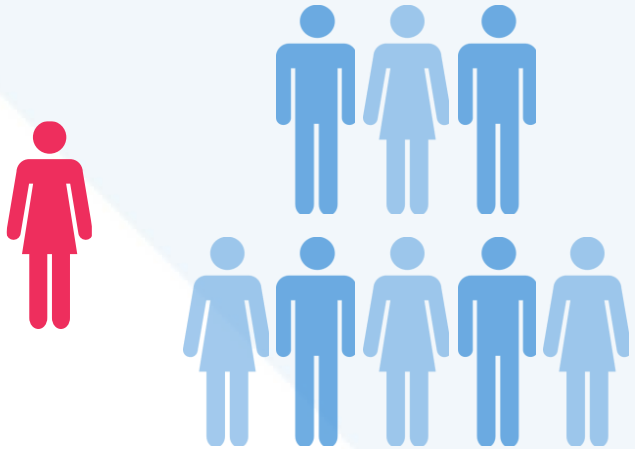
**EFSA journal 2021;19(2):6406

*WHO: World Health Organization;

Prevalence of *Salmonella*

Confirmed cases are just the tip of the iceberg

In 2016, 94,530 confirmed salmonellosis cases were reported by 28 MS, resulting in an EU notification rate of 20.4 cases per 100,000



4.08 M

However, the estimated number of true human salmonellosis cases in the EU in the same year was **4.08 million**

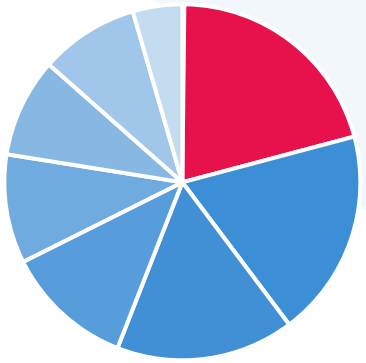
PM-EG-22-0021

EFSA J.2019;17(2):5596

Salmonella caused foodborne outbreaks in 23 EU member states

Salmonellosis:

- Represents 50% of all foodborne outbreaks related to **hospitalizations**
- Represents **1/5 of all foodborne outbreaks**



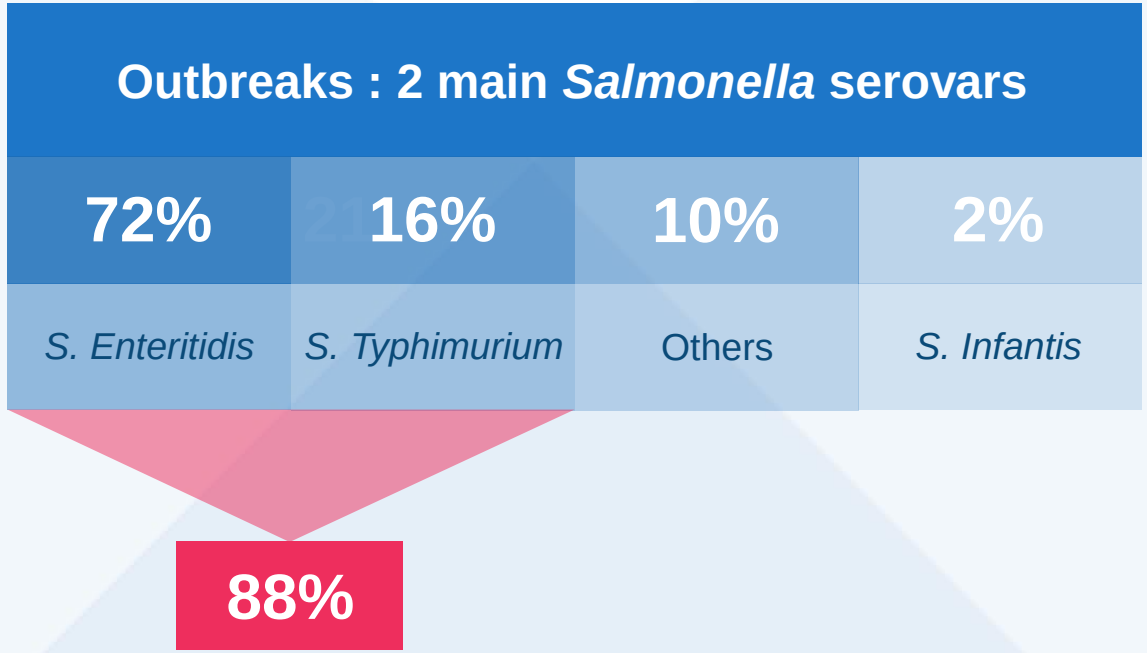
Number of countries reporting food-borne outbreaks			
23	**21**	**18**	**13**
Salmonella	Norovirus	*Campylobacter*	*Clorstridium perfringens*
11	**10**	**10**	**5**
STEC	*Bacillus cereus*	*Listeria*	*Shigella*

