

# Biological agents and prevention of work-related diseases: a review

European Risk Observatory

Summary

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## Abstract

A subset of all microorganisms cause disease(s) in humans (pathogens), and the health effects caused by biological agents have a major impact on public health. Worldwide, an estimated 320,000 workers die annually from work-related infectious diseases, 5,000 of whom in the EU. More insight into and awareness of biological risks is therefore vital for a detailed evaluation of these health effects, including those of combined exposures.

This 'review on work-related diseases due to biological agents' project, commissioned by EU-OSHA, intended to provide more insight into the problems and to provide information about health effects related to biological agents for policymakers, actors in occupational disease monitoring and recognition, actors at the enterprise level and those in sectoral organisations. The report presents the results of the review, including information on emerging risks, monitoring systems and examples of prevention measures. The views of different parties, workplace practitioners and experts (based on interviews and focus groups), and their converging and diverging views, were included. As biological agents are widespread, several sectors were addressed more specifically: animal-related work, waste and wastewater treatment, healthcare, arable farming, and occupations that involve travelling or exposure to travellers.

Recommendations at the European level from the project include harmonisation of monitoring systems with regard to collection of data, the need for better implementation of policy measures to increase their effectiveness, more knowledge exchange, developing reliable and standardised measurement methods for exposure to biological agents, and suggestions for changes in the EU Directive on biological agents. At the national level, the visibility and the approachability of experts should be improved, and the importance of dealing with the workplace risks from biological agents and awareness raising should be emphasised. At the sector and company level, wider approaches for sector-transcending risks and process approaches with a broader scope and higher level solutions should be implemented. An approach similar to a lifecycle approach in chemicals management could be adopted that includes all steps and tasks of a worker (locally), seeing all possible risks that the worker encounters. A combined risk approach (taking a broader scope and including more (diverse) risks (biological risks, physical risks, chemical risks, and/or risks from biological agents) would emphasise the importance of workplace risk assessment. More general, broader prevention policies and measures that also protect workers from exposure to biological agents should be implemented to tackle unintentional exposures.

## Executive summary

This project, commissioned by EU-OSHA, intended to provide more insight into the health problems encountered by workers that are exposed to biological agents and the challenges to their employers. It also aimed to provide information on structured approaches to recognising and preventing the effects of biological agents that may support the work of policymakers, actors in occupational disease recognition and reporting, actors at the enterprise level and those in sectoral organisations.

### Definitions and scope of the project

Directive 2000/54/EC on the protection of workers from risks related to exposure to biological agents at work defines 'biological agents' as *micro-organisms, including those which have been genetically modified, cell cultures and human endoparasites, which may be able to provoke any infection, allergy or toxicity*. It goes on to define 'micro-organism' as a *microbiological entity, cellular or non-cellular, capable of replication or of transferring genetic material*. This research project uses a wider definition of biological agents, namely: *microorganisms and carriers of plant or animal origin that can cause adverse health effects in workers, and that can be divided into two groups: living (micro)organisms (such as bacteria, viruses, fungi, yeasts and prions) and substances or structures that originate from living or dead organisms (such as exotoxins, endotoxins, glucans, mycotoxins and allergens)*.

Only a small subset of microorganisms – pathogens – cause disease in humans. Health risks related to biological agents occur in all kinds of circumstances and (occupational) environments.

## Project design

The project consisted of five tasks that feed into each other:

1. literature review on specific work-related diseases (WRDs) due to biological agent exposure and review of selected monitoring systems, complemented by a stakeholder survey;
2. structured interviews with experts on their views on policy and practices;
3. focus groups with workplace intermediaries;
4. a stakeholder workshop in which the intermediate findings of the research were presented and commented on;
5. final report summarising the abovementioned tasks, including policy recommendations.

The various tasks provide an overview of what is known from literature and practice on health effects of biological agents, sectors and occupations at risk, and policy and prevention measures in selected sectors. Together this enables an assessment of the discrepancies and similarities between research, policy and current practices, showing the gap between what is known from research on biological agents and the risks they pose and what is currently done to prevent exposure to biological agents (policy and practices).

This report (task 5) presents the summary of the integrated tasks 1 to 4 and provides policy recommendations that decision makers can consider for improving the prevention and control of the effects of biological agents at the workplace.

## Methods

### *Literature review (task 1)*

The aim of the scientific literature review was to identify and summarise existing reviews on biological agents and adverse health outcomes and studies on monitoring systems, databases and the provisions of EU Directive 2000/54/EC<sup>(1)</sup>. An extensive search was carried out in databases containing both official scientific literature and grey literature. In addition to the literature search, a stakeholder questionnaire was developed to gather information on data sources that help target the prevention of diseases and emerging risks caused by biological agents and monitoring systems of exposure and disease. It also collected the views of the stakeholders on priorities for research and prevention, as well as information on campaigns, prevention programmes and particularly interesting case studies or smaller outbreaks of diseases linked to exposure to biological agents. The questionnaire was distributed among members of EU-OSHA's network of focal points, the European Foundation for the Improvement of Living and Working Conditions' (Eurofound's) European Observatory of Working Life (EurWORK)<sup>(2)</sup>, the Partnership for European Research in Occupational Safety and Health (PEROSH)<sup>(3)</sup> and Modernet (Monitoring trends in occupational diseases and tracing new and emerging risks in a network)<sup>(4)</sup>. The questionnaire also supported the selection of national monitoring systems from Denmark, France, Germany, the United Kingdom, the Netherlands and Finland, for further exploration and comparison. The literature review was published by EU-OSHA in 2019 (EU-OSHA, 2019a). It provides an overview of the most relevant biologic agents workers are exposed to and the resulting health problems, including extensive overview tables of the most relevant agents and diseases in different occupations and sectors.

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<sup>(1)</sup> Directive 2000/54/EC of the European Parliament and of the Council of 18 September 2000 on the protection of workers from risks related to exposure to biological agents at work (seventh individual directive within the meaning of Article 16(1) of Directive 89/391/EEC).

<sup>(2)</sup> EurWORK gathers all Eurofound's resources on working conditions and industrial relations, and is supported by a network of European correspondents across all EU Member States and Norway. Eurofound runs two regular surveys on working life issues — the European Working Conditions Survey (EWCS) and the European Company Survey (ECS) — which are another major resource for the observatory.

<sup>(3)</sup> PEROSH partners aim to coordinate and cooperate on European research and development efforts in OSH. The network comprises 13 OSH institutes, all of which play key roles in their national affiliations to governments/authorities and health and accident insurance systems.

<sup>(4)</sup> Modernet was founded in 2008 as a collaboration between academic centres investigating occupational disease and work-related ill health incidence in a few EU Member States. Between 2010 and 2014, the network grew to include 12 more European countries and one institute from Australia.

It also explores the allergenic effects of biological agents and provides an in-depth insight into the monitoring systems from the above-mentioned sectors and conclusions and recommendations for monitoring of exposures and disease.

### ***Semi-structured interviews with experts on policy measures (task 2)***

A total of 25 interviews were conducted with experts from Denmark, Finland, France, Germany, and the Netherlands to obtain their view on policy and existing policy measures in their country for five groups of high-risk occupations (animal-related occupations, waste and wastewater management, health care, agriculture and occupations that involve travelling and contact with travellers). The interviews were semi-structured and conducted either online via Skype or face-to-face. To make sure that the experts had the same starting point, an introductory document clarifying the definitions and concepts used during the interview and providing a list of examples of OSH policy was sent to them in advance. Five experts per country took part in the interviews, resulting in a total of 25 interviews. The interviewees were from different fields and disciplines, and worked in research, policy and practice, and consultancy.

