EDUCATIONAL RESEARCH REPORT

Evaluation of a Harmonized Undergraduate Catalog for Veterinary Public Health and Food Hygiene Pedagogy in Europe

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ABSTRACT

Current and emerging veterinary public health (VPH) challenges raised by globalization, climate change, and industrialization of food production require the veterinarian's role to evolve in parallel and veterinary education to adapt to reflect these changes. The European Food Hygiene catalog was developed to provide a list of topics relevant to Day One Competencies in VPH. A study was undertaken to ensure that the catalog and teaching practices were pertinent to the work of public health veterinarians. Relevant stakeholders were consulted using questionnaires and semi-structured interviews. A long questionnaire was distributed to 49 academics teaching VPH in European veterinary schools to review topics listed in the catalog. Eighteen responses were received (36.7%), representing 12 European countries. There was general agreement that most topics were appropriate for the undergraduate VPH curriculum. A short questionnaire was distributed to 348 European veterinarians working in the industry. Twenty-four questionnaires (6.7%) were received, representing eight European countries. Despite the low participation rate, topics needing greater emphasis in the undergraduate curriculum included Hazard Analysis Critical Control Points (HACCP), food microbiology, and audits. Seven semi-structured interviews with public health veterinarians working in the UK identified the need for curricular changes including greater practical experience and a shift from a focus on meat inspection to risk management. This may be partly achieved by replacing traditional lectures with authentic case-based scenarios. The study findings can be used to inform the future direction to VPH education for veterinary students across Europe.

Key words: veterinary public health, food hygiene, One Health, veterinary curriculum, Day Once Competencies

INTRODUCTION

Veterinary public health (VPH) is an academic discipline that encompasses the principles of prevention and control of zoonotic and animal diseases and of food hygiene and foodborne diseases.[1] In the veterinary curriculum of most European veterinary schools, VPH is synonymous with food hygiene (FH) and regulatory veterinary work (i.e., working as an official veterinarian [OV] in abattoirs), whereas the related subject of veterinary epidemiology is taught separately. In this article, the term VPH is used as per the typical European interpretation.

The VPH curriculum in Europe should equip veterinary students with the skills necessary to satisfy the Day One Competencies (or exit outcomes) required by accreditation bodies like the European Association of Establishments for Veterinary Education (EAEVE) in Europe and the Royal College of Veterinary Surgeons (RCVS) in the UK. These are underpinned by the European Directive 2005/36/EC (and subsequent amendments) on the recognition of professional qualifications.[2] For both EAEVE and RCVS, the Day One Competencies (D1C) in FH revolve around the ability to conduct antemortem and post-mortem inspection of animals presented for slaughter.[3,4] This will contribute to the prevention of foodborne hazards entering the food chain and the associated risk to public health. EAEVE also identifies auditing skills—which are part of the veterinary tasks undertaken during official controls at the abattoir and other food-producing establishments—as a competency.[5,6] The European Union Regulation 2017/625 on official controls has highlighted that the protection of human and animal health, animal welfare, and the environment can only be achieved by adopting a holistic approach throughout the agri-food chain.[7] The same principles are supported by the World Organisation for Animal Health (OIE) in its recommendations on the competencies of graduating veterinarians.[8] Therefore, veterinary schools should train students to develop a risk-based mind-set while applying their FH skills to the entire agri-food supply chain in a One Health context, not just at slaughter. Post-graduate specialization and on-the-job training are necessary to achieve proficiency in performing these duties.

Globalization has resulted in changes to the socioeconomic and socio-demographic climate, with barriers to the movement of people and goods being relaxed and an increasing range of food available. As such, food can be sourced from many disparate locations and subject to different food quality and hygiene standards, meaning that food hazards know no boundaries. Therefore, FH expertise and the role of the veterinarian in public health (PH) are changing and need to evolve to continue to be relevant in a global context.[9]

The changing situation globally may appear to necessitate an increase in the breadth of VPH teaching. However, an indiscriminate increase in the VPH curriculum content would compound the pre-existing concerns of an already overloaded veterinary curriculum.[10] An increase in VPH content at the expense of other disciplines is not realistic when comparing the proportion of veterinarians in Europe working in PH after graduation with other areas of the profession.[11] Instead, what is envisaged is a modernization of the VPH curriculum and a refocusing of VPH learning and teaching practices on the essential D1Cs needed to tackle current and future FH concerns.[12,13]

One of the main challenges facing VPH education in Europe is that the subject is unpopular among veterinary students, who struggle to see the relevance of working as a veterinarian in PH. There is no easy solution, and VPH educators need to address this problem from different angles. In 2011, a meeting was organized at the University of Leipzig in Germany; VPH teachers from nine European countries attended. It was unanimously recognized that

a forum was needed specifically to discuss learning and teaching practices in VPH. The following year, at the University of Ghent in Belgium, the European Veterinary Food Safety Teachers group (EVFSTG) was established and tasked with improving teaching quality in VPH. The EVFSTG currently has 27 members representing veterinary schools in 24 European countries. The group meets once a year to discuss innovations in VPH pedagogy, and members are responsible for cascading information to the rest of their teaching team and ensuring senior management at their institutions are made aware of developments.

One objective of the EVFSTG was to discuss the proposal from EAEVE for a harmonized European VPH curriculum for all undergraduate students.[6] As a starting point, the group reviewed the English version of the *Catalogue for Teaching Food, Meat and Dairy Hygiene in Germany, Austria and Switzerland*, developed for German-speaking countries.[14] The group refined the content by removing topics that were not considered relevant at a pan-European level. The first edition of a harmonized *European Catalogue for Teaching Food, Meat and Dairy Hygiene* (hereafter, the European Food Hygiene [EFH] catalog) was published in August 2018.[15]

At following EVFSTG meetings, it was debated whether the EFH catalog provided the D1Cs required of veterinary graduates, met employers' expectations, and aligned with OIE's recommendations on veterinary education to facilitate veterinarians' international mobility.[16] If so, the catalog could then be used when planning future VPH teaching at European veterinary schools and to define learning outcomes of VPH courses. These aims became particularly relevant in view of the uncertainties associated with the UK's departure from the European Union and the unforeseen changes to education resulting from the COVID-19 pandemic. Importantly, the EFH catalog would also contribute to consistency in VPH activities conducted by veterinary graduates across Europe and facilitate mobility of veterinarians working in VPH.

In 2017, a research project was launched to evaluate the fitness for purpose of the EFH catalog by evaluating its alignment with current educational needs identified by academics teaching VPH and those actively working in VPH across Europe. A secondary aim was to collate field veterinarians' suggestions to improve teaching of undergraduate students in VPH.

MATERIALS AND METHODS

The project comprised three stages. Stage 1 consisted of a long questionnaire to evaluate the content of the EFH catalog, distributed to the European academics teaching VPH. In Stage 2, a short questionnaire to collect opinions on the future of VPH education was distributed to European veterinarians currently or with previous experience working in PH. During Stage 3, semi-structured interviews were conducted to further explore the themes emerging from the short questionnaire with veterinarians working in PH and to elicit more in-depth views on improving VPH education.

The target population included academics teaching VPH from all European countries except Germany, Austria, and Switzerland, as they had already agreed on the content of their catalog. All participants (academics and veterinarians) were made aware of the aims of the project and the nature of involvement in the research, and they agreed to take part by signing a consent statement. This research project received approval from the Royal (Dick) School of Veterinary Studies Human (research) Ethical Review Committee (HERC) (HERC_182_18).

Stage 1: Long Questionnaire for Academics

The list of topics in the first edition of the EFH catalog[15] was used as a template to create the long questionnaire. There were 305 topics divided into three sections: the Food Hygiene syllabus (131 topics), the Meat Hygiene syllabus (103 topics), and the Dairy Hygiene syllabus (71 topics). The questionnaire was distributed to academics teaching VPH in European veterinary schools who were members of the EVFSTG[15] and/or members of the European College of VPH (https://ecvph.org/). Participants were asked to provide a response for each topic using the following scale:

0. I don't teach this topic because it is not relevant.
1. I don't teach this topic because I don't have the time.
2. I don't teach this topic because it is taught by another department.
3. I teach this topic but briefly or recommend for self-study.
4. I teach this topic as it is important.

Stage 2: Short Questionnaire for Veterinarians

A short questionnaire was developed and was distributed to veterinarians working in PH recruited through the EVFSTG and two private companies that employ European veterinarians working in abattoirs in the UK on behalf of the government authority. The questionnaire collected demographic information (age, gender, nationality, veterinary school and year of graduation, previous and past occupations, years of VPH experience) and used open-ended questions to elicit personal views on undergraduate VPH education as follows:

1. Taking into consideration your career in FH/VPH, what are the topics that were not taught at your vet school but you think are necessary to fulfill your role?
2. What are the FH/VPH topics that were taught at your vet school, but not in enough depth to fulfill your role?
3. What are the FH/VPH topics that were taught at your vet school, but you find less relevant to your role?
4. Is there anything else you would like to comment on that would have improved your veterinary education in FH/VPH?