PM-EG-22-0021

EFSA Journal 2021;19(2):6406

There are more than 2,500 *Salmonella* Serovars

- 88% of the human *Salmonella* outbreaks are caused by two serovars



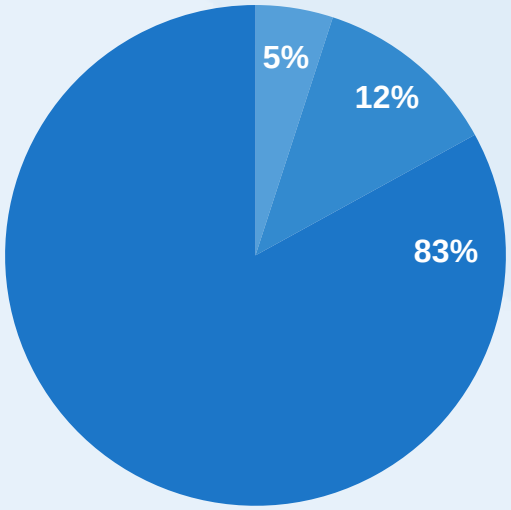
PM-EG-22-0021

EFSA Journal 2021;19(2):6406

Salmonellosis Represents 24% of the Total Foodborne Economic Burden in the USA

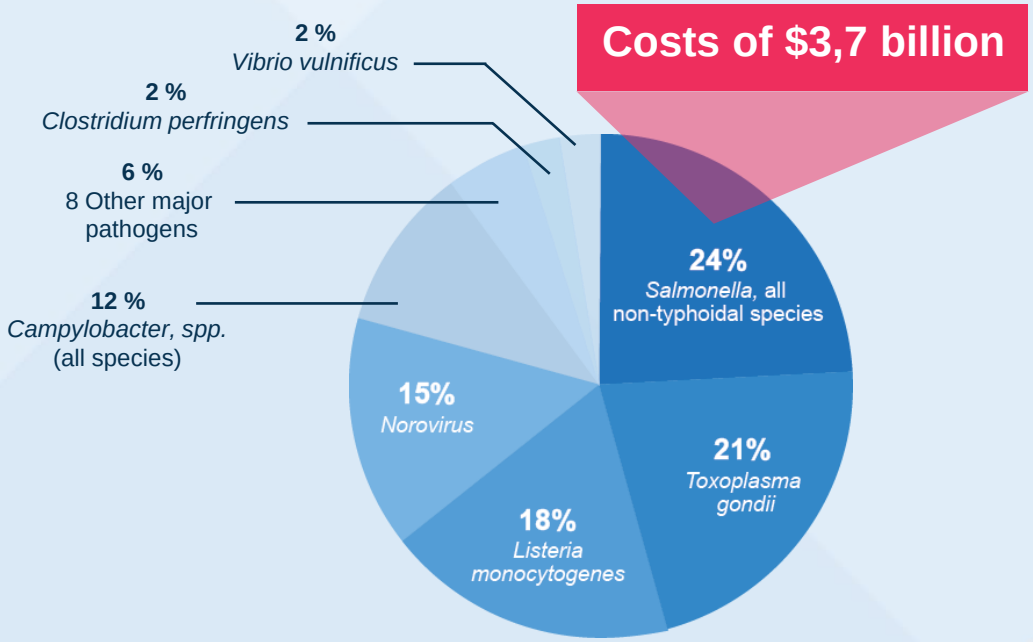
- 15 leading pathogens

Costs of $15,5 billion



- Productivity loss ($856 million)
- Medical costs ($1.8 billion)
- Deaths ($12.8 billion)