### ***Focus groups (task 3)***

The objective of the focus groups was to learn from the experience of intermediaries (OSH service providers, labour inspectors, safety technicians, occupational health services, trade union representatives, etc.) to identify specific upcoming risks and any lack of measures regarding work-related diseases due to biological agents, and to address the possible need for additional measures. A total of 39 experts participated in the focus group discussions held in Denmark, Finland, France, Germany and the Netherlands. Many experts were familiar with biological agents in more than one sector, and thus able to participate in discussions on topics from different sectors.

### ***Stakeholder workshop (task 4)***

The goal of the stakeholder workshop was to inform stakeholders of the project's (intermediate) main findings, and to enable a discussion (on a policy level) with relevant experts and stakeholders on what could be done on both the European and national level to (better) control the risks associated with exposure to biological agents in the workplace. The participants had received the draft final report and discussion questions beforehand. In total, 37 persons (from Austria, Belgium, Bulgaria, Croatia, Denmark, Finland, Germany, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Norway, Portugal, Romania, Slovenia, the Netherlands, and the United Kingdom) attended the workshop. During the workshop, the (intermediate) main findings (tasks 1-3, including emerging risks, monitoring systems and options for policy measures) of the project were presented. Furthermore, a representative of the European Commission provided information on the results of an evaluation of the EU OSH acquis and proposals for amending Directive 2000/54/EC. A representative of the German Committee on Biological Agents presented on the national policy framework on biological agents in Germany. A representative from France presented on a national monitoring approach addressing emerging diseases in France, and a representative from Finland presented a national prevention policy approach (the farmers' occupational health services (FOHS)). The presentations were followed by group discussions and a plenary discussion in which the outputs of the different discussion groups were summarised. The discussion topics were 1) monitoring of diseases due to biological agents and exposures to biological agents, 2) policies and practices in place for managing and controlling exposures to biological agents in the workplace, 3) specific sectors and groups, and 4) EU directive on biological agents.

## **Results**

Based on the outcomes of the literature search and the interviews, five groups of high risk occupations were identified and more information was collected on these sectors: animal-related occupations, waste and wastewater management, healthcare, arable farming and occupations that involve travelling for work and contact with travellers, such as for example in customs work. The result of this research is summarised in five articles describing the specific risks from biological agents for workers in these occupations and examples of prevention measures and programmes, as well as specific vulnerable groups in these sectors and this report (EU-OSHA, 2019a-f). Three of these five groups of occupations, i.e. animal-related occupations, waste treatment and healthcare were discussed in the focus groups,

which explored current and emerging workplace risks and the policies and initiatives in place to prevent these risks.

The association between occupation and diseases resulting from biological agents (excl. allergens) is clear among healthcare workers at risk of blood-borne and other infections, and for occupations that involve the intentional or inadvertent handling of animals. For allergenic agents, the sectors and occupations that were identified as being at a clear occupational risk are the agricultural and fisheries sector, the food industry, the wood-working and metal industry, and occupations in waste management and wastewater treatment.

### **High-risk occupations**

Regarding **animal-related occupations** (abattoir and slaughterhouse workers, agricultural workers (including animal farming), laboratory workers, veterinarians), animal farmers frequently mentioned and reported respiratory health effects.



Veterinarians may get infections through direct animal contact or bites by vectors (e.g. ticks, lice). Among abattoir and slaughterhouse workers, bird-related zoonoses, bacteria-related diseases and tick-borne diseases may occur more frequently. Smaller outbreaks of Q fever were also reported by stakeholders. Laboratory workers who handle insects or laboratory animals are particularly exposed to allergenic agents. Immediate onset of hypersensitivity reactions from exposure to laboratory animals' urine, hair, dander and/or saliva are possible.

**Organic dust** – which facilitates the spread of bacteria and viruses – was identified as a high priority risk and is mainly caused in these occupations by intensive breeding of animals and dust generated when feeding animals and cleaning. Exposure to organic dust could be reduced by raising awareness and providing guidance on how to avoid exposure and how to improve cleaning methods, correct storage and handling of feed and litter, and, if necessary, the use of personal protective equipment (PPE). Hygiene measures and the separation of work clothing from street clothing (black-white areas) can help prevent the spread of infections and organic dust to other areas of farms.



In **arable farming**, workers are exposed to a diverse range of biological agents due to their work with crops, and this can lead to various diseases. Tick-borne diseases, Crimean-Congo haemorrhagic fever (CCHF) and lung diseases are reported in this sector, and exposure to organic dust is frequent. Farmer's lung, caused by inhalation of microorganisms from products stored in conditions favourable for their growth, is likely the most common allergic condition among agricultural workers. Lyme disease is also predicted to be a significant health concern in the coming decades because of the spread of ticks due to changes in climatic conditions. Policy measures exist to prevent farmer's lung and other farmers' diseases related to the growth of moulds and bacteria. Existing measures are, for example, dust-avoiding storage and processing methods of hay grains, animal feed or litter.



The waste and wastewater **management** sector comprises different subsectors: waste collection and handling of waste, recycling and composting, and wastewater treatment. Infections with HIV and hepatitis B may be caused by sharps injuries during handling and sorting of waste. Many experts stressed the need in this sector for vaccinating workers to prevent bloodborne diseases due to needlestick injuries. Adverse respiratory effects due to exposure to bioaerosols or organic dust are also frequently reported in this sector, in particular among waste handlers and these exposures may also cause irritation of the nose and an increase of immune system activity. The wide variety of risks during waste handling, composting and recycling makes it difficult to determine the best way to control risks due to biological agents. Possible measures against the risks in this sector are technical solutions such as improving ventilation or separating workers from waste entirely and better training and information for workers. The experts also stressed the need for clear regulations and the setting of maximum limit values to improve OSH prevention.



Allergenic agents are considered a clear risk in sewage and wastewater plants. A causal relationship between exposure to non-infectious airborne biohazards and the occurrence of gastrointestinal symptoms, fever, respiratory symptoms, skin disorders, eye irritation, headache, fatigue and nausea among the workers of sewage treatment plants was reported. Leptospirosis, an infectious disease that can pass from rats to humans when a minor skin injury is exposed to water or soil contaminated with animal urine, caused by *Leptospira* spp., has also been reported among wastewater and sewage workers.

Of all the sectors considered in this review, most information regarding work-related diseases due to exposure to biological agents was available for **the healthcare sector**. Health risks are most frequently reported in relation to accidents with sharps (mostly needlestick injuries), which may lead to viral infections. The primarily described diseases are influenza, tuberculosis, hepatitis and HIV. Policy measures in the healthcare sector are, for example, the implementation of safe needle systems and emphasis on continuous training and information for medical as well as non-medical staff (e.g. cleaning personnel) and temporary workers.



**Surgical smoke**<sup>(5)</sup> is an issue that was mentioned in relation to the use of newer operation techniques, but not addressed by the experts who discussed prevention measures. Nevertheless, it should be mentioned that this sector is considered well-regulated because of its relatively high awareness of biological risks and its workers following the regulations. This primarily counts for nurses and doctors, however for cleaners and foreign workers there is still a lack of awareness to be observed.