Questionnaire Validation, Data Acquisition, and Analysis

The questionnaires were piloted between August and December 2017 by members of EVFSTG. The final version of each questionnaire was distributed using Online Surveys (https://www.onlinesurveys.ac.uk/) with a link in an email sent to both cohorts of participants. The questionnaire was open from February until May 31, 2018, and reminders were sent in March and April to encourage further responses. Completed questionnaires were downloaded into Excel, and information that could identify respondents (nationality and veterinary school) was removed before analysis to maintain anonymity. The long questionnaire data were analyzed using descriptive statistics. For the short questionnaire, free-text entries from questions 1, 2, and 3 were clustered under main headings by two authors (AS, JDP) and assigned to broad categories matching the EFH catalog and collated for descriptive statistical analysis. For question 4, qualitative analysis was used to identify relevant and recurrent topics.

Stage 3: Semi-Structured Interviews

Participants for the semi-structured interviews were based in the UK and were recruited at the national UK conference of the VPH Association held in September 2018, as well as via the authors' professional networks. The veterinarians participating

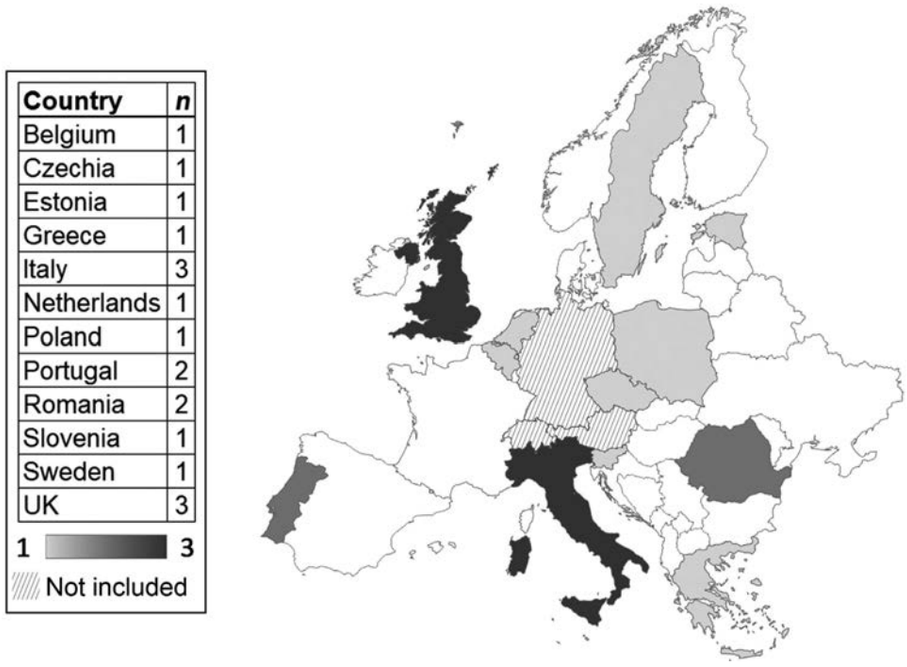

Figure 1: Map and frequency table of academic participants in the long questionnaire (*n* = 18)

in the interviews did not take part in the questionnaires. All interviews were conducted by the one researcher (CS), in person or by phone. At the start of the interview, the researcher explained the scope of the project and the preliminary results of the short questionnaire and then asked the interviewee to consent to participate before proceeding. The structure of the interview was as follows:

- Comment on the main themes that emerged from the short questionnaire.
- Offer suggestions on the best way to teach these topics while considering the constraints of an overloaded curriculum in European veterinary schools.
- Give any final comment to improve VPH education in veterinary schools overall.

Interviews were recorded on a digital audio recorder. Audio files were downloaded and stored on a secure, password-protected university computer. Audio files were transcribed, and a thematic qualitative analysis was performed independently by two of the authors (AS, JDP) following the methodology described by Braun and Clarke.[17]

RESULTS

Stage 1: Long Questionnaire for Academics

The long questionnaire was distributed to 49 academics responsible for organizing and teaching the VPH course at their institutions. They represented 24 European countries. Eighteen responses were received (36.7%), representing 12 European countries. The participant frequency by country is shown in Figure 1, and the responses to all the topics in the questionnaire are shown in Figure 2.

For the Food Hygiene syllabus (Figure 2a, b; 131 topics), the results show an overall agreement among academics that the majority of the topics were important and therefore relevant to the undergraduate VPH curriculum. For some topics such *transmission of resistance gene* (Figure 2a, topic 4.38), 14 academics (77.8%) either reported that they did not have time to teach it, only briefly mentioned it, or recommend it for self-study. Foodborne hazards like mycotoxins or prions (Figure 2a, topics 4.29, 4.30) were considered important to teach and included in the curriculum by 10 academics (55.5%). Furthermore, only seven academics (38.9%) considered it important to teach practical aspects of fish hygiene (including crustaceans and mollusks) (Figure 2b, topics 8.19.a, 8.20.a). The main topics identified as not being taught and not relevant to the VPH curriculum were clustered around product-specific hygiene requirements, including food of plant origin (Figure 2b, topics 7.01–7.18), food analysis (Figure 2b, topics 8.01–8.25), and basic principles of official controls (Figure 2a, topics 2.18, 2.21).

The Meat Hygiene syllabus (Figure 2c; 103 topics) indicated strong agreement about the importance of the meat hygiene topics (theory and practical) related to ante- and post-mortem inspection (topics 11.1–11.40, 14.1–14.13). Some differences were observed between academics regarding teaching of topics related to game meat hygiene (topics 12.1–12.9, 14.14) and import and export of meat (topics 13.1–13.4).

For the Dairy Hygiene syllabus (Figure 2d; 71 topics), although the majority of academics agreed on the importance of teaching most of these topics, the responses were divided as to whether the VPH academics or those from another department were delivering the teaching (topics 16.1–17.16), showing less ownership of some components of the syllabus. Some examples of topics that were identified as less relevant in the VPH curriculum were product-specific legislation (topics 15.9, 19.1), specific dairy products (topics 19.13–19.21), and nutritional significance of dairy products (topics 16.12, 19.2).

(a)