Costs of $3,7 billion



PM-EG-22-0021

Sandra Hoffmann, Bryan Maculloch, and Michael Batz,Economic Burden of Major Foodborne Illnesses Acquired in the United States, United States Department of Agriculture, EIB-140, May 2015

Cost of *Salmonella* Illness in the EU

efsa
European Food Safety Authority

Table 1: Estimation of the true incidence, burden and costs of human salmonellosis in the EU 27

A. True incidence based on reported rates			**Source/calculation**
a	Reported rate of salmonellosis, 2008	26.4 per 100,000	CSR 2010
b	Total population EU-27, 01/01/2008	498,000,000	EUROSTAT[19]
c	Total reported cases EU-27, 2008	130,000	a x b
d	Underreporting factor	5-100	Expert estimated
e	Total cases EU-27, 2008	660,000-13,000,000	c x d
B. True incidence based on serosurveillance			**Source/calculation**
f	Incidence rate of sero-infection	0.24 per year	Simonsen et al., 2009
g	Incidence of sero-infection EU-27	120,000,000	f x b
h	Ratio of symptomatic to asymptomatic cases	1:100 - 1:500	Estimated
i	Total cases EU-27	1,200,000 - 6,000,000	g x h
C. Disease burden			**Source/calculation**
j	Burden of salmonellosis NL, 2006	1,600 DALYs	Haagsma et al., 2009
k	Total cases NL, 2006	43,000,000	Ibid.
l	Burden per case	0.04	j / k
m	Burden of salmonellosis, EU-27	24,000-490,000 DALYs	e x l
D. Cost of illness			**Source/calculation**
n	Cost-of-illness salmonellosis NL, 2006	11,000,000 €	Haagsma et al., 2009
o	Costs per case	250 €	n / k
p	Cost-of-illness EU-27	170,000,000-3,300,000,000 €	e x o

Costs of illness
170 to 3300 M€
Estimation

PM-EG-22-0021

EFSA, European food and safety agency, EFSA Journal 2010; 8(4):1546 77

Salmonella Control is important to prevent spread across borders

- By food or traveling people
- Every food producer needs to adopt best global practices regarding Food Safety

Foodborne diseases are a **major global public health concern** but they are **preventable**