Travelling is generally assumed to increase the geographical spread of diseases not commonly encountered in Europe. **Occupations that involve travelling or contact with travellers** were considered of concern because of changing patterns in travelling and global trade, the emerging risks related to travelling to and from endemic areas and the potential spread of diseases. Specifically, hepatitis E incidence is associated with travelling to endemic areas. Moreover, the migration of immigrants/refugees to Europe may also introduce such diseases and this may put workers in services to migrants at risk.

The types of workers at risk of contracting similar diseases to those of leisure and business travellers are transport staff and workers at borders (e.g. airline personnel, customs workers), global trade workers, workers in war zones, epidemic control (field) workers, epidemiologists, journalists and media

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<sup>(5)</sup> Surgical smoke plume is a dangerous by-product, a gaseous material generated from the use of lasers, electro-surgical pencils, ultrasonic devices, and other surgical energy-based devices. As these instruments cauterise vessels and destroy (vaporise) tissue, fluid, and blood, a gaseous material known as surgical smoke plume is created. It is estimated that approximately 95 % of all surgical procedures produce some degree of surgical plume.

professionals. The diseases associated with infection risks to these workers are avian flu, Q fever, dengue fever, Ebola/Marburg virus infection, tularaemia, legionellosis, measles, tuberculosis, yellow fever, SARS, cholera and meningitis.

### **Other occupations and sectors**

Although the qualitative research mostly focused on the five prioritised sectors and groups of occupations, information on other sectors was also obtained, in particular from the literature review. There is a clear association between occupation and disease among forestry workers (tick-borne-related diseases), sex workers (sexually transmitted diseases), and workers maintaining air-conditioning systems, who are at risk of *Legionella* infection. Childcare was mentioned as a risk, because children may be exposed to more biological agents and transfer the biological agents to workers through physical contact.

### **SMEs**

Although hardly any information was retrieved regarding small and medium-sized enterprises (SMEs) in the literature survey, the experts and practitioners involved in this study agreed that the management of biological agents may be challenging for SMEs, given their lack of knowledge and awareness. Consequently, training and awareness-raising were recognised as particularly important in SMEs, of which there are many in, for instance, the agricultural sector (both arable farming and livestock farming). They are difficult to reach, and often have less (financial) means to implement control measures.

One way in which to reach SMEs could be the implementation of policy measures at the municipal level, which may create a more direct approach between the local government and SME owners, resulting in more communication and awareness. It would also be beneficial to work through the sectoral organisations, who know best the specific conditions of the sector and provide very short, sector-specific information to SMEs. Italy has provided subsidisation since 2010 for enterprises that want to improve their working conditions, including the control of risks due to biological agents. In Ireland, a tool called 'BeSmart' (Business Electronic Safety Management and Risk assessment Tool) aims to help business owners/managers prepare a risk assessment and safety statements for the workplace. The tool



highlights the main hazards in a sector and covers biological agents. In the Netherlands, Stigas<sup>(6)</sup> provides a tool for entrepreneurs and workers in the agricultural sector.

Another approach was chosen in Finland when setting up occupational health services for the agricultural sector that work as intermediaries for the prevention messages and are provided with specific technical knowledge for the sector. They provide consultancy at farms and at the same time perform health checks among workers at these farms.

### **Vulnerable groups**

One of the objectives of this research was to identify vulnerable groups among the workers exposed to biological agents. Vulnerable groups across occupations include trainees and (young) workers in their first jobs (who may be at a higher risk than their more experienced colleagues), pregnant workers, elderly workers (being more susceptible to the effects of biological agents), the immunocompromised, people with chronic diseases, temporary workers, foreign/migrant workers, cleaners and maintenance workers and workers that have undergone chemotherapy. Legal

<sup>6</sup> Stigas is an independent knowledge institute that works for all agricultural and green sectors. Stigas stimulates employers, employees and the self-employed in the agricultural and green sectors to work healthily, safely and sustainably. Their services include: 1) legally required activities such as risk inventory, risk evaluation and preventive medical research, 2) information and training for machine safety, hygiene and healthy movements during work and 3) programmes for e.g. sustainable employability.

requirements are laid down in two EU directives covering pregnant and breastfeeding workers, and young workers, and the national requirements implementing these directives should be taken into account when setting preventive measures for those groups. However, the other vulnerable groups identified in this review should also be taken into account in workplace risk assessment and specific preventive and protective measures need to be set for them.



Vulnerable groups specific to a sector include young health workers working abroad or in resource-poor countries and temporary workers in agriculture and Cleaning and maintenance workers are also considered to be at high risk in the waste treatment sector.

Some groups of workers may be more vulnerable to specific biological agents and these include those exposed to organic dust: pregnant women, people with pre-existing diseases, like lung diseases, allergies and asthma, people who suffer from diabetes (because of increased risk of infections) and people with (other) chronic diseases. These risks could be addressed by applying more stringent dust prevention measures and using protective equipment.

There is a need to improve training programmes for new workers in work sectors and occupational groups that are identified as being at a high risk of biological agent- or allergen-related diseases in this report. Awareness should be raised among employers about the needs of these groups and their obligation to protect them at work.

## **Emerging risks**

One of the objectives of this review was to collect information on emerging risks related to biological agents' exposure at work, the related health problems and how these could be prevented. The validation of the information in the literature review and in the qualitative research with experts for this review that was retrieved is not straightforward, however. Information on the prevalence or incidence of exposure to biological agents and the associated diseases is scarce.

The concept of emerging risks covers newly created or newly identified risks, growing risks or risks that are becoming more widely known or established. The definition of emerging risk was first included in an EU-OSHA forecast of emerging biological risks (EU-OSHA, 2007).



An 'emerging OSH risk' is often defined as any occupational risk that is both new and increasing.

In terms of biological agents in Europe, new bacteria developed through bioengineering and increased exposure to bacteria and fungi due to the increased collection and separation of organic waste were considered significant emerging risks. The experts involved in this review warned that the expected increase in green jobs in the future may result in an increased prevalence of sensitisation to biomass-related allergens.

Furthermore, due to the huge migration flow of recent years, the risk of transfer of biological agents from the Middle East and Africa to Europe is considered an important factor. Despite the greatly increased movement among populations from very diverse regions (including Asia, Middle East, Africa) to the European region, research on the transfer of biological agent-related diseases from populations outside the region was limited to only one publication, although without occupational context, indicating an important research and monitoring gap.

Climate change is also considered a significant parameter with respect to newly created risks in that it influences the geographical distribution of the vectors (ticks, mosquitoes) of biological agents, thereby facilitating the spread of diseases that are new to a region. Risks linked to exposure to biological agents at work emerging in Europe, as detected by the literature review, are for example, Rift Valley fever, yellow fever, malaria, dengue, chikungunya, and Crimean Congo haemorrhagic fever. The hepatitis E virus appears to be an emerging problem in several industrialised countries, where it is mostly associated with either travelling to a hepatitis E virus-endemic area, for example, airline personnel, or with contact with pigs (which are a major reservoir of the hepatitis E virus).