TOPICS	0	1	2	3	4
Food Law and Organisation of Food Control					
2.1.a. National Food control	0%	0%	6%	0%	94%
2.2.a. Food control in the EU	0%	6%	6%	6%	83%
2.3.a. Tasks of veterinarians in for control and in the food industry	0%	0%	0%	0%	100%
Food Law					
2.4.a. General principles of food law	0%	6%	0%	6%	89%
2.5.a. Principles of legislation	6%	6%	0%	22%	67%
2.6.a. Consumer protection policy of the EU	6%	6%	17%	39%	33%
2.7.a. International trade law pertaining to food	6%	11%	11%	56%	17%
2.8.a. Basic requirements for the marketability of food	6%	11%	17%	44%	22%
2.9.a. Horizontal legislation	6%	0%	18%	12%	65%
2.10.a. Regulation (EC) No 178/2002, EU hygiene package and follow-up regulations	0%	0%	0%	17%	83%
2.11.a. Further relevant national and EU legal provisions	0%	6%	6%	33%	56%
2.12.a. Legislation on food labelling (EU)	0%	6%	11%	33%	50%
2.13.a. Legislation on food additives (EU)	0%	11%	11%	33%	44%
2.14.a. Basic principles of legislation on food supplements, genetic modified organisms and novel food	6%	17%	11%	33%	33%
2.15.a. Legislation on residues and contaminants	0%	6%	11%	11%	72%
Basic principles of official food control					
2.16.a. Organisation of official controls, sampling	0%	0%	0%	11%	89%
2.17.a. Control of materials and articles intended to come into contact with foodstuffs	0%	11%	11%	44%	33%
2.18.a. Administrative courts	6%	11%	56%	22%	6%
2.19.a. Right of appeal	11%	6%	50%	22%	11%
2.20.a. Administrative offences	6%	6%	56%	28%	6%
2.21.a. Fines, criminal offences	6%	6%	50%	28%	11%
Quality and Safety of Food					
3.1.a. Quality concept, quality control, hygiene as quality factor	0%	0%	11%	22%	67%
3.2.a. Generally accepted trade practice	11%	6%	11%	50%	22%
3.3.a. Quality assurance, quality management	0%	0%	22%	22%	56%
3.4.a. Food safety management	0%	0%	11%	6%	83%
3.5.a. Auto control programm	0%	0%	11%	11%	78%
3.6.a. HACCP concept, risk analysis, risk assessment, risk communication	0%	0%	0%	0%	100%
3.7.a. GMP/GHP	0%	0%	11%	11%	78%
3.8.a. Hygiene requirements for food premises, processes and staff	0%	0%	11%	6%	83%
3.9.a. Hygiene training of staff	0%	0%	6%	28%	67%
3.10.a. Cleaning and disinfection	0%	0%	0%	22%	78%
3.11.a. Nutritive, pathophysiological and dietary aspects implicated in the consumption of food	19%	0%	25%	38%	19%
3.12.a. Quality, safety and control of organic food	6%	24%	12%	41%	18%
3.13.a. Legislation on organic food	6%	18%	12%	47%	18%
Food Microbiology					
4.1.a. Microorganisms in the food chain	0%	0%	17%	0%	83%
4.2.a. Ecology	0%	0%	22%	33%	44%
4.3.a. Natural presence in soil, water, animals and humans; biofilms	0%	11%	17%	17%	56%
4.4.a. Microbiological contamination of food	0%	0%	0%	0%	100%
4.5.a. Contamination processes (primary/secondary contamination, cross-, de-, recontamination)	0%	0%	6%	6%	89%
4.6.a. Sources of contamination	0%	0%	6%	6%	89%
4.7.a. Generation time, lag-phase, growth kinetics, sublethal damage	0%	0%	17%	11%	72%
4.8.a. Significance of bacterial counts	0%	0%	11%	11%	78%
4.9.a. Marker organisms, microbiological limits (food safety criteria, process hygiene criteria)	0%	0%	0%	0%	100%
4.10.a. Tenacity and factors influencing survival and inactivation of microorganisms	0%	0%	12%	12%	76%
4.11.a. Extrinsic/intrinsic factors (temperature, aw-value, pH value, sodium chloride, Eh value, nitrate/nitrite)	0%	0%	11%	6%	83%
4.12.a. Hurdle concept	0%	0%	17%	6%	78%
4.13.a. Predictive microbiology	0%	17%	22%	17%	44%
4.14.a. Selected characteristics of microorganisms	0%	6%	28%	11%	56%
4.15.a. Pathogenicity and virulence factors	0%	0%	33%	11%	56%
4.16.a. Toxin production	0%	0%	22%	6%	72%
4.17.a. Resistance properties	0%	0%	28%	17%	56%
4.18.a. Enzyme activity	0%	0%	22%	44%	33%
4.19.a. Starter and protective cultures, bio-conservation	0%	6%	17%	28%	44%
4.20.a. Pre- and probiotics	0%	11%	17%	39%	33%

TOPICS	0	1	2	3	4
Biological Hazards					
4.21.a. Zoonoses and zoonotic agents	0%	0%	6%	0%	94%
4.22.a. Food-borne pathogens	0%	0%	6%	0%	94%
4.23.a. Infection/intoxication / toxiinfection	0%	0%	11%	0%	89%
4.24.a. Epidemiology, pathogenesis, clinical symptoms, prophylaxis, virulence factors, pathogenic behaviour	0%	6%	11%	6%	78%
4.25.a. pathogens: Salmonella, Campylobacter, Staphylococcus aureus, Clostridium perfringens, Clostridium l	0%	0%	0%	6%	94%
4.26.a. Viruses	0%	0%	11%	22%	67%
4.27.a. Protozoa	0%	0%	17%	22%	61%
4.28.a. Parasites	0%	0%	17%	6%	78%
4.29.a. Prions	0%	0%	29%	12%	59%
4.30.a. Mycotoxins	0%	0%	22%	22%	56%
4.31.a. Biogenic amines	0%	6%	17%	11%	67%
4.32.a. Natural toxins in food (toxic fish, shellfish poisoning)	0%	6%	17%	0%	78%
4.33.a. Monitoring and control of zoonoses (food-borne infections) in all stages of the food and feed chain	0%	0%	6%	17%	78%
4.34.a. Current EC Directive on the monitoring of zoonoses and zoonotic agents	0%	11%	17%	11%	61%
4.35.a. Control programmes	0%	6%	17%	28%	50%
4.36.a. Outbreak investigations	0%	0%	17%	28%	56%
4.37.a. Food allergy, food intolerance	0%	6%	17%	50%	28%
4.38.a. Transmission of resistance genes	6%	11%	28%	33%	22%
5. Chemical Hazards (residues and contaminants)					
5.1.a. Basic principles	0%	0%	17%	6%	78%
5.2.a. Sources	0%	0%	17%	11%	72%
5.3.a. Food chain	0%	0%	17%	11%	72%
5.4.a. Adverse effects on health	0%	6%	17%	28%	50%
5.5.a. Prophylaxis	0%	0%	17%	33%	44%
5.6.a. Control, monitoring	0%	0%	17%	33%	50%
5.7.a. Maximum residue limits	0%	0%	17%	11%	72%
5.8.a. Categories of substances	0%	0%	17%	11%	72%
5.9.a. Veterinary medicinal products	0%	0%	28%	6%	67%
5.10.a. Pesticides	0%	6%	28%	22%	44%
5.11.a. Harmful substances originating from technological processes	6%	6%	22%	17%	50%
5.12.a. Migration/nanoparticles	11%	11%	33%	17%	28%
5.13.a. Environmental contamination	0%	0%	22%	17%	61%
5.14.a. Food and feed additives	6%	0%	17%	22%	56%
Food Preservation					
6.1.a. Historical background	11%	6%	11%	39%	33%
6.2.a. Physical methods of preservation	6%	0%	11%	11%	72%
6.3.a. Chemical methods of preservation	6%	0%	12%	6%	76%
6.4.a. Biological methods of preservation	6%	0%	11%	17%	67%
6.5.a. Packaging	6%	0%	6%	22%	67%
Food Spoilage					
6.6.a. Microbiological spoilage	0%	0%	6%	11%	83%
6.7.a. Spoilage by original enzymes	0%	6%	11%	17%	67%
6.8.a. Spoilage by parasites and pests	0%	0%	6%	24%	71%
6.9.a. Chemico-physical causes of spoilage	0%	0%	11%	11%	78%
6.10.a. Principles of spoilage prevention	0%	0%	11%	6%	83%

Legend	
100%	(0) I don't teach this topic because it is not relevant
75%	(1) I don't teach this topic because I don't have the time
25%	(2) I don't teach this topic because it is taught by another department
0%	(3) I teach this topic but briefly or recommend for self-study
	(4) I teach this topic as it is important

(b)

TOPICS	0	1	2	3	4
Product-specific Food Hygiene and Technology, Process Control					
7.1.a. Product-specific legislation	12%	12%	24%	24%	29%
7.2.a. Nutritional significance	12%	29%	41%	18%	0%
7.3.a. Product range	7%	13%	27%	33%	20%
7.4.a. Terminology, definitions, generally accepted trade practice, presentations, quality characteristics	13%	13%	6%	25%	44%
7.5.a. Labelling and packaging if applicable	6%	6%	13%	25%	50%
7.6.a. Composition	13%	13%	13%	19%	44%
7.7.a. Technology	12%	6%	6%	12%	65%
7.8.a. Microbiology	6%	12%	12%	6%	65%
7.9.a. Changes (spoilage, defects, misleading)	6%	18%	12%	12%	53%
7.10.a. Process control (health risks, CCP)	0%	6%	6%	12%	76%
7.11.a. Meat as raw material (poultry, horse, cattle, goat, sheep, game, pork, ostrich, rabbit meat)	0%	0%	0%	11%	89%
7.12.a. Fats	12%	18%	6%	24%	41%
7.13.a. Meat and meat products (minced meat/minced meat products, cured and smoked meat products, saus	0%	0%	0%	6%	94%
7.14.a. Eggs und egg products	0%	0%	6%	11%	83%
7.15.a. Fish und fishery products (frozen, salted, fried, cooked, smoked fish, marinades, caviar, semi- preserv	0%	6%	11%	6%	78%
7.16.a. Crustaceans and molluscs	0%	6%	12%	24%	59%
7.17.a. Honey	0%	12%	6%	18%	65%
7.18.a. Food of plant origin	24%	6%	29%	24%	18%
Practical Course on Food Analysis					
8.1.a. Basic principles	0%	7%	7%	20%	67%
8.2.a. Product knowledge of the mentioned product groups	6%	6%	6%	25%	56%
8.3.a. Sensory evalution	13%	19%	6%	6%	56%
8.4.a. Chemical methods of analysis (fat, protein, moisture, connective tissue,…)	18%	18%	18%	6%	41%
8.5.a. Microbiological methods of analysis and serological diagnosis of zoonotic agents	0%	18%	6%	12%	65%
8.6.a. Rapid methods	6%	12%	12%	24%	47%
8.7.a. Analysis of residues	6%	13%	31%	19%	31%
8.8.a. gravimetry, histological analysis, immunological methods	6%	24%	41%	18%	12%
8.9.a. Animal species differentiation	6%	13%	25%	25%	31%
8.10.a. Analysis of following groups and interpretation of results, preparation of test reports including evaluatic	0%	27%	7%	33%	33%
8.11.a. Meat of all species	0%	24%	6%	18%	53%
8.12.a. fats	18%	24%	6%	18%	35%
8.13.a. Minced meat	0%	24%	6%	18%	53%
8.14.a. Cured and smoked meat	0%	35%	6%	12%	47%
8.15.a. Sausages	0%	24%	6%	12%	59%
8.16.a. Meat delicatessen/ready-to-eat products	0%	19%	13%	19%	50%
8.17.a. Canned food	6%	24%	6%	12%	53%
8.18.a. Deep-frozen products	13%	25%	6%	19%	38%
8.19.a. Fish, fishery products	0%	29%	12%	18%	41%
8.20.a. Crustaceans and molluscs	13%	27%	13%	13%	33%
8.21.a. Eggs	0%	29%	6%	29%	35%
8.22.a. Convenience, fast food	13%	31%	13%	31%	13%
8.23.a. Spices	13%	38%	13%	13%	25%
8.24.a. Honey	13%	25%	6%	31%	25%
8.25.a. Further products (i.e. Plant food)	33%	22%	33%	11%	0%