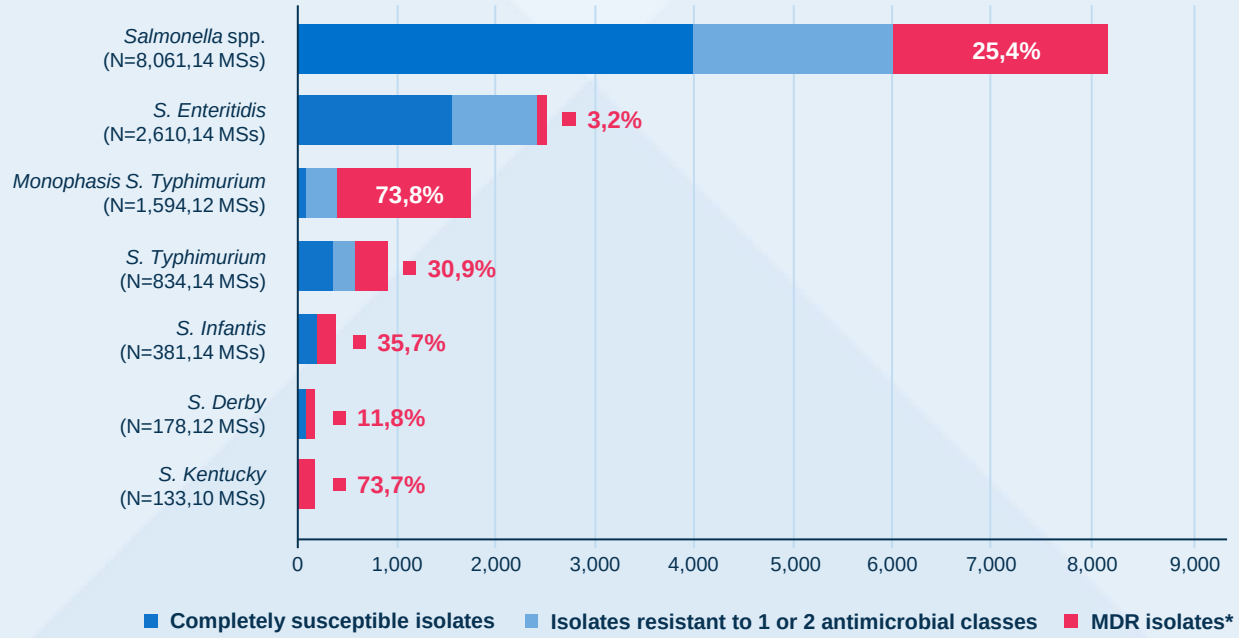
Prevention campaign from the WHO

PM-EG-22-0021

Antimicrobial Resistance is a Global Concern and a threat to Food Safety

- **Antimicrobial resistance is the inability or reduced ability of an antimicrobial agent to inhibit the growth of a certain bacterium**
- Multidrug-resistant non typhoidal ***Salmonella*** infections may have more **serious human health implications**
- Poultry *Salmonella* vaccines may help reducing antimicrobial resistance in humans.

Complete susceptibility and multi-drug resistance in *Salmonella* spp. Isolates from humans in European Union, 2019



PM-EG-22-0021

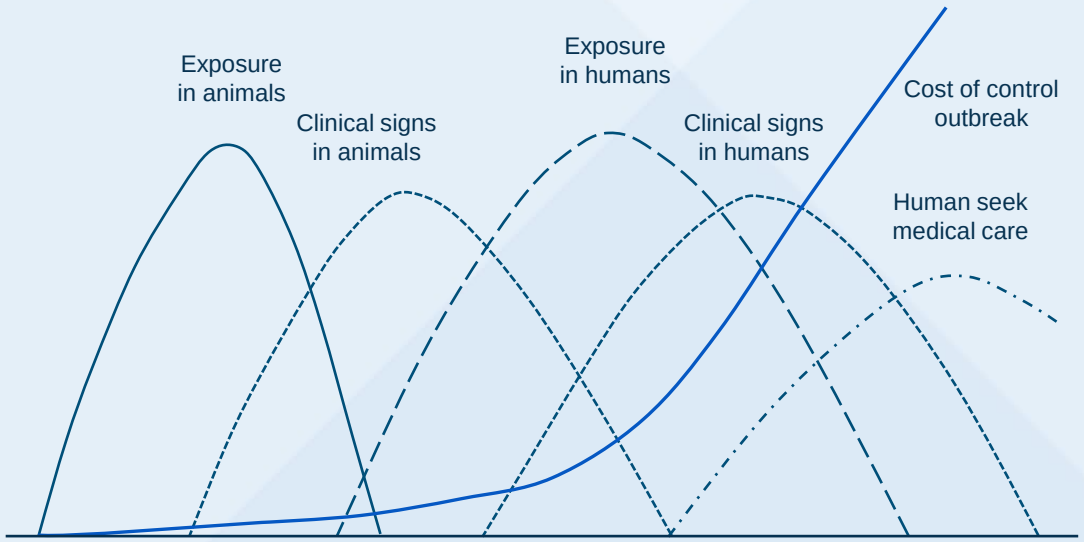
EFSA Journal 2021;19(4):6490

*MDR : resistance to 3 or more classes

Prevention is less expensive than treatment

- The World Bank: **costs for zoonotic diseases control is much higher than the prevention cost.**
- **Layers** have a production cycle up to 2 years and are particularly susceptible to infection with non-typhoidal *Salmonella* infections.
- **Vaccination of all layers with 3 doses in Europe will cost 3 to 66 times less compared to treatment costs**
- However, other sources, such as the pork sector and food of non-animal origin, contribute significantly to the burden of human cases as well

Early control of zoonotic disease is both cost-effective and prevents human disease



Source: Adapted from IOM (2009)

Cost of Salmonellosis in EU **170-3300 M** Euro*

Cost of *Salmonella* vaccination in layers in EU **50 million** Euro (3 doses for 400 million pullets)