Indeed, the EU-OSHA expert forecast on emerging biological risks (EU-OSHA, 2007) indicated that livestock may act as a reservoir of biological agents, potentially resulting in global epidemics or zoonoses, covering diseases such as severe acute respiratory syndrome (SARS), avian influenza, the Ebola and Marburg viruses, cholera, dengue, measles, meningitis, yellow fever, Q-fever, legionellosis, tuberculosis, and tularaemia, all of which may be particularly relevant to animal-related workers (EU-OSHA, 2007). This was confirmed by the research in this review which identified a wide range of possible zoonoses. In addition, there may be a wider spread of these diseases due to either climate change, changes in the way the sectors are organised, for example for breeding and transport of animals, the travelling patterns or the economic changes and the goods and migration movements caused by globalisation of the economy. The recent Coronavirus epidemic is one example of such an impact. An



overview of the many diseases and biological agents causing them is provided in the literature review (EU-OSHA, 2019a).

For animal-related occupations, especially animal farming, the increasing industrialisation of activities was recognised as an issue due to the increase in size of industrialised farms and numbers of animals, facilitating the spread of diseases. Intensive breeding and technological changes in agriculture are also putting workers at risk of being exposed to organic dust. The increased resistance of microorganisms to antibiotics was another risk mentioned in the literature and tackled in several Member States; this development puts care professionals as well as workers in the agricultural sector at risk because of intensive breeding and widespread use of antibiotics. It was reported that the high number of animals kept in husbandry may lead to bacterial resistance to antibiotics.

Changing patterns in human behaviour, notably travel behaviour, are also considered a major player in emerging risks. The fact that vaccination programmes for diseases such as pertussis and malaria, which are most commonly associated with developing countries, now exist in EU states suggests that some countries (e.g. the United Kingdom, the Netherlands) recognise the importance of (work) travel in the distribution of diseases from the EU region.

Stakeholders had also mentioned a few issues in addition to those identified in the literature review, such as the resurgence of tuberculosis, linked, *inter alia*, to migration of people from outside the EU; the wider spread of vector-borne diseases and leptospirosis, linked to climate change; and the issue of new viruses. The Zika virus was one that has recently caused concern, and which was nonetheless not prominent in the literature search. In addition to these issues, experts and stakeholders highlighted the resurgence of common childhood diseases, the unpredictability of allergic reactions and the importance of addressing antibiotic resistance. GMOs and tetanus were two issues that were not identified in the literature survey and were not addressed by experts and workplace practitioners. Finally, re-emerging diseases were also identified, such as Q-fever, tuberculosis and influenza among occupations in agriculture and healthcare.

## Monitoring systems

The systems for monitoring exposure to biological agents and/or the related diseases assessed in this review vary to a large extent among the five evaluated countries. They differ in terms of what is monitored, how frequently it is monitored and the level of detail in monitoring. Moreover, the information from monitoring systems is often not publicly accessible, and if the information is available it is often summarised, for example by class of biological agents, omitting the culprit biological agent(s) and making it difficult to identify the disease.



It is even more difficult to monitor disease when it is caused by a mixture of biological agents, for example farmers' lung caused by organic dust. This limits the possibilities for a comparative analysis of work-related or recognised occupational diseases at the EU level. Ideally, to harmonise the different monitoring systems, it was suggested by the experts that information is made available to stakeholders as much as possible, with a standard set of key parameters that need to be monitored. It would help if the output from the systems in each country

were published according to causative agents (exposures), industries/sectors, jobs/occupations, age, and gender. It was also recommended that English be used as the overall reporting language, and that the level of detail that should be reported is agreed on.

## Underreporting

Furthermore, diseases in general, and thus also work-related diseases related to biological agents, are known to be underreported. Providing more guidance and training on, for instance, criteria for the recognition of specific diseases due to biological agents, may result in less underreporting. In combination with a harmonised structure of monitoring systems in European countries, a better overview of the occurrence of disease due to exposure to biological agents in the workplace, including emerging biological risks, could be generated. This would provide better information that could be used to target and prioritise preventive measures. It would also enable comparison between countries and between industries within countries. This in turn could result in more effective preventive or control strategies being implemented.

## A missing link to prevention

Even with a suitable output, it is unclear to what extent the stakeholders use this information to target prevention. In general, the information is provided in annual reports, which are distributed among stakeholders such as ministries and the Labour Inspectorate. However, the information is not very precise and as the analysis of the data in this review shows, is not useful for a detailed assessment by disease, biological agents, allergen, sector, occupation, age or gender. As no information on the prevalence of diseases or exposures can be gathered, it is very difficult to identify those groups that are most exposed or rank and prioritise sectors or occupations or the causative agents for action and prevention.

Some systems do, however, collect information on follow-up action at the workplaces and this information can be very valuable where similar problems occur, in research or for the development of workplace guidance. Experts have highlighted the need to digest and communicate such information in a way that makes it accessible to the workplace level and suitable to the target groups. Such a function does seem to be fulfilled by some of the expert networks that exist, for instance those that are linked to a reporting system (for instance for specific zoonoses) or those linked to the alert and sentinel systems.

## Limited coverage of sectors and occupations

Self-employed workers are often not included in the registration process. Some systems report limited coverage of specific sectors of the workforce (e.g. agriculture) or specific groups of workers, such as maintenance workers, who may not be covered either by legislation or by notification and recognition procedures. In the chapter on vulnerable workers a number of workers with potentially insufficient coverage were identified, for example temporary workers (for instance migrant workers in agriculture or waste management), young workers or trainees, for instance when they engage in health systems abroad, or those who travel for work or are in contact with travellers or immigrants, for example. It is not sure whether diseases they contract in the course of their travelling or placements abroad are registered as work-related or occupational diseases. More effort is therefore needed to ensure the recognition of health problems affecting those groups, their work-relatedness and reporting of diseases to the monitoring systems and raise awareness among those who report these diseases.

## Types of diseases that are recorded

Both **infectious and respiratory and allergic diseases** related to biological agents exposure were covered by the systems, despite the fact that the second group was not related to specific biological agents or even exposures. These diseases are multifactorial and biological agents, including specific ones, can be identified as one of the causes, but it is difficult to link the effect to one cause or one agent. Workers affected by these diseases are normally exposed to a mixture of biological agents (for example in organic dust) and a mixture of biological and chemical agents. This may challenge the definition principle of recognised occupational diseases, which postulates the need for an occupational disease to be primarily caused by a specific agent that can be clearly identified. Nevertheless, some of the systems described in this review do allegedly include diseases aggravated by certain exposures, for instance to biological agents. The diseases registered under these categories also represent a high proportion of the diseases linked to biological agents. It may very well be that the guidance documents for the different countries and diseases provide more detail.



What also emerges from the analysis is that **zoonoses** are recorded to a varying degree, although their importance is recognised in literature and by the experts who contributed to this review. While zoonoses are differentiated in the compensation system (IIDB) in the UK, and are also included in the French sentinel system, this is not the case in the official statistics of occupational diseases in Germany for example, where they are presented under one category, although they represented about one quarter of the notified diseases in the latest statistics from 2018. Again, this makes it difficult to differentiate between occupations and causes of disease and target prevention.

### Detection of emerging risks

For the detection of new occupational health risks, instruments other than those used for monitoring known occupational diseases may be needed. Information that is routinely collected as part of the public health system could possibly be used to this end and several complementary methods are considered necessary for the detection of emerging risks, such as epidemiological studies, health surveillance studies, and the evaluation of cases, ideally by an (international) team of experts. A warning system for emerging biological risks should be combined with an action plan aiming at a rapid response to minimise the risks due to these agents at the workplace. In France, for example, an alert system ensures warnings are exchanged to prevent the spread of emerging zoonotic diseases for which registration is not mandatory. A network of professionals from (occupational) health services in multidisciplinary teams can exchange information on alerts. The target groups are farmers, and foresters, workers in animal husbandry, environment professionals and workers at zoological parks. This measure can likely be transferred to other countries and this example could be followed for other diseases.

