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Editorial

Dear Readers,

I am delighted to welcome you to 2023 issue of SANITARNO INŽENIRSTVO / International Journal of Sanitary Engineering Research. As the managing editor of this journal, I'm excited to bring you the latest research, innovations, and best practices in the field of public and environmental health. Our journal strives to uphold high standards of objectivity, quality, and scientific integrity, which are crucial for the advancement and development in this important area.

In this issue, we invite you to explore various topics, such as the Advantages of Greenery in Hospital Environments, A Study on Implementation and Perception of Preventive Hygiene Measures, and Risk Management and Risk Communication of Illegal Use of Sulphites in Meat Preparations. Our esteemed authors have contributed research articles that will undoubtedly deepen your understanding of the challenges and opportunities in these areas.

On behalf of the entire editorial board, I extend my gratitude to the authors for their efforts in preparing their contributions, to the reviewers for their critical review and expertise, and our readers for their continued support. I am confident that this edition of the journal will be a valuable source of knowledge and inspiration for everyone interested in public and environmental health.

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Advantages of greenery in hospital environment - a literature review

Sedina Kalender – Smajlović [1] and Mateja Dovjak* [2]

ABSTRACT

Background: Incorporating greenery into hospital environment contributes to the sustainable development goals by mitigating health, environmental and economic problems. Despite the increasing interest in plants, gardens and green roofs in general built environments, the benefits of greenery in hospital environment are still under-researched. The aim of this review was to summarize the relevant literature and describe the benefits of greenery in hospital environment.

Methods: The PubMed, Springer Link and CINAHL databases were searched to identify relevant studies and articles published between 2012 and 2023. The keywords used were hospitals, greenery, green systems, vegetation, and room plants. The language restriction was that articles were published in English.

Results: Following the PRISMA methodology, seven eligible studies were included in the literature review. Evidence shows that the presence of greenery affects patient health outcomes and the well-being of healthcare staff. Moreover, the healing and therapeutic effects greenery in the hospital environment have been identified. Greenery also has a positive psychological effect on healthcare workers and visitors. Humanizing healthcare spaces and connecting them with nature empowers patients, reduces stress and pain, and improves emotional well-being.

Conclusion: The biophilic design concept increases occupant connectivity to the natural environment through vegetation at the location, including implemented green building envelope systems (green walls and roofs) and the introduction of indoor plants. It should be incorporated into the established steps of hospital design. In summary, more research is needed, particularly on the potential impact of plants on hospital-acquired infections.

Keywords: Room plants; Hospitals; Vegetation; Green systems; Greenery; Plants

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Literature Review article

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INTRODUCTION

A lot of space is lost in positioning buildings at location areas. »Camouflage architecture« is based on rationalization, where land is draped over the building envelope. Green building systems (i.e. green roofs, green walls and green building envelopes) are passive techniques that can be used to solve the problems of modern cities. Such an approach contributes to the sustainable development of an urban environment [1]. With the Industrial Revolution, urban space expanded much faster and with greater changes than in previous evolutionary periods.

The large areas that modern cities occupy, their structure, materials, and the general lack of vegetation have inevitably altered the climatic characteristics of urban spaces. These changes directly affect the local climate of urban areas, especially the central parts of cities, leading to a significant increase in urban temperature and other changes, known as the urban heat island effect [2].

Greenery contributes to sustainable development with environmental, economic and health benefits.