PM-EG-22-0021

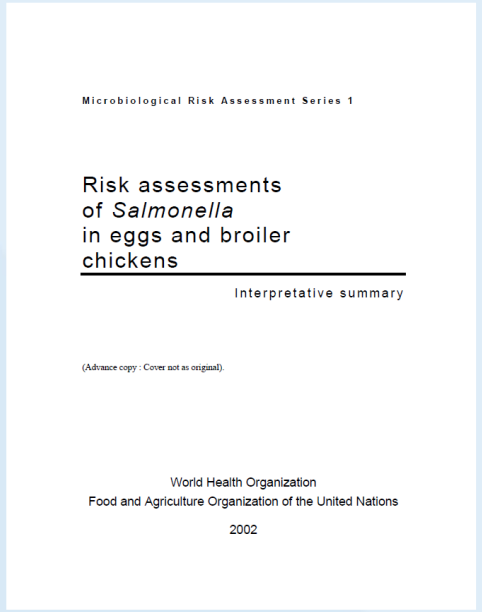
PEOPLE, PATHOGENS, AND OUR PLANET, Volume 2, The Economics of One Health, Report No. 69145-GLB, 2012, The World Bank. * EFSA Journal 2010; 8(4):1546 77

Human Salmonellosis and Food Link

- Eggs and poultry meat have a major role as vehicles of human cases according to the WHO

HAZARD IDENTIFICATION

During the past two decades, *Salmonella* Enteritidis has emerged as a leading cause of human infections in many countries, with hen eggs being a principal source of the pathogen. This has been attributed to this serovar's unusual ability to colonize ovarian tissue of hens and be present within the contents of intact shell eggs. Broiler chicken is the main type of chicken consumed as poultry in many countries. Large percentages are colonized by salmonellae during grow-out and the skin and meat of carcasses are frequently contaminated by the pathogen during slaughter and processing. Considering the major role eggs and poultry have as vehicles of human cases of salmonellosis, an assessment of different factors affecting the prevalence, growth and transmission of *Salmonella* in eggs and on broiler chicken carcasses and the related risk of human illness would be useful to risk managers in identifying the intervention strategies that would have the greatest impact on reducing human infections.


Microbiological Risk Assessment Series 1

Risk assessments of *Salmonella* in eggs and broiler chickens

Interpretative summary

(Advance copy : Cover not as original).

World Health Organization
Food and Agriculture Organization of the United Nations

2002

PM-EG-22-0021

WHO, world health organization report 2002

Vaccination of Poultry Helps to Reduce the Public Health Risk due to *Salmonella*

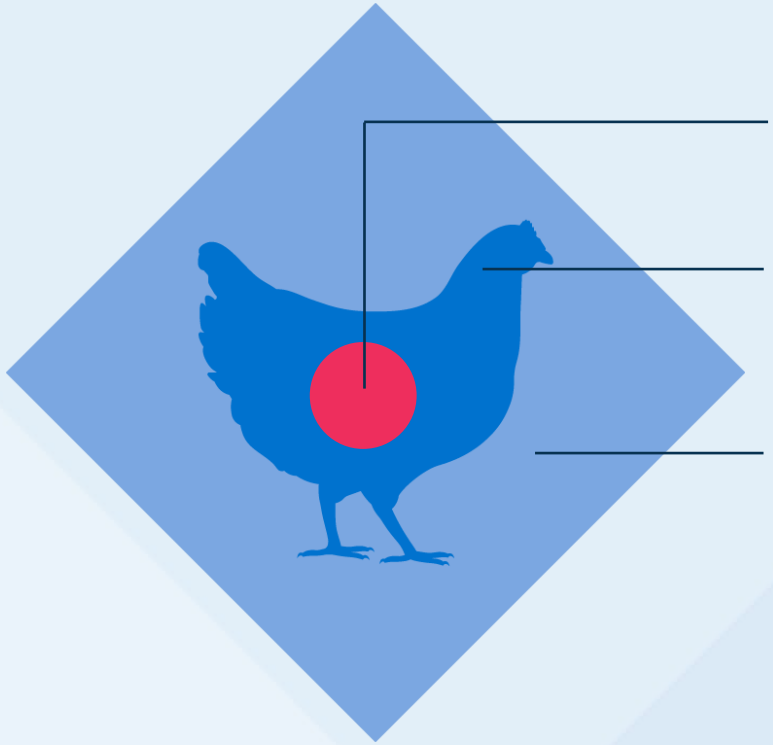
- Safe business
- Safe travels
- Safe food