The identification of new and/or emerging risks could be part of the regular monitoring system of occupational exposures and/or diseases and could be based on the evaluation of a case by of an (international) team of experts, for example, using their national experience, data mining and literature searches, such as done in the French RNV3P system. Such an approach is proposed by the Modernet occWatch system<sup>(7)</sup> that registers cases across countries. National alert and sentinel approaches are explored more in detail in another study commissioned by EU-OSHA that analysed more in depth such systems and provided recommendations in this respect (EU-OSHA, 2018b). Wider access to the background information available in these systems on exposures and conditions of exposure as well as the potential causes for any health problems would ensure that the systems can be adjusted and refined and ongoing training and retraining can be provided to reporters. Such a feedback mechanism does exist for a number of alert systems that are described in this review and the valuable contribution of these systems to the improvement of workplace monitoring should be more widely recognised. These systems (for example the RNV3P system or the SIGNAAL system developed in Belgium and the Netherlands) could help identify emerging disease as they also collect case information and include a thorough assessment.

A network of professionals from (occupational) health services who participate in multidisciplinary teams (veterinarians, general practitioners, occupational physicians) could be provided with support for the rapid exchange of information for prevention of zoonotic disease, for instance. Sectoral organisations could investigate in their own sectors and facilitate epidemiological studies. Depending on the networks providing the information, whether occupational health centres as in the French approach or specialist networks such as dermatologists or pulmologists in the UK THOR networks, the specialist knowledge could be a valuable asset to progress in the recognition of diseases at the international level.

A more direct link between public health systems and OSH systems could enable the collection of valuable information that may be used to target the prevention of exposure to biological agents at the workplace. For instance, to combine experience of sentinel systems for infectious or chronic diseases from public health with knowledge of exposure patterns from occupational health, would support better identification of the work-related diseases, the causes, the context, help avoid underreporting, and

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<sup>7</sup> OccWatch (<https://occwatch.anses.fr/node/10>) stands for "Occupational Diseases Watch". It is a Sentinel Clinical Watch System dedicated to the highlighting of newly occurring Occupational Diseases. OccWatch sentinel clinical system is powered by the French Agency for Food, Environmental and Occupational Health & Safety (ANSES), the operator of the French National Network for Work-related Diseases Vigilance and Prevention (RNV3P), which developed for several years a specific approach to handle new work-related diseases.

enable an assessment of the contribution of work to overall disease rates. Equally, the information from such registries whether their purpose is the protection of animal health (in the case of zoonoses) or of public health (in case of registries that register certain infectious diseases, such as tuberculosis, for example) could be useful to recognise outbreaks of diseases and organise timely workplace prevention in the concerned sectors. The precondition for this would, however, be an exchange mechanism with occupational health authorities or expert networks.

General practitioners are sometimes involved in the registration of occupational diseases and could also register cases of occupational diseases that are not picked up by occupational physicians and other OSH professionals involved. However, some information would be needed to make such information useful for workplace purposes, for instance on the work history of the person in question. It could be supplemented by information from job-exposure matrices as proposed by some experts in the stakeholder workshop. The Finnish institute for occupational health FIOH has developed the FINJEM, the Finnish Job Exposure Matrix. Even when only a job title is known, the exposure of a worker can be estimated based on the exposures measured in large groups of workers with similar job titles. Exposures that are relevant for biological hazards in the FINJEM database are those to organic dusts (such as animal, flour, plant, softwood and hardwood dust) and to microbiological agents (mould spores and gram-negative bacteria of non-human origin). Other job-exposure matrices could be built on this model.

### Monitoring of exposure

Little information is available on exposure to biological agents at the workplace. The exposures are not measured frequently, and as good quantitative data on exposure and the associated effects is missing, a very limited number of occupational exposure limits (OELs), mostly at a very general level and not related to a specific agent, and only a few systems for monitoring exposure exist. However, although quantification of exposure to biological agents is complex, several measurement and analytical methods for biological agents do exist. Further development of these methods is recommended to enable control or prevention of such exposures and this includes the availability of immunological tests. Exposure measurement methods should be developed for those diseases that are most frequently recorded and measurement for agents causing respiratory and skin diseases and important sectors identified in the review should be prioritised.

### Availability of reliable, standardised exposure assessment methods and tools

With regard to the measurement of biological agents, instead of assessing the exposure levels of individual biological agents, one option would be to focus on more general markers of exposure to biological agents (such as organic dust or bioaerosols, endotoxins as a marker for Gram-negative bacteria, peptidoglycan or muramic acid as a marker of Gram-positive bacteria, glucans as a marker of fungi/moulds, and extracellular polysaccharide antigens of the *Aspergillus* and *Penicillium* species (EPS-Pen/Asp) as a more specific marker of fungal exposure). The availability of standardised measurement methods could stimulate exposure assessment, surveillance studies and epidemiological studies, which in turn may lead to the derivation of OELs.

For risks involving chemicals, radiation and vibration, several workplace risk assessment methods and tools exist. However, for biological agents it is difficult to obtain a complete overview of the risks because hardly any tools are available. Control banding could be considered, by means of, for instance, a qualitative assessment of biological risks at the workplace by using, for example, risk assessment tools in combination with options for control measures as a first step to reduce risks. In combination with available exposure data, this would be a step towards quantitative assessment. First examples of tools using such an approach are described in the report.

## Further recommendations

### Improving the prevention at the workplace

The majority of the prevention policies identified in this review are aimed at preventing specific diseases among workers, such as respiratory diseases (e.g. asthma, farmer's lung), infectious diseases from bacteria or viruses (e.g. MRSA, Ebola, BSE, influenza, tuberculosis) and blood-borne infections (e.g. hepatitis B, HIV), and do not seem to cover the whole range of risks due to biological agents that were

identified through literature review and expert interviews. They focus mainly on situations with a clear risk of infection, and to a much lesser extent to biological risks arising from unintended exposures.

Overall, the policies and prevention measures described by the experts regarding all sectors were successful and most were transferrable across countries. Raising awareness of the topic among workers and employers as well as developing appropriate (technological) solutions was regarded as crucial. Reported success factors were effective OSH services, involvement of key intermediaries, cooperation between actors at the regional level, systematic health surveillance and systematic exposure assessment (for instance in a particular sector, or aimed at a particular group of workers).

### Respecting the hierarchy of prevention measures:

Many of the preventive measures mentioned by the experts are individual measures (for example use of PPE or monitoring the use of PPE or vaccination) rather than linked to a general prevention approach. Rather than following the hierarchy of control measures prescribed by European legislation, which sets out that the risk should be eliminated altogether and only if it cannot, should collective organisational or technical measures be taken, and only as a last resort, individual measures such as PPE. It is particularly worrying that on the other hand, the experts have also highlighted the lack of access to appropriate PPE or lack of appropriate storage areas for such equipment that ensures its usability, as well as the fact that workers have to use the same PPE for long periods of time. They recommended the provision of additional information and training, and the opportunity for employers and workers to try PPE in a supervised way, to ensure a good fit with their practical needs.