Greenery contributes to sustainable development with environmental, economic and health benefits. Environmental benefits include i. rainwater allocation and purification [3], ii. improvement of air quality, iii. sound insulation and improved acoustics [4], iii. reduction of the urban heat island effect [5], iv. increasing energy efficiency (on global, regional, and local levels) [6, 7], v. green roofs as a substitute for lost landscape areas [3] and natural habitat for animals and plants [8]. In addition to economic benefits in terms of lower renovation costs [2], lower energy costs [9,10], lower wastewater/meteoric water management costs and space use [3], several benefits of green systems are reflected in all health determinants. These include social, psychological and physical health. An experimental study on the effects of green roofs on the built environment [9] highlights the contribution of green roofs to the reduction of mortality and morbidity as a result of minimizing the harmful effects of excessive heat and air pollution in urban environments. The Green Roof Organisation [11] considers green roofs as elements of healthy cities and states that horticultural therapy leads to better recovery after surgery. Simonič and Dobrilovič [3] argue that recreational spaces improve health and aesthetics, socializing, and positively affect the indoor climate by increasing thermal comfort and occupant productivity as well as reducing sick building syndrome.

Several trial studies have revealed that observing nature or even images of nature scenes have beneficial effects on mood and mental health.

Plants and planted landscapes are known for their therapeutic benefits. Hospitals are increasingly adopting therapeutic landscapes such as healing gardens, horticultural therapy, and memory gardens [12]. In recent decades, human-plant research has increasingly focused on providing empirical evidence of the relationships between plants and health [13]. Several trial studies have revealed that observing nature or even images of nature scenes have beneficial effects on mood and mental health. A Japanese study [14] reports that looking at plants altered EEG recordings and reduced stress, anxiety, anger and sadness, and lowered blood pressure, pulse rate and muscle tension. Another Japanese study [15] found that looking at a green hedge was physiologically more beneficial than looking at a concrete fence.

Despite the increasing interest in green plants, gardens and green roofs, the benefits of greenery in the hospital environment are still under-researched. In the hospital setting, environmental factors and architectural layout should be emphasized as part of infection control measures, in addition to identifying patients at risk for hospital-acquired infections and following standard precautions to reduce transmission [16]. As noted by Gould et al. [17], there are frequent discussions on hygiene and infection risks associated with cut flowers introduced into the hospital environment. It has been reported that this practice is no longer allowed in many wards because the flowers are considered to be hygienically problematic, cause allergies, and harbour bacteria in the water that can cause infections. Based on these findings, this study aimed to summarise the relevant literature and describe the benefits of greenery in the hospital environment.

Despite the increasing interest in green plants, gardens and green roofs, the benefits of greenery in the hospital environment are still under-researched.

MATERIALS AND METHODS

The PubMed, Springer Link and CINAHL databases were searched to identify relevant studies and articles published in the last decade (2012-2023). The keywords used were hospitals, greenery, vegetation, green systems, outdoor plants and room plants. The language restriction was that the articles were published in English. Studies and review articles describing greenery were summarised. Literature selection was made as illustrated in Table 1.

Based on these findings, this study aimed to summarise the relevant literature and describe the benefits of greenery in the hospital environment.

RESULTS

The search results are shown in Figure 1. The systematic review included seven articles. An overview of the studies analyzed is shown in Table 2.

Table 1: Inclusion and exclusion criteria

	Inclusion criteria	**Exclusion criteria**
Language	• English	• All others
Date of publishing	• 2012 – 2023	• Before 2012
Article category	• Original research • Systematic review • Review article	• Editorials • Professional articles • Letters
Keywords	• Room plants and hospitals • Vegetation, green systems, greenery, plants	

Natural elements in the hospital environment can reduce patients' feelings of stress.