Legend	
100%	(0) I don't teach this topic because it is not relevant
75%	(1) I don't teach this topic because I don't have the time
25%	(2) I don't teach this topic because it is taught by another department
0%	(3) I teach this topic but briefly or recommend for self-study
	(4) I teach this topic as it is important

Figure 2: Long questionnaire to academics: Frequency tables by syllabus

(a, b) Long questionnaire to academics (*n* = 18): the Food Hygiene syllabus; table of response frequencies for each topic. **(c)** Long questionnaire to academics (*n* = 18): the Meat Hygiene syllabus; table of response frequencies for each topic. **(d)** Long questionnaire to academics (*n* = 18): the Dairy Hygiene syllabus; table of response frequencies for each topic.

(c)

TOPICS	0	1	2	3	4
Principles of Meat Hygiene					
9.1.a. Objectives and aims of meat hygiene	0%	6%	0%	6%	88%
9.2.a. Historical background	0%	0%	0%	44%	56%
9.3.a. Tasks of veterinarians associated with Veterinary Public Health and food chain for meat: animal welfare, consumer protection, environmental protection, ante-and post-mortem inspection, audits of good hygiene practices, epizootics	0%	0%	0%	0%	100%
9.4.a. Basic principles of meat hygiene (also compare food and milk hygiene and other disciplines of veterinary medicine)	0%	0%	0%	27%	73%
9.5.a. Organisation of hygiene controls in meat production and processing	0%	0%	0%	6%	94%
9.6.a. Basic principles of international agricultural policy, Common Agricultural Policy of the EU, WTO, SPS, Codex Alimentarius, OIE	0%	0%	24%	35%	41%
9.7.a. Quality management in agricultural practice	0%	24%	47%	12%	18%
9.8.a. Basic principles of meat processing and technology	0%	0%	12%	12%	76%
9.9.a. Basic principles, concepts and methods of good manufacturing practice and quality management in the meat sector as well as risk analysis and HACCP	0%	0%	6%	6%	88%
9.10.a. Prevention/reduction of risks to human health via meat consumption including basic epidemiological principles, monitoring and surveillance systems	0%	6%	12%	6%	76%
Hygiene and technology of meat production					
9.12.a. Tasks of slaughterhouses and meat processing establishments	0%	0%	0%	0%	100%
9.13.a. Structural, operational and hygiene requirements for slaughterhouses and meat processing establishments	0%	0%	0%	6%	94%
9.14.a. Transportation of slaughter animals	0%	0%	0%	0%	100%
9.15.a. Pre-transport handling, transport of slaughter animals(moving, loading, rest periods)	0%	0%	0%	12%	88%
9.16.a. Animal welfare	0%	0%	6%	0%	94%
9.17.a. Influences on meat quality	0%	0%	0%	6%	94%
9.18.a. Meat production technology	0%	0%	6%	0%	94%
9.19.a. Slaughter lines: cattle, pig, small ruminants, horses, poultry, rabbits	0%	0%	0%	0%	100%
9.20.a. Animal welfare	0%	0%	6%	0%	94%
9.21.a. Methods of stunning	0%	0%	0%	0%	100%
9.22.a. Shechita, ritual slaughter, illigal slaughter	6%	0%	0%	18%	76%
9.23.a. Chilling and freezing technology, storage, thawing	6%	6%	12%	6%	71%
9.24.a. Meat transport	6%	6%	0%	24%	65%
9.25.a. Animal byproducts	0%	6%	6%	12%	76%
9.26.a. post-mortem changes	6%	0%	0%	6%	88%
9.27.a. Classification of carcasses, cutting, meat cuts	0%	6%	12%	18%	65%
9.28.a. Hygiene management in meat production	0%	0%	0%	6%	94%
9.29.a. Responsibilities of the food business operator	0%	0%	0%	12%	88%
9.30.a. Food business operators own checks	0%	0%	0%	12%	88%
9.31.a. Official control	0%	0%	0%	0%	100%
9.32.a. Minimum requirements for staff hygiene, rooms, facilities and equipment	0%	0%	0%	18%	82%
9.33.a. Process control (health risks, CCP)	0%	0%	0%	0%	100%
European and National Meat Hygiene Legislation					
10.1.a. Legislation on veterinary medicine aspects of health protection food safety, animal health, animal welfare and medicinal products.	0%	0%	6%	0%	94%
10.2.a. Directive (EC) No 178/2002 and EU hygiene package along with implementation regulations (national legislation on meat hygiene; e.g. Food Hygiene Regulation on Food of Animal Origin; general administrative regulation).	0%	0%	6%	6%	88%
10.3.a. Adjoining legislation, especially on animal welfare and epizootics, disposal of offal, animal by-products, TSE, environment	0%	0%	12%	12%	76%
Ante-mortem Inspection					
11.1.a. Basic principles	0%	0%	0%	0%	100%
11.2.a. Responsibilities of the food business operator	0%	0%	0%	6%	94%
11.3.a. Food chain information	0%	0%	0%	0%	100%
11.4.a. Official veterinarian, approved veterinarian, official auxiliary, internal personnel; professional qualification and education	0%	0%	0%	6%	94%
11.5.a. Methods of examination	0%	0%	0%	0%	100%
11.6.a. Principles of assessment	0%	0%	0%	6%	94%
11.7.a. Worker protection, animal welfare, environmental protection	0%	0%	6%	0%	94%
11.8.a. Special forms of slaughter (such as emergency, domestic, ritual slaughter)	0%	0%	0%	12%	88%
11.9.a. Ante-mortem inspection at the holding farms	0%	6%	6%	6%	82%
11.10.a. Control of animal transport	0%	0%	6%	6%	88%
11.11.a. Ante-mortem inspection at the slaughterhouse	0%	0%	0%	6%	94%
11.12.a. Decisions after ante-mortem inspection (e.g. prohibition of slaughter; measures concerning animal welfare)	0%	0%	0%	0%	100%