What can be concluded from the findings is that awareness needs to be raised among employers and workers about the existing legal framework and the importance of applying collective rather than personal measures. What is commonplace in the management of chemical risks should be so too in the approach to the prevention of workplace risks from biological agents.



This should also include keeping the number of those exposed as low as possible, designing work processes so as to avoid or minimise exposure, developing technical measures at the design stage of work premises and work procedures, appropriate signage, plans to deal with accidental exposure, and measures for safe waste collection and handling and transport of biological agents, all measures that are included in the biological agents directive.

It should also be mentioned that Directive 2000/54/EC includes special control measures such as containment categories for laboratory work and industrial processes, and special attention is paid to healthcare and veterinary care facilities. The list of biological agents included in the directive also gives a separate indication in cases where the biological agents are likely to cause allergic or toxic reactions, where an effective vaccine is available, or where it is advisable to keep a list of exposed workers for more than 10 years. However, there are no details for the sectors and occupations with unintended exposure described in this review.

In addition to these prevention measures, hygiene measures are particularly important: this includes the separation of break and changing rooms, appropriate washing and toilet facilities, and the separation of work and other clothing.



Differentiation between 'clean' and 'dirty' areas (black-white areas) avoids the spread of contamination in sectors such as waste management, farming and health care, but issues linked to work clothing may also be relevant to other occupations such as border staff and transport workers. This is relatively simple to organise and can be applied in many of the sectors/occupations that are considered of concern with regard to risks due to biological agents. While these measures may be implemented in healthcare or the food industry for other reasons (patient or food safety), for instance, they are not in other sectors and should be implemented in the agriculture or waste management sector, for instance.

### **Vaccination and how to address low vaccination rates**

Vaccination was a prevention measure that was mentioned many times by the experts involved in this review, for example regarding exposures in health care, waste management and animal-related professions and regarding the protection of armed forces. According to the biological agents directive, workers should be informed of the benefits and drawbacks of both vaccination and non-vaccination, and vaccination must be offered free of charge to workers, and the list of biological agents in the directive provides information on those agents for which vaccination is available. Quite a few of the sectors considered in this review would benefit from vaccinations being offered to workers and effectively



applied. However, vaccination rates are low and the reasons behind should be explored. There were also contrasting views as to whether or not there should be obligatory vaccinations, for example for healthcare workers.

### Needlestick injuries prevention

Needlestick injuries and the transmission of bloodborne viruses were widely addressed in the literature survey and by the OSH experts and practitioners, mostly, but not only, related to the healthcare sector, and for example the waste management sector. In addition to safe needle systems, national surveillance of accident types and the circumstances surrounding blood-related infections, prioritising the prevention of risks, was also proposed. The availability of safe needle systems is an issue and therefore the experts considered that interventions at the level of the providers are also needed.



Awareness needs to be raised at the management level of healthcare establishments, in particular those operating in mobile care and home care, and among those who purchase needles for private purposes of the risks of improper waste disposal, as well as those who dispatch the needles to users. Including pharmacies in the awareness-raising approach could be crucial.

Needlestick injuries are covered by EU directive 2010/32/EU on the prevention from sharp injuries in the hospital and healthcare sector<sup>(8)</sup>, followed up by an EU financed project, with a number of recommendations in line with the ones stemming from this review. The reports from the project (HOSPEEM/EPSU, 2013) highlight non-permanently employed staff such as trainees, students or interns; newly employed workers; temporary agency staff; part-time staff only working at weekends or at night as groups at risk. In light of the figures mentioned in these reports and the finding that needlestick

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<sup>8</sup> EU Directive 2010/32/EU on the prevention from sharps injuries in the hospital and healthcare sector implements the Framework Agreement on prevention from sharp injuries in the hospital and healthcare sector signed by the European social partners the European Hospital and Healthcare Employers' Association (HOSPEEM) and the European Federation of Public Service Unions (EPSU) on 17 July 2009, which is an annex to this directive.

injuries are severely underreported in the healthcare sector as well as in other sectors, action at the level of enterprises and providers is urgently needed.

### Covering unintended exposures

The Biological Agents Directive states that the obligations of employers still apply, even if the results of the workplace risk assessment show that an activity does not involve a deliberate intention to work with or use a biological agent but may result in workers being exposed to a biological agent, as in the activities listed in Annex I to the directive:

- 1 work in food production plants;
- 2 work in agriculture;
- 3 work activities in which there is contact with animals and/or products of animal origin;
- 4 work in health care, including isolation and post-mortem units;
- 5 work in clinical, veterinary and diagnostic laboratories, excluding diagnostic microbiological laboratories;
- 6 work in refuse disposal plants;
- 7 work in sewage purification installations.

There may be other work activities that involve unintended exposure that are not included in this annex. Many of the occupations at risk identified in this review involve a considerable part of unintended exposures, as workers may be exposed to biological agents which originate from the work process or materials used in the work process, without the biological agent being deliberately used during work tasks (which could be the case, for instance, in a biotechnological process to produce enzymes, in vaccine production, in the production of antibiotics, in some research labs or in food production).



Rather than focusing on identifying each and every biological agent that may be present at the workplace, general prevention principles should be applied and some of them have already been mentioned above. This includes

- ventilation, incl. local exhaust ventilation where appropriate;
- dust- and aerosol-avoiding measures;
- avoiding contact with contaminated surfaces, animals and tools;
- regular cleaning and maintenance;
- closed systems or vehicles;
- the separation of dirty and clean areas, as well as
- appropriate PPE.



Furthermore, an approach that focuses on high-risk activities or processes within a sector, instead of a biological agent-based approach, may be more effective for the development and implementation of preventive measures. A process approach would especially facilitate the development of prevention measures for a specific process, e.g. sorting of waste. For multi-exposure risks for example, exposure to organic dust, solutions should be created on a higher than individual level by developing technological solutions that separate workers from the biological agents entirely.

Prevention measures regarding unintended use of biological agents could be built on those set out for intentional use of biological agents in other sectors, for example farms learning from approaches in the healthcare sector, for instance regarding antibiotic resistance. The report provides information on many measures, whether specific to sectors and occupations or general. However, it also identified a need for risk assessment tools that take into account the hierarchy of control measures as well as the specificities of biological agents (e.g. their ability to grow and spread, health effects, viability) and provides examples of successful guidance such as for example the technical rules for biological agents in Germany.

The combined risk approach was recommended in particular for unintended exposures, for example when developing preventive measures for risks such as organic dust (which contains a variety of moulds and bacteria). Control measures do not necessarily differ between different fields (e.g. biological agents and chemical agents), and the efficacy of these measures is assumed to be comparable. Considering prevention measures that are already in place to control other exposures (e.g. dust and chemical substances) may prove to be a good alternative approach to control biological risks.

### ***The importance of allergens***

The identification of allergens linked to biological agents' exposure and their differentiation from chemicals agents is the most challenging issue identified in this review — although it is the most researched issue — as the exact cause of the allergy at the agent level cannot easily be identified. In the literature on allergenic agents, a differentiation between chemical agent and biological agent is not normally applied, although there are cases where a link between a substance originating from microorganisms and allergenic effects is elucidated. Some of the main causes are identified this report and include organic dust, moulds in buildings, flour dust, industrial enzymes, and specific bacteria occurring for example in waste management, wood processing and metalwork.