PM-EG-22-0021

2. Which is the best approach to control *Salmonella* and therefore support a **sustainable business**?

PM-EG-22-0021

360º Approach



Salmonella 360° prevents *Salmonella* in three ways:

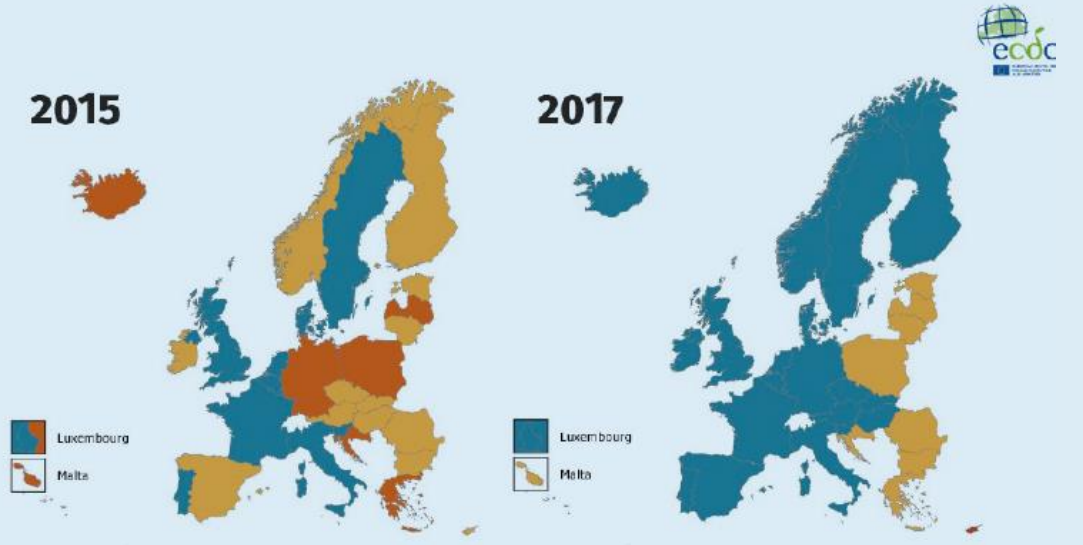
- **Building active immunity**
  with Vaccines that offer protection across the lifecycle
- **Supporting bird immunity**
  with Nutritional products that promote intestinal health and reduce opportunities for Salmonella to colonize
- **Protecting bird immunity**
  with The Food Safety Program to assess *Salmonella* risk factors and mitigate *Salmonella* transmission with **Bioprotection products**.

PM-EG-22-0021

New Diagnostic Tools Allow Fast Traceability of the Origin of Illness

- **Fast traceability** of human illness to food sources would pose **consequences for stakeholders**: Farmers, retailers, government bodies

WGS-based typing* use in national public health reference laboratories



Revez J et al. Frontiers in Public health. 2017

*WGS-base typing : Whole Genome Sequencing base typing

PM-EG-22-0021

The New WHO "Immunization Agenda 2030" Campaign

- Salmonellosis is the deadliest FBD
- We can reduce the risk to people by vaccinating chickens

World Health Organization

- Everyone should benefit from this prevention in the world

Vision	Impact goals
A world wher everyone, everywhere, at every age…	Reduce mortality and morbidity from vaccine-preventable diseases for everyone throughout the lifecourse
…fully benefits from vaccines…	Leave no one behind, by increasing equitable access and use of new and existing vaccines
…for good health and well-being	Ensure good health and well-being for everyone by strengthening immunisation within primary health care and contributing to universal health coverage and sustainable development