TOPICS	0	1	2	3	4
Post-mortem inspection					
11.14.a. post-mortem inspection procedures: cattle, swine, sheep, goats, horses, poultry, rabbits	0%	0%	0%	0%	100%
11.15.a. Risk-based post-mortem inspection	0%	0%	0%	0%	100%
11.16.a. Standard inspection procedure, visual inspection	0%	0%	0%	0%	100%
11.17.a. Extended inspection, inspection in the event of doubt	0%	0%	0%	0%	100%
11.18.a. Conditions for meat inspection, minimum inspection time and maximum number of inspected animals	6%	6%	0%	18%	71%
11.19.a. Further official tests	0%	0%	0%	19%	81%
11.20.a. Principles and diagnostic application of current tests in meat hygiene	0%	0%	0%	18%	82%
11.21.a. Examination for Trichinella in meat	0%	6%	0%	0%	94%
11.22.a. Microbiological/bacteriological examinations	0%	0%	0%	12%	88%
11.23.a. Antibiotic susceptibility testing and examinations on residues and contaminents	0%	6%	0%	12%	82%
11.24.a. Examinations for defects in meat quality	0%	13%	0%	19%	69%
11.25.a. Findings of ante-mortem and post-mortem inspections	0%	0%	0%	6%	94%
11.26.a. Infectious diseases (zoonoses, epizootics)	0%	0%	6%	0%	94%
11.27.a. Parasitoses in slaughter animals	0%	0%	0%	0%	100%
11.28.a. Residues and contaminants in meat	0%	0%	6%	12%	82%
11.29.a. Changes in meat quality	0%	0%	6%	24%	71%
11.30.a. Technopathies	6%	12%	18%	24%	41%
Decisions and measures after post-mortem inspection					
11.32.a. basic principles	0%	0%	0%	0%	100%
11.33.a. Examples (e.g. Trichinellosis, cysticercosis, tuberculosis, findings of further tests)	0%	0%	0%	0%	100%
11.34.a. Treatments in order to render meat fit for consumption	0%	0%	6%	13%	81%
11.35.a. Health marking (according to EU and national rules)	0%	0%	6%	6%	88%
11.36.a. Documentation, records, communication of inspection results	0%	6%	0%	6%	88%
11.37.a. information and communication technology	6%	6%	6%	29%	53%
11.38.a. Meat inspection statistics	0%	24%	6%	29%	41%
11.39.a. Monitoring and surveillance systems	0%	18%	0%	24%	59%
11.40.a. Disposal of animal by-products not intended for human consumption (category 1, 2 and 3)	0%	0%	6%	6%	88%
Game Meat, Meat of Exotic Species					
12.1.a. Legislation	0%	12%	0%	29%	59%
12.2.a. Protection of species	12%	29%	24%	18%	18%
12.3.a. National and European legal provisions concerning hygienic and hunting of wild animals (e.g. Game law)	0%	18%	18%	6%	59%
12.4.a. Economic, hygienic and nutritional significance of game meat	0%	24%	18%	47%	12%
12.5.a. Hunting (wildlife managment, wild game species, appropration, hunting methods, closed seasons	6%	29%	41%	12%	12%
12.6.a. Handling after killing	0%	29%	0%	18%	53%
12.7.a. Official inspections (wild game, farmed game)	0%	18%	0%	12%	71%
12.8.a. Diseases of game	0%	18%	41%	12%	29%
12.9.a. Hygiene and critical points in production of game meat	0%	12%	6%	29%	53%
Import and Export of Meat	0%	0%	0%	0%	0%
13.1.a. EC internal market	0%	18%	18%	53%	12%
13.2.a. Third countries, import controls	6%	6%	12%	59%	18%
13.3.a. Quality meat programs	0%	25%	25%	31%	19%
13.4.a. Quality assurance systems in meat production enterprises	0%	19%	19%	44%	19%
Meat Hygiene: Practical courses					
14.1.a. Inspection of food chain information	0%	0%	0%	6%	94%
14.2.a. Ante-mortem inspection, inspection at the holding of provenance	0%	0%	0%	6%	94%
14.3.a. Demonstration of stunning devices, slaughtering	0%	0%	0%	0%	100%
14.4.a. Examination for Trichinella	0%	6%	12%	6%	76%
14.5.a. Process hygiene, microbiological examinations	0%	0%	6%	6%	88%
14.6.a. Bacteriological examinations, antibiotic susceptibility testing	0%	0%	12%	12%	76%
14.7.a. Additional examinations (e.g. pH measurements, water binding capacity)	0%	18%	6%	6%	71%
14.8.a. Inspection procedures	0%	0%	0%	0%	100%
14.9.a. Cattle	0%	0%	0%	0%	100%
14.10.a. Pigs	0%	0%	0%	0%	100%
14.11.a. Horses	0%	19%	0%	19%	63%
14.12.a. Small ruminants	0%	0%	0%	18%	82%
14.13.a. Poultry, rabbits	0%	6%	6%	0%	88%
14.14.a. Game (farmed game/wild game)	0%	31%	0%	31%	38%
14.15.a. Cutting	0%	6%	6%	29%	59%
14.16.a. Cleaning and disinfection, including detection methods	6%	24%	0%	6%	65%
14.17.a. Preparation of test reports	0%	25%	0%	25%	50%

(d)

TOPICS	0	1	2	3	4
Basic Principles of Milk and Dairy Hygiene					
15.1.a. Structures of dairy industry	0%	6%	50%	6%	38%
15.2.a. Economic impact of production and processing of milk on national and international markets	0%	0%	59%	24%	18%
15.3.a. Principles of national, internal and international policies in agriculture (milk associations, IDF, Codex Alimentarius	0%	7%	53%	20%	20%
15.4.a. Marketing (incl. Direct marketing, organic sector)	12%	12%	53%	18%	6%
15.5.a. Veterinary responsibilities	0%	0%	35%	6%	59%
15.6.a. Regulations (see also Food Hygiene)	0%	0%	25%	0%	75%
15.7.a. Regulation (EC) No 178/2002 and national Food and Feed Code	0%	0%	18%	18%	65%
15.8.a. EU hygiene package	0%	0%	18%	12%	71%
15.9.a. product-specific regulations	12%	6%	24%	12%	47%
15.10.a. GHP conditions and QS systems	6%	0%	31%	13%	50%
15.11.a. QM	6%	6%	35%	12%	41%
15.12.a. HACCP	6%	0%	24%	6%	65%
15.13.a. DIN 22000	12%	24%	35%	12%	18%
Milk Production					
16.1.a. Anatomical and physiological basics	0%	0%	75%	6%	19%
16.2.a. Milk synthesis and compositions	0%	0%	47%	7%	47%
16.3.a. Synthesis and composition of major compounds	6%	0%	44%	6%	44%
16.4.a. Water, proteins and other nitrogenous substances, lipids, carbohydrates	13%	0%	38%	6%	44%
16.5.a. Minerals, trace elements, vitamins, enzymes	13%	0%	31%	19%	38%
16.6.a. Milk of other species (sheep, goat, buffalo, horse)	0%	0%	40%	27%	33%
16.7.a. Factors influencing milk production, composition and technological properties	0%	0%	64%	0%	30%
16.8.a. Genetics	0%	0%	80%	7%	13%
16.9.a. lactation stage and number	0%	0%	80%	7%	13%
16.10.a. Keeping, feeding, climate	0%	7%	73%	0%	20%
16.11.a. Diseases and medicinal therapy	0%	0%	87%	7%	7%
16.12.a. Nutritional and technological significance of the compounds	7%	0%	53%	7%	33%
Milk Technology					
17.1.a. Manual milking	0%	0%	59%	0%	41%
17.2.a. Machine milking	0%	0%	59%	0%	41%
17.3.a. Design of the cluster	0%	0%	71%	0%	29%
17.4.a. Milking systems (small bucket, pipe milking system, milking parlour, milking robots)	0%	0%	59%	6%	35%
17.5.a. control milking technique	0%	0%	56%	0%	44%
17.6.a. Hygiene of milking	0%	0%	47%	0%	53%
17.7.a. Milking and mastitis	0%	0%	53%	6%	41%
17.8.a. Milking problems	0%	0%	59%	6%	35%
17.9.a. Definition of mastitis (IDF) and mastitis causing agents	0%	0%	65%	0%	35%
17.10.a. Influence on milk quality	0%	0%	44%	13%	44%
17.11.a. Cooling	0%	0%	47%	0%	53%
17.12.a. Regulations	0%	0%	35%	6%	59%
17.13.a. Techniques	12%	0%	35%	0%	53%
17.14.a. Cleaning and disinfection	0%	0%	43%	14%	43%
17.15.a. Substances and mode of action	6%	6%	41%	12%	35%
17.16.a. Procedures of cleaning and disinfection	6%	6%	41%	6%	41%
Quality of Raw Milk					
18.1.a. Requirements from EU and national legislation	0%	0%	24%	6%	71%
18.2.a. Hygienic requirements for raw milk production	0%	0%	24%	6%	71%
18.3.a. Hygienic requirements for dairies	0%	0%	24%	18%	59%
18.4.a. Criteria for raw milk	0%	0%	24%	6%	71%
18.5.a. Requirements from national laws	0%	0%	25%	6%	69%
18.6.a. Parameters, intervals and methods of control	0%	0%	25%	0%	75%
18.7.a. Measures for the case of limit exeedance	0%	6%	35%	0%	59%
18.8.a. Microbiology	0%	0%	29%	0%	71%
18.9.a. Initial and secondary contamination microbiota	0%	0%	24%	6%	71%
18.10.a. Pathogenic microorganisms	0%	0%	24%	0%	76%
18.11.a. Spoilage microorganisms	0%	0%	24%	0%	76%
18.12.a. Indicator microorganisms	0%	0%	24%	6%	71%
18.13.a. Residues and contaminants	0%	0%	25%	13%	63%
18.14.a. Causes and contamination levels	0%	0%	24%	18%	59%
18.15.a. Detection methods	0%	0%	24%	24%	47%
18.16.a. Measures of consumer protection	0%	0%	24%	24%	53%