With regard to allergenic agents, the sectors and occupations with clear risks (in addition to the waste treatment sector) are the fisheries sector, the food industry, the textiles, wood-working and the metal industry. Water-miscible cutting coolants, for example, provide an environment that encourages the development of microorganisms, particularly bacteria and fungi, which can release sensitising cellular breakdown products and metabolites such as endotoxins and mycotoxins. Some OELs and technical guidance values for worker protection have been set in particular for some organic dusts, such as flour dust, or for endotoxins.

Although diseases related to allergens originating from biological agents exposure are among the most prevalent identified in the literature review as well as in the data extracted from monitoring systems, the exact causes are very rarely referred to in the statistics reports publicly available, with the exception of organic dust and farmers' lung, and the proportions of diseases referred (generally grouped across all causes (e.g. hypersensitivity pneumonitis)) are merely estimated and cannot be retrieved from the official statistics. However, the statistics do refer to diseases exacerbated by exposure to biological agents and related substances, and therefore do, in some way, recognise the multifactorial nature of such diseases.

Data from health surveillance could also be used to identify causes and the groups of workers, occupations and sectors more at risk. Indeed, this is one of the elements of the successful approach by the Finnish occupational health services for the agricultural sector and it has resulted in improvement of the figures for farmers' lung and helps resolve problems in specific cases where those working on farms already show health problems. Employers could be reminded of the obligation set out in the biological agents directive that grants workers the right to health surveillance. Those arrangements shall be such that it is directly possible to implement individual and occupational hygiene measures. It could be more widely applied to identify and follow workplaces where health problems have occurred, identify the root causes and ensure that prevention measures are directly implemented.



As a successful example of health surveillance, the experts suggested screening (future) workers for existing allergies or health problems, like the triage method for sensitisation (which in the future can lead to allergies and work-related asthma) for bakery workers in the Netherlands. The downside of screening is, however, the possible health effects on the worker when performing the tests involved, and that people may lose their job based on the outcome of these tests. It is conceivable to adapt workplaces instead of applying prescreening to select workers according to their sensitivity. Health surveillance should be linked to preventive measures to prevent health outcomes due to biological agents rather than selection of workers who may resist in unhealthy conditions.

An example of the development of a (technical) solution in which a combination of organisational, technological and human factors is taken into account, was the implementation of far advanced compartmentation with strict cleaning and clothing regimes and good ventilation in the laboratory animal facility in which laboratory animal allergy was observed, where the same rules applied for both personnel as visitors. Similar approaches apply in other areas such as waste management and proper facilities need to be provided to workers to ensure procedures such as hand washing, decontamination of work clothing and disinfection. In quite a few areas where biological agents may occur, work clothing may be provided or needs to be separated from street clothing, owing to the infection and growth potential of biological agents. One area where this should be applied and may not be consistently is for example the farming sector. It would also be important to respect these hygienic measures to help avoid the spread of zoonoses at source.

The German committees for biological agents and for hazardous substances have designed a joint technical rule on sensitisers that covers both biological and chemical agents. It provides details on workplace risk assessment, prevention measures and other obligations, such as for example the protection of vulnerable groups. A similar pragmatic approach could be taken in other countries, and experts from both areas could cooperate to design prevention measures for these diseases.

Furthermore, some databases, such as the MEGA database in Germany and the Finnish FIOH job-exposure matrix hold data on exposures to some allergenic factors, such as organic dust or textile fibres, and in highly exposed sectors such as waste management. The exchange of this data would facilitate the identification of groups at risk and help set targeted prevention measures.

The alert systems in place in some countries could also be valuable tools to identify potential causes of allergy linked to biological agents exposure. As the contribution of occupational exposures to allergic diseases is not easy to be defined, cooperation between occupational physicians and general health practitioners, as well as pulmonologists and dermatologists, would be beneficial, to enhance prevention of these diseases.

Lastly, annex III to the biological agents Directive (list of classified biological agents) gives a separate indication in cases where the biological agents are likely to cause allergic or toxic reactions, for example through endotoxins. The exposures to endotoxins and the groups at risk from these exposures are another area that urgently needs more research and monitoring in order to design systematic prevention approaches.

### ***Being prepared for outbreaks of serious diseases***

The SARS epidemics incl. the recent Covid-19 pandemic and the effects of other serious zoonoses such as BSE have shown that urgent measures are needed to protect workers from the impact of a transmission of infectious diseases from animals to man. What these epidemics have also shown is that a broad range of occupations could be concerned by such diseases, although at the onset this may not have been recognised. One issue mentioned by the experts in this context is pandemics and epidemics preparedness, and another is monitoring of these serious diseases. The respondents to the questionnaires in task 1 have mentioned several cases of smaller outbreaks, of for instance Q fever, at the local level. The German experts pointed out that healthcare workers in outpatient medical care are the first to be exposed to possible outbreaks because they treat infected patients and should therefore be included in preventive measures and receive training and information on how to deal with the risks. Considering the wide range of agents in question and the variety of sectors concerned, awareness-raising of these threats is urgently needed among all actors and the importance of the topic needs to be brought to the attention of policy makers. Emergency plans should be set up in enterprises for such incidences, but most of the time they are missing, whether it concerns an outbreak of a zoonosis in the farming sector or in the healthcare sector. This obligation, which is also a requirement on employers according to the biological agents Directive, should be made more operational and be brought to the attention of sectoral organisations together with the documentation and information requirements that come with it (recording exposed workers and informing them).

Experts explained that a number of monitoring systems that collect notifications of such diseases exist, mostly in the area of public health, but the information was not centralised and therefore not easily accessible; there is also a missing link to occupational safety and health. These systems cover specific infections, in particular zoonoses, and some coincide with priorities identified in the occupational field, such as the increase in tuberculosis infections and tropical diseases, or the increasing number of outbreaks of legionellosis. Some of these systems were installed in the public health field to improve prevention for groups of workers that are not well covered by occupational disease registration systems. This is the case for systems that record cases of brucellosis, for example, which are relevant for agriculture, a sector with a high proportion of self-employed and family workers. If warning system such as epidemics warning and monitoring (for instance the EuroFlu Net approach mentioned by the French experts or obligatory reporting schemes for certain zoonotic or infectious diseases) are not in place and do not link up with OSH institutions, workplaces and sectors are very likely to be deprived of means to react on time to outbreaks such as those of BSE, foot and mouth disease, avian flu, or the increase of nosocomial infections with multiresistant organisms. Such events are likely to arise again, and it needs to be ensured that the response includes OSH considerations beyond the mere provision of PPE as in the case of the Covid-19 epidemic. Contingency plans and approaches need to be coordinated with other ministries (health, migration or internal affairs, agriculture, etc.) and it is important that the protection of workers is recognised as a priority in these approaches.

### ***Sector level***

The workplace practitioners involved in the focus groups stressed the need to act at the sectoral level and increase awareness among employers and workers in the sectors covered by this research. Some sectors that are highly affected by biological exposure, such as the agricultural sector, have a high number of SMEs, and the working conditions are changing due to restructuring and increasing industrialisation. They are also an audience that is difficult to reach, and have high proportion of temporary and migrant workers that may be particularly vulnerable. Implementation of legislation would be improved by practical guidance for employers in plain language on how to read and use the provisions of the Directive. An example of elaboration at a practical level are the Technical Rules in Germany.