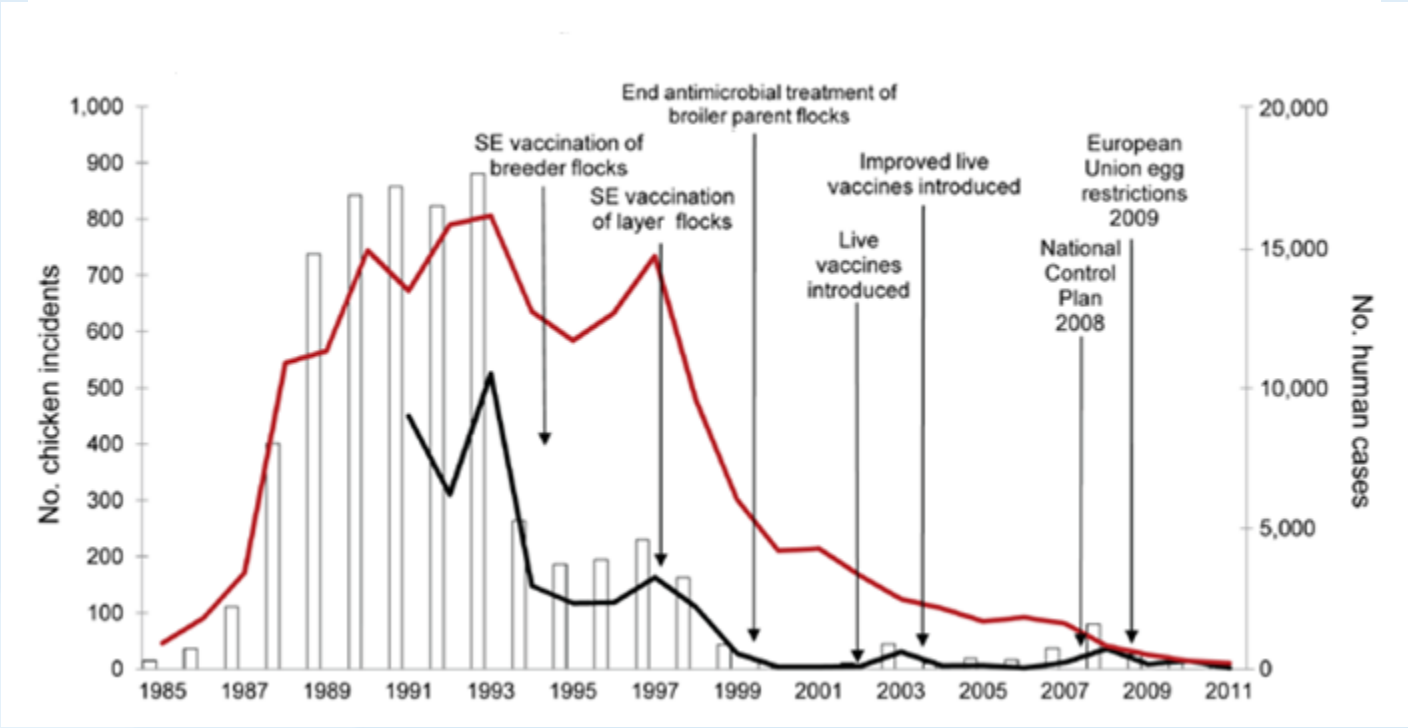
PM-EG-22-0021

https://www.who.int/teams/immunization-vaccines-and-biologicals/strategies/ia2030

Role of Veterinary Vaccines in Prevention of Human Salmonellosis

- *Salmonella* vaccines help reducing farm contamination and human cases

Human & chicken *Salmonella* Enteritidis infections 1985-2011
In England and Wales