TOPICS	0	1	2	3	4
Hygiene and Technology of Milk Processing					
19.1.a. Product-specific legislation	19%	0%	13%	19%	50%
19.2.a. Nutritional significance	12%	6%	29%	29%	24%
19.3.a. Product range	0%	13%	20%	27%	40%
19.4.a. Terminology, definitions, generally accepted trade practice, presentations, quality characteristics	6%	18%	18%	18%	41%
19.5.a. Labelling and packaging if applicable	6%	18%	18%	18%	41%
19.6.a. Composition	6%	6%	18%	18%	53%
19.7.a. Technology	6%	0%	18%	6%	71%
19.8.a. Microbiology	0%	0%	18%	12%	71%
19.9.a. Changes (spoilage, defects, misleading)	0%	0%	18%	12%	71%
19.10.a. Process control (health risks, CCP)	0%	0%	18%	6%	76%
19.11.a. Raw milk (available at farms)	0%	0%	18%	24%	59%
19.12.a. Heat treated milk (Sterilization, UHT, pasteurized milk)	0%	0%	12%	0%	88%
19.13.a. Milk products	12%	0%	12%	12%	65%
19.14.a. Cream products	12%	12%	12%	12%	53%
19.15.a. Preserved products	12%	6%	12%	6%	65%
19.16.a. Fermented products	12%	6%	12%	6%	65%
19.17.a. Mixed products	12%	18%	12%	12%	47%
19.18.a. Butter and milk fat spreads	12%	6%	12%	6%	65%
19.19.a. Cheese and whey	0%	0%	12%	24%	65%
19.20.a. Ice and desserts	18%	18%	12%	6%	47%
19.21.a. Milk protein products, lactose products, milk fat products	13%	19%	13%	13%	44%
Dairy Hygiene: Practical Courses					
20.1.a. Basic principles	0%	6%	25%	6%	63%
20.2.a. Sampling (producer, dairy, retail)	6%	6%	24%	0%	65%
20.3.a. Product knowledge (raw and heat treated milk, milk products)	12%	12%	12%	6%	59%
20.4.a. Sensory evaluation	18%	12%	12%	6%	53%
20.5.a. Rapid methods (density, freezing point, actual and potential acidity, electrical conductivity, verification of heat tre	6%	12%	18%	18%	47%
20.6.a. Microbiological methods of analysis and serological diagnosis of zoonotic agents	0%	18%	24%	18%	41%
20.7.a. Cytological analysis	6%	18%	47%	12%	18%
20.8.a. Chemical analysis	12%	12%	29%	18%	29%
20.9.a. Detection of antibiotics	0%	6%	31%	6%	56%
20.10.a. Analysis of following product groups and interpretation of results, preparation of test reports including evaluatio	0%	20%	27%	13%	40%
20.11.a. Raw and heat treated consumers milk	0%	18%	29%	12%	41%
20.12.a. Milk products	18%	12%	18%	6%	47%

Legend	
100%	(0) I don't teach this topic because it is not relevant
75%	(1) I don't teach this topic because I don't have the time
25%	(2) I don't teach this topic because it is taught by another department
0%	(3) I teach this topic but briefly or recommend for self-study
	(4) I teach this topic as it is important

Zone	Country	*n*
Eastern	Estonia	2
	Poland	2
	Romania	4
North	Germany	1
	UK	2
South	Italy	2
	Portugal	1
	Spain	10

1 — 10

	Years from graduation			Years of VPH experience			Job title			European zone		
Category	***0–5***	***6–10***	***>10***	***0–5***	***6–10***	***>10***	***OV***	***Manager***	***Clinical***	***North***	***South***	***Eastern***
number	4	7	13	8	7	9	16	4	4	3	13	8

Figure 3: Map, frequency table, and demographic information of veterinarians participating in the short questionnaire (*n* = 24)
VPH = veterinary public health; OV = official veterinarian

Stage 2: Short Questionnaire for Veterinarians

This questionnaire was distributed to 348 European veterinarians working in VPH. Twenty-four completed questionnaires (6.7%) were received, representing veterinarians who had graduated from veterinary schools in eight European countries. Due to the low number of responses, and to facilitate descriptive statistics, the eight European countries have been clustered together as northern, southern, and eastern European zones based on their geographical distribution. Demographic data are reported in Figure 3. Despite the low participation rate, it was possible to appreciate a consensus on the relevance of the topics that had been taught during participants' undergraduate training. A summary of the main themes extracted from responses is presented in Table 1.

Question 1: Topics That Were Not Taught at Your Vet School, but You Think Are Necessary to Fulfill Your Role

Thirteen topics were identified from 34 free-text answers. In addition, 29% of respondents specifically stated that no topics needed to be added to the VPH curriculum. This was particularly relevant for veterinarians doing clinical work (*n* = 4; 75%) (*n* = the total number of veterinarians in the demographic group as reported in Figure 3; the percentage is the proportion of veterinarians in that group who mentioned the topic), especially from northern European countries (*n* = 3; 67%) but less so for veterinarians working as OVs (*n* = 16; 19%), graduating in southern Europe (*n* = 13; 15%), and with less than 5 years of VPH work experience (*n* = 8; 13%). Of the respondents, 20% indicated that more teaching on legislation and enforcement was needed during undergraduate studies. This was more relevant for veterinary managers working for the government (*n* = 4; 50%) from northern European countries (*n* = 3; 67%). Seventeen percent of the respondents indicated that more teaching on welfare at slaughter was required; this was particularly noted by veterinarians with less than 5 years of VPH work experience (*n* = 8; 25%) and those from southern European countries (*n* = 13; 23%). More teaching on recognizing post-mortem pathology was noted as important for 13% of the respondents. This was more relevant to veterinarians who had graduated more than 10 years previously (*n* = 13; 23%) and who graduated in Spain (*n* = 10; 30%). Among the other topics, audits and food microbiology were both mentioned (*n* = 2; 8%), in particular, from veterinarians graduating in eastern European countries.

Question 2: Topics That Were Taught at Your Vet School but Not in Enough Depth to Fulfill Your Role

Nine topics were identified from 37 free-text answers. When asked to identify any topics that had not been taught in enough depth at their veterinary schools, 13% of the respondents stated "none" (or equivalent wording). More practical training in VPH (*n* = 10; 42%) was the main theme. This was particularly of concern for veterinarians graduating in southern Europe (*n* = 13; 46%). It was mentioned by veterinarians who had graduated less than 5 years previously (*n* = 4; 75%) and those who were working as an OV (*n* = 16; 44%), but also by more experienced veterinarians with 6–10 years of VPH work experience (*n* = 7; 71%). Hazard Analysis and Critical Control Points (HACCP) was the next topic identified as not taught in enough depth at veterinary schools (*n* = 7; 29%). As above, this was brought up

Table 1: Frequency of specific topics suggested by European veterinarians working in VPH in the short questionnaire

Topics	Topics that were NOT TAUGHT but are relevant to my role	Topics that were NOT TAUGHT IN ENOUGH DEPTH but are relevant to my role	Topics that were taught but are LESS RELEVANT to my role
	Frequency (%)		
None	29	13	54
Legislation and enforcement	25	25	–
Welfare at slaughter	17	8	–
Post-mortem pathology	13	21	4
Audits	8	4	–
Population health	8	–	–
General meat hygiene	8	–	–
Food microbiology	8	–	4
Practical emergency slaughter	4	–	–
Ethics	4	–	–
Management	4	–	–
Outbreak investigation	4	–	–
Emerging diseases	4	–	–
Egg hygiene	4	–	–
Food production	–	4	–
HACCP	–	29	–
Practical training in VPH	–	42	–
Milk hygiene	–	4	–
Zoonoses	–	4	–
Food quality	–	–	13
Food technology	–	–	13
Foods other than meat	–	–	8
Sample analytics	–	–	8

VPH = veterinary public health; HACCP = Hazard Analysis Critical Control Points

by veterinarians who were less than 5 years from graduation (n = 2; 50%) and those working as an OV (n = 16; 31%), as well as by more experienced veterinarians with more than 10 years' experience (n = 10; 44%), especially those graduating in southern Europe (n = 13; 38%). The topic of legislation and enforcement was also present in 25% of responses by veterinarians both less than 5 years from graduation (n = 2; 50%) and with less than 10 years of VPH work experience (n = 8; 38%), mainly graduating in southern Europe (n = 13; 38%). Other topics of interest also mentioned in question 2 were post-mortem pathology (n = 5; 21%), welfare at slaughter (n = 2; 8%), and audits (n = 1; 4%).

Question 3: Topics That Were Taught at Your Vet School, but You Find Less Relevant to Your Role

Six topics were identified from 25 free-text answers. Across all categories of veterinarians, 54% of respondents stated that there had been no irrelevant topics in their VPH curriculum. Food quality and food technology were both listed as unnecessary topics by 13% of respondents. This was more evident for veterinarians with 6–10 years of VPH work experience (n = 7; 29%) and for those from northern (n = 3; 33%) and eastern European (n = 8; 25%) countries. Food microbiology (n = 1; 4%) and post-mortem pathology (n = 1; 4%) were also mentioned.