Figure 1: Flow diagram

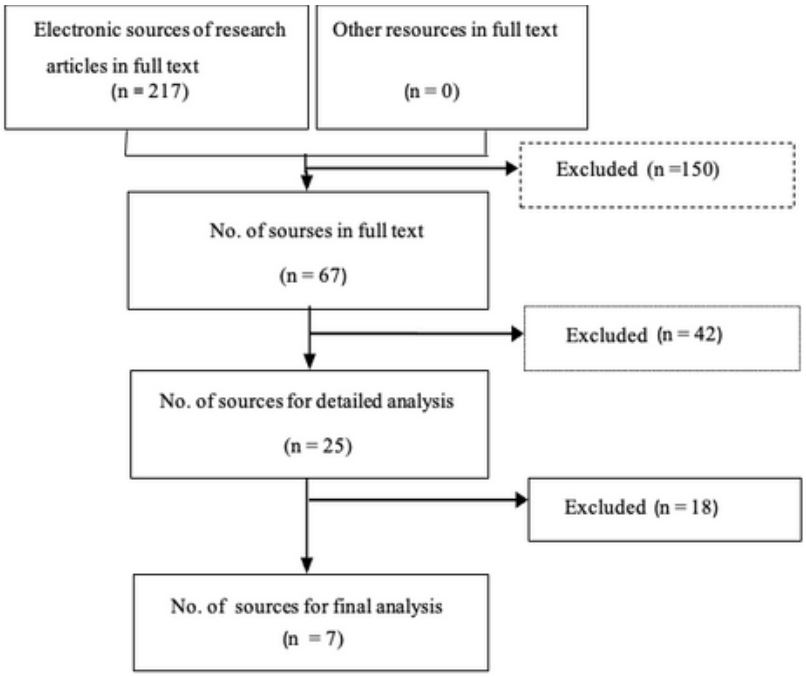

Table 2: Index of articles included in the final analysis

Authors, year	**Aim**	**Type of study**	**Population**	**Country**	**Results**
Kim, Ahn [18] (2021)	To investigate the role of green spaces in the immediate surroundings of a hospital on the incidence of asthma.	Cross-sectional study	Patients with asthma	California, United States of America	Findings suggest that creating dense or clustered tree patches and small-scale green spaces could substantially improve air quality and reduce asthma emergency room visits.
Beukeboom, Langeveld, Tanja-Dijkstra [19] (2012)	To investigate the effect of exposure to nature or artificial nature on reducing patients' stress.	Field research	N = 457 patients (60% women and 40% men) in two radiology waiting rooms	Netherland	Natural elements in the hospital environment can reduce patients' feelings of stress. The presence of greenery or posters of plants in waiting rooms creates a pleasant atmosphere that has a positive effect on patients' well-being.
Qi, Yan, Lau, Tao [20] (2021)	To investigate the impact of the hospital environment (paediatric clinic) on patients and relatives.	Case study	N = 195 persons	China	Optimizing the design of the waiting area in pediatric clinics, focusing on functional layout, flow organization, supporting facilities and environmental details, can improve overall satisfaction with pediatric waiting rooms.
Ali Khan, Amin, Khan, Imtiaz, Khan, Imran, Asad, Badshah [21] (2016)	To investigate the therapeutic horticultural impact of indoor plants and floral arrangements on health outcomes in surgical patients.	Case study	N = 270 patients	Pakistan	Plants and floral arrangements have an effect on shorter postoperative length of stay, lower analgesic intake, and lower pain intensity than a ward without greenery.
Raanaas, Patil, Hartig [22] (2012)	To study the effect of looking out of the window on the natural environment by patients in rehabilitation.	Longitudinal quasi-experiment	N = 288 patients	Norway	Looking out of the window at the natural environment helps improve physical and mental health. Differences were found according to gender and a diagnostic group of patients.
Korpela, De Bloom, Kinnunen [23] (2014)	To study the effects of houseplants and looking out of the window on recovery and restoration.	Literature review	N = 63 articles	Finland	In a hospital setting, the view on nature is important. Research reveals the therapeutic effects of natural environments that reduce stress. They focus on the effects of looking at or exercising in nature, the setting and effects of indoor plants and views on nature through windows.
Song, Ikei, Nara, Takayama, Miyazaki [24] (2018)	To examine the effects of viewing bonsai on autonomic nervous system activity, prefrontal cortex activity and subjective ratings of psychological relaxation in elderly patients undergoing rehabilitation.	Cross-sectional study	N = 14 participants	Japan	