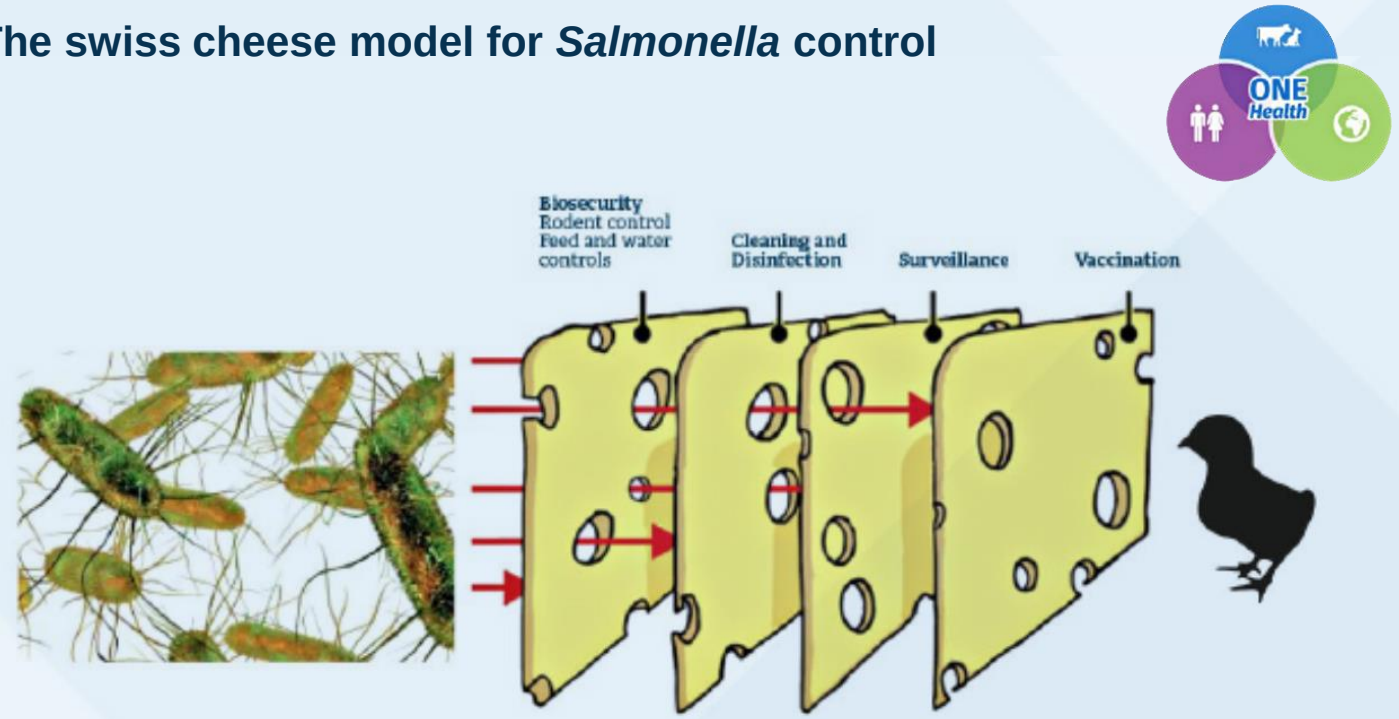


PM-EG-22-0021

Lane C, et al. Salmonella enterica Serovar Enteritidis, England and Wales, 1945–2011.Emerging Infectious Diseases - www.cdc.gov/eid 2014; 20(7):1097-104.

Vaccination of Poultry Helps to Reduce Public Health Risk from *Salmonella* infection

The swiss cheese model for *Salmonella* control



PM-EG-22-0021

https://en.wikipedia.org/wiki/Swiss_cheese_model

Salmonella control and One Health

Non-typhoidal Salmonellosis

- Silent disease
- Bacteria can survive months in the environment of the poultry house
- Non vaccinated flocks continue to be a threat for the whole industry
- Control measures are most successful if they are introduced by legislation or by industry associations

PM-EG-22-0021

Why has *Salmonella* Control Become Urgent?

- Global efforts from WHO/FAO to **reduce** foodborne diseases
- Governments have responsibility to protect **public health**
- Farmers who invest into a *Salmonella* control will have a **sustainable** business

World Health Organization

PM-EG-22-0021

WHO: https://www.who.int/home FAO: https://www.fao.org/unfao/procurement/general-information/en/

Key Messages

- **Salmonellosis** is the **deadliest foodborne disease** globally and is underestimated
- **Eggs** and egg products are the **main source for human infection**
- If you are an egg producer, there is a **risk for your brand** and your operations

Investing into an integrated *Salmonella* prevention program focused on controlling SE and ST will support a more sustainable business

PM-EG-22-0021