Question 4: Is There Anything Else You Would Like to Comment on That Would Have Improved Your Veterinary Education in Food Hygiene/VPH?

Out of 24 free-text answers, 11 (45.8%) re-emphasized that more practical training in VPH would improve VPH education, 1 (4.2%) asked for more teaching on EU new regulations, and the remainaing respondents stated there was nothing more to add.

Stage 3: Semi-Structured Interviews

Seven semi-structured interviews were conducted with veterinarians working in the UK: four were OVs, two were former OVs now working for other government authorities, and one was a former OV now working as a veterinary advisor for the UK government. A unanimous theme from all the veterinarians was the need to increase the practical training in VPH by, for example, introducing mock audits of food-producing establishments into veterinary training where knowledge and integration of legislation, HACCP, and food microbiology can be applied at the same time. The following is an example of an interviewee comment:

> Of course they teach us legislation but not really in a practical way. I think [it] is better if someone will go in a slaughterhouse and I don't know if here in England [that] will be allowed. To say, look about the legislation that we have just learned this week, let's say hygiene regulation 853, you see in that paragraph it says about the walls, inspect this room, for example, to learn in a more practical way. So they can read the paragraph of legislation and you go with them in the slaughterhouse and ask the students to identify what is wrong, just their impression. Is this wall clean, is this floor clean, is this operator doing what he should do? (Interviewee 1)

Interviewees were also keen to give examples of activities that could be achieved in-house at veterinary school by, for example, using pictures related to authentic case-based scenarios on animal welfare to diagnose pathology at post-mortem inspection or provide microbiology testing reports to allow students to interpret the results:

> I think it will be useful to maybe have some scenario-based teaching on what you do if you came across certain welfare issues in the lairage. Because for me that is definitely, yes, probably one of the biggest things to deal with working as an OV … because I found it difficult to gauge with what was enough to report to the local authorities. (Interviewee 6)

An important aspect was also a need for practical training in communication and negotiation skills in order to effectively liaise with farmers, operators on the production line, and senior management. As well as having a working knowledge of the practical and financial implications of problem resolution, other professional skills were considered necessary, particularly

improving self-confidence and resilience when dealing with difficult situations, especially as a new graduate:

> Because you will finish the university and you are not confident in your knowledge and after that you are not confident in your powers and what you do. If you say something they need to respect so, you are there like oh my god, what else I have to do now because he was shouting at me and he knows better than me because for sure a lot of managers in the plant will know more things than you at the beginning because they have the experience for 20 years or more. That's the thing, they [the students] need more support. (Interviewee 4)

To appreciate the complexity of working in the food industry, some interviewees advocated for veterinary schools owning a commercial abattoir to use for teaching and research purposes and to show the students the implications of running this kind of business. Where there is limited access to an abattoir for teaching, the use of a virtual simulator to train in practical aspects of FH was also mentioned as an educational option:

> For example, if they are doing let's say a chamber in a slaughterhouse and on the virtual reality you can have some non-compliances with comments: here the ceiling, I don't know, is rusty, things like that and when you see with your own eyes, condensation, bad practice on slaughter hygiene and you will see exactly what is happening. And you have like decision on what to do and how to speak to the FBO [food business operator]. This will be tremendous work to do but it will change the learning process. (Interviewee 3)

DISCUSSION

The primary aim of this research project was to evaluate the content of the EFH catalog and to determine whether it is suitable to prepare veterinary students for the current and future challenges in VPH. A secondary aim was to collate veterinarians' suggestions to improve VPH teaching for undergraduate students. A consultation process was undertaken with academics and veterinarians working in the sector using questionnaires and semi-structured interviews. European academics indicated via the long questionnaire that the EFH catalog included most of the topics that were appropriate for a modern undergraduate VPH curriculum. The low number of responses to the questionnaires did not allow for quantitative statistical analysis of the results. However, qualitative analysis of free-text answers in the short questionnaire identified recurring themes that can be used to inform future directions of VPH education. Semi-structured interviews with PH veterinarians identified the need for curricular changes including greater practical experience and a shift from a focus on meat inspection to risk management. Risk management in food safety is defined by the World Health Organization as "the process of weighing policy alternatives to accept, minimize or reduce assessed risks and to select and implement appropriate options."[18(ch.5)]

Topics That Are Taught and Are Relevant to the VPH Role

The results of the long questionnaire showed an overall agreement among VPH academics that most topics in the EFH catalog were important and therefore relevant to the undergraduate VPH curriculum. Some differences were observed related to country-specific requirements (e.g., wild game meat hygiene in countries where hunting is common, or fish hygiene where veterinarians perform official duties in fish markets). It is therefore important that the European VPH curriculum allow for some degree of flexibility so that more time is devoted to teaching topics that are relevant to each country. In the case of inspection of fishery products, however, although this can be country-specific, it is important to consider the rising contribution of fish in terms of provision of animal protein worldwide.[19]

While meat inspection was taught by VPH academics across European veterinary schools, milk hygiene and food analysis teaching was mostly delivered with or by colleagues working in other departments (e.g., farm animal clinics, epidemiology, or pathology). This approach is often an organizational solution to a lack of veterinary expertise in FH and food microbiology in some veterinary schools.[20] The implication of other departments delivering VPH content is that they might not be familiar with practical PH aspects or provide a One Health approach to the topics as they may be inclined to expand on their field of expertise rather than focusing on FH and PH. It can be speculated that this may not constitute a problem in terms of content delivery, per se, but it may have an impact on students' experience and perception of VPH if the teacher does not show the same level of confidence and enthusiasm in teaching VPH as they do when teaching their own subject. This could therefore be a contributing factor to the unpopularity of VPH among students.

Some topics of particular relevance to specific hazards such as antimicrobial-resistant pathogens, mycotoxins, and infective proteins like prions were not taught by all the VPH academics but by their colleagues. This warrants further investigation as it is important to link these important PH and One Health topics across the curriculum. The EFH catalog could be used as a tool to support such discussions, and it may also help to spot duplication of teaching in the curriculum and reduce curriculum overload. This result is interesting because of the importance of adopting a holistic approach in reducing antimicrobial resistance in animals and food, which is also relevant to other disciplines in a One Health context.[21] Mycotoxins are considered to be a future primary foodborne hazard due to global warming,[22] and prions are linked to the bovine spongiform encephalopathy crisis, whose global repercussions endure.[23]

In the short questionnaire for veterinarians, 29% of respondents stated that no topics needed to be added to the VPH curriculum. A possible reason for this view is that most students go into clinical practice, and for them, the VPH content taught at the veterinary schools is sufficient. In the authors' experience, some students report that there is too much VPH content in the curriculum at the expense of other clinical disciplines, and this may contribute to the unpopularity of VPH. On the other hand, the veterinarians currently working in PH felt that more VPH teaching was needed at veterinary schools for future PH veterinarians to perform their duties. Contrasting stakeholder views on this point indicate a need to find the right balance of VPH content in the curriculum by focusing on D1Cs and avoiding curriculum overload.

Topics That Are Taught and Are Not Relevant to the VPH Role

Academics and veterinarians agreed on topics that are not relevant to the VPH curriculum. The nutritional significance of food and food of plant origin are more applicable for post-graduation specialization level than as D1Cs for veterinary students. Similarly, the rules and guidelines for import and export of food to and from different countries and the associated legal and administrative

procedures are more appropriate to on-the-job training for OVs. Differentiating topics at each level of training will help reduce the burden on the undergraduate curriculum.

Topics That Are Not Taught in Enough Depth in the VPH Curriculum

More teaching on legislation and enforcement is needed during undergraduate studies, according to 25% of respondents. Interestingly, good knowledge and application of legislation and enforcement is key to the work of OVs and even more so for managers in providing pertinent advice to OVs. However, in many European countries, veterinarians working in PH need to attend post-graduate courses to be licensed as OVs (e.g., the UK OV course) and familiarize themselves with the legislation and enforcement practices specific to their country. Therefore, it is more appropriate to expand this topic as part of a post-graduate specialization rather than in the undergraduate curriculum and as part of on-the-job training to perform OV duties.

Practical teaching of pathology for post-mortem inspection is the second topic that requires greater emphasis in the VPH curriculum, as it is essential to perform official controls at the abattoir and is a D1C.

HACCP was identified as the third topic that needs more teaching at veterinary schools. This result validates the relevance of HACCP as one of the cornerstones of modern FH and safety.[24] This is an example where practical training on audits of food-producing establishments or by using authentic case-based scenarios may help students integrate and apply underpinning knowledge to real-world situations.