Experiences in a sector are sometimes transferable to other sectors and should be used accordingly. Cooperation with and between sectoral organisations could support the transfer of knowledge and guidance to the workplace level and help identify areas of concern, for example when conditions are changing in the sector. Several issues, such as the increase in multi-resistant microorganisms, the industrialisation of agriculture and environmental regulations that have an impact on waste management cycles, could be brought to the attention of policy-makers and workplace practitioners at an earlier stage.

Another suggestion from OSH experts was that the sectoral organisations could investigate specific issues, such as asthma in specific occupations, to support research and prevention, or support such research actively, by addressing their members and supporting data collection.

Moreover, it is recommended that companies and industry sectors receive guidance on how to set up surveillance programmes and how to design programmes to control and prevent exposure in specific work environments. The effectiveness of policy measures would be stimulated by effective information exchange between countries on policy measures and lessons learned.

### **Policies across sectors**

Some biological risks were identified as an important issue in several sectors (e.g. organic dust, microorganisms causing multiple resistance to antibiotics, zoonotic agents). An approach similar to a lifecycle approach in environmental protection or a supply chain approach in chemicals legislation might deliver effective solutions to avoiding exposure or help set out preventive measures. Such an approach entails tracking the biological agents from their effects on human health back to the source from which they originated, which would enable action against the problem at the source and at all subsequent stages. For instance, to prevent needlestick injuries in waste-sorting centres, one measure could be to provide information early on to consumers, to prevent needles being disposed of in the general waste bin; this could be in the form of guidance for patients distributed at pharmacies on how to dispose of used needles in a safe way and providing specific needleproof waste receptacles. Such an approach is more likely to take vulnerable groups into account, as they are more likely to be identified as part of the chain of events, for instance cleaning workers in hospitals and maintenance workers in waste treatment, similarly to a supply chain approach. Other examples of supply chain approaches identified in this review include tackling the issue of resistance to antibiotics by reducing the use of antibiotics in both animal care and human care, and preventing further distribution of antibiotics in the environment (for instance via surface water) by means of waste(water) treatment.

### **National level**

Biological agents are often not considered an OSH priority at the national level, which has resulted in a reactive rather than a proactive approach, compared with other dangerous substances in the workplace, and has limited resources for research, inspections and consultations. If biological agents were a higher priority on the national OSH policy agenda, more knowledge regarding this topic would be generated, which in turn would help employers to deal with this risk in the workplace more effectively.

At the national level, the visibility and approachability of experts and a proper dialogue and better collaboration between relevant stakeholders at several levels would facilitate influencing the agenda-setting process as well policy development and change. In several countries, there are expert networks with knowledge of exposure to biological agents at work that have different focuses and different statuses. The organisation of expert groups/meetings/platforms (at national and international level) would stimulate the sharing of knowledge, make it possible to respond more quickly in the case of an identified emerging risk, and would for instance facilitate reaching more harmonisation with regard to registration systems for relevant diseases and exposures to biological agents. On the one hand, the recognition of health problems could be improved and, as in the RNV3P network in France, alerts could be issued to prevention actors when a new risk or a new disease is recognised. On the other hand, these issues could be brought to the attention of policy-makers and those who develop standards, to ensure that they are addressed in regulations, guidance and the control of implementation by, for example, labour inspectors.

The experts also highlighted the need for a better link between public health and OSH actors at all levels. This is relevant for a better assessment of the diseases linked to exposure to biological agents, but also

to the practical prevention and the identification of emerging risks. The recent COVID-19 epidemic is a very illustrative example. Other factors that were considered important for policies to be successful were media attention and public awareness.

## **European level**

The experts and stakeholders involved in this review agreed that the EU directive on the protection of workers from biological agents at work provided an important framework that reflected the general prevention principles of the Framework Directive. However, they raised a few important points that may be considered when revising the directive or designing guidance for its implementation.

At the European level, a wider definition of biological agents could be considered in Directive 2000/54/EC (Annex III); in addition to living (micro)organisms, substances or structures that originate from living or dead organisms, allergens and carriers of a variety of biological agents (such as bioaerosols or organic dust) could be included. The directive's definition of biological agents means that substances or structures that originate from living or dead organisms (such as exotoxins, endotoxins, glucans, mycotoxins and allergens) seem to fall outside its legislative purview, including the toxic, allergenic or irritative effects of these substances. This may have implications for how well these biological substances are considered in the national monitoring systems and health policies of Member States. These substances may fall in between the regulations for chemical and biological agents, and may thus be either structurally under-reported and/or not managed appropriately. It should be ensured that there is no gap in prevention of OSH risks between the chemical and biological agent-driven risks and the legislative areas are complementary and cover all risks, notably in sectors where awareness of the issues is low and prevention may be difficult to implement. Some of these sectors have been reflected upon in this review, for example, the agricultural sector, which is characterised by a wide range of tasks and procedures that may involve risks.

On the other hand, in the stakeholder workshop (EU-OSHA, 2018a) it was agreed that the scope and the definitions of the current biological agents in the Directive is useful, yet the list of biological agents should be updated more frequently. Some Member states, such as Germany, for example, provide a list of biological agents of risk group 1. The harmonised categorisation and classification of these agents is also an important issue for monitoring exposure. The classification systems that are in use in France and Germany can serve as practical examples of harmonisation. Exchange of national information at the European level would facilitate the creation of an international list of biological agents or the regular update at the European level through technical amendments.

It was also recommended that the annexes to the directive be made context specific for jobs and sectors, and a wider range of occupations and activities that are considered to be 'at risk' be taken into account more specifically in European legislation, to make sure that more are tackled by prevention measures in the relevant professions. In addition to the sectors in which working with biological agents is part of the primary process (industrial processes, laboratories and animal rooms) or in which workers come into contact with human or animal patients (healthcare and veterinary care facilities), the annexes could be adapted to refer better to specific jobs and sectors, especially those with mainly unintended exposures, such as composting, (waste water) recycling, agriculture (animal and arable farming), food processing, home/outpatient care, education, and occupations such as cleaning and maintenance work. The finding that a wider range of occupations is considered 'at risk' should be reflected in the Directive, to ensure that these are also included in the development and implementation of preventive measures in the relevant professions.

Including a reference to vulnerable groups could be considered, as they may vary depending on the sector and the biological agent. In the recent coronavirus epidemic, for instance, workers with respiratory disease or asthma and other workers with chronic health problems were identified as being at particular risk. These aspects may differ depending on the group considered and in the specific case of biological agents, issues such as immune status may also play a role.

Guidance for labour inspectors would also help support the implementation of the directive that may be quite challenging in sectors with unintended exposures. Some of these are fast-growing sectors, such as waste management and home care, and, at the same time, control and inspection may be a



challenging task in these sectors. An exchange between those who implement the regulations in practice and an exchange with OSH services could be beneficial.

Finally, the development of a European (or even global) (warning) system would make it possible to respond more quickly and in a more structured way to emerging biological risks. Examples of alert systems exist at national and international level and some are described in this review. It could be an important step forward towards better prevention of risks for European workers.

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**The European Agency for Safety and Health at Work (EU-OSHA)** contributes to making Europe a safer, healthier and more productive place to work. The Agency researches, develops, and distributes reliable, balanced, and impartial safety and health information and organises pan-European awareness raising campaigns. Set up by the European Union in 1994 and based in Bilbao, Spain, the Agency brings together representatives from the European Commission, Member State governments, employers' and workers' organisations, as well as leading experts in each of the EU Member States and beyond.

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