Practical Training in VPH

The analysis of the responses to the short questionnaire and the semi-structured interviews clearly identified two main topics: (a) legislation and enforcement and (b) practical training in VPH. These results are consistent with the findings of Maijala and Korkeala in Finland.[25] Other topics relevant to modern VPH curriculum were post-mortem pathology, HACCP, food microbiology, and audits. It is worthwhile to note that these topics have a strong practical ethos, further endorsing the need to increase the practical training in VPH in Europe. For example, conducting mock audits of food safety management systems during abattoir visits can help students link relevant topics together in a practical way. To help overcome some challenges presented by hands-on practical training in the workplace (e.g., performing post-mortem inspection of carcasses at the abattoir, access to abattoirs), e-learning tools can be used as aids to prepare for practical training and ensure students can then make the most of on-site learning opportunities. A specific example for meat hygiene e-training is the virtual slaughterhouse simulator, an innovative tool that allows students to follow animals from arrival at the lairage along the line to post-mortem inspection. The simulator can support traditional lectures, prepare students for practical classes, and be used to stimulate interactive problem-solving skills.[26]

The interview results suggest that new approaches in teaching VPH, such as greater use of pictures and test results from real cases, should be used to complement traditional lectures. There has been a trend to move away from teacher-led lectures and toward more active learning, with greater interaction between teachers and students in an inclusive student-centered environment,[27] accepting that in the appropriate context, lectures can still have the capacity to inspire.[28] Increasingly, educational interventions such as authentic case-based scenarios and other means are a focus; these support the development of problem-solving and clinical reasoning abilities rather than simple knowledge acquisition.[29] These approaches have the potential to promote a more intellectually stimulating environment for both (faculty) staff and students, but they can have costs in terms of staff time (e.g., to facilitate small groups and/or prepare the cases, etc.) and may be particularly challenging in larger class sizes. Although teaching techniques can be adjusted depending on different circumstances (e.g., facilities, number of students, number of teaching staff), the contents of the course and, in particular, staff–student contact time should be much more focused on discussing problem-based case scenarios in the classroom rather than on delivering scientific concepts only.[30] Problem-based scenarios, especially if adapted from real cases, have the potential to link different scientific concepts and to demonstrate how they are applied in real life situations, giving a One Health perspective to the students. In this context, e-learning can be useful, particularly for media-rich resources such as images and videos, and provide interactivity with real-time feedback.[20]

Day One Competencies, Professional Practice, and Employability

Two important themes identified during the interviews were (a) the need for training to include communication and negotiation skills to deal with different stakeholders and (b) ways to improve self-confidence and resilience when dealing with difficult situations, especially for recent graduates. These findings are relevant when considering the competencies desired by those employing VPH professionals, which have been identified by Alonso et al.[31] in descending order of importance: (a) problem solving in an analytical and scientific way; (b) efficient and effective organization of work; (c) clear expression of thoughts; (d) broad horizon and inter-/multidisciplinary thinking; and (e) social competence, empathy, and ability to work in team. In 2015, Stärk et al.[32] revisited the competencies for government veterinary services for the future and concluded that improving communication skills along with technical knowledge was necessary. It is interesting to note that the competencies identified by Alonso et al. and Stärk et al. have been included as part of many curricular reviews in recent years, which have increased emphasis on the development of clinical reasoning, problem-solving, and professional skills, with less on content knowledge.[4] Many veterinary schools are including specific professional skills courses within their curriculums, with an increased emphasis on improving student resilience and mental health at work.[33]

In addition, the range of job opportunities for VPH professionals is extending beyond more traditional government and academic work. For example, the food industry is becoming more aware of the importance of the role that veterinarians can play, with a shift from technical roles to roles that emphasize leadership (Figures 4 and 5). With an increased range of job opportunities for veterinarians in PH, veterinary schools should consider how to complement Day One Competencies with specific skills related to the careers students may chose after graduation. For example, some specific VPH competencies could be offered in undergraduate elective courses, furthering post-graduate qualifications or on-the-job training.

Limitations and Areas for Future Research

Information that could identify a respondent in long questionnaires (nationality and veterinary school) was removed before analysis to maintain anonymity. It was accepted that removing

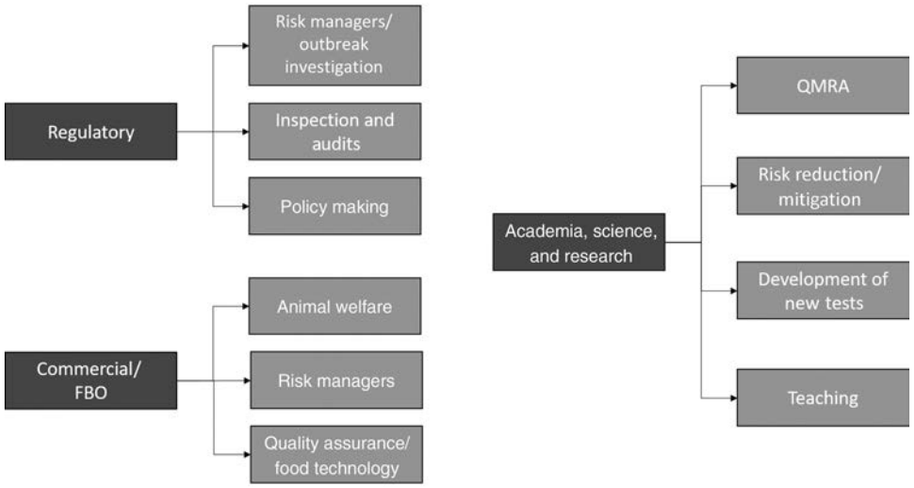

Figure 4: Main job categories available to VPH professionals

VPH = veterinary public health; FBO = food business operators; QMRA = quantitative microbiological risk assessment
This topic was discussed at the European Veterinary Food Safety Teachers Meeting, Uppsala (June 2016).

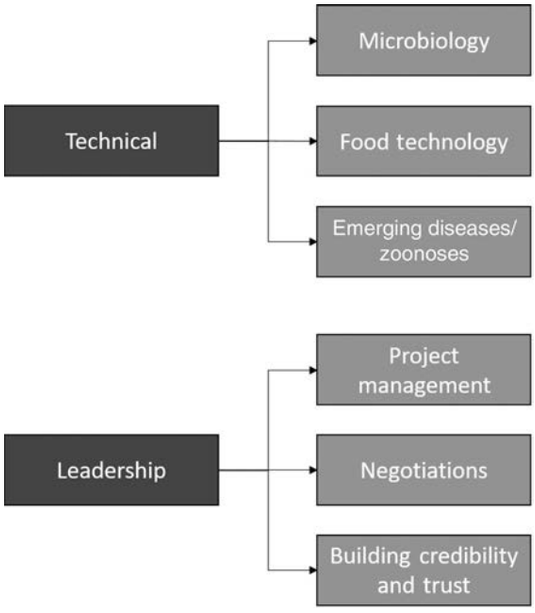

Figure 5: Main job competencies expected from VPH professionals

VPH = veterinary public health
This topic was discussed at the UK VPH Teachers Meeting with government authorities, Cambridge (September 2016).

nationality and veterinary school reduced the ability to draw conclusions related to those variables. The low number of responses to the questionnaires did not allow for quantitative statistical analysis of the results, and this can be seen as a limitation of this study. For the long questionnaire, the need to evaluate 305 items likely affected the response rate. However, the 18 (of a possible 49) academics did represent 12 countries, and general agreement existed about most topics in the EFH catalog. The response to the short questionnaire was low (24/348) and may indicate that these individuals did not prioritize completing a survey as part of their daily work. In retrospect, we should perhaps have sought additional ways to raise awareness among this group. In addition, it would have been helpful to perform a more granular country-based analysis, but the low response rate to the short questionnaires prevented it. This can be considered an area for future research.

Another limitation is that the VPH curriculum may have changed since the time that the veterinarians who participated in our study graduated, especially if that was some years ago. The participants were likely to have reflected on the curriculum they experienced; therefore, their suggestions need to be checked against the current curriculum at veterinary schools. Last, interviews were conducted with veterinarians working in PH in the UK only, so the findings may not be relevant or generalizable across Europe.

Future research should explore the perspectives of students (a stakeholder not included in this study) about the future of VPH education and, in particular, how to spark their interest in VPH in the undergraduate curriculum. The study findings will be presented and discussed at the next EVFSTG meeting and will promote the relevance and value of using the EFH catalog as well as discussing opportunities to engage in new ways of teaching. The study team is encouraged by the recent award of the Una Europa Seed Funding grant in February 2021 to facilitate the creation of a network of European VPH educators and to complement the EVFSTG initiative.

CONCLUSIONS

The results of this study show that the EFH catalog is a valid and useful tool on which to base VPH teaching and potentially provide a more harmonized European VPH curriculum. Useful enhancements to approaches to teaching and learning practices were identified to better align with employers' requirements and the modern role of veterinarians in VPH. Veterinary schools across Europe have the opportunity to adopt a more collaborative and consistent approach to improving and modernizing the ever-evolving pedagogy of VPH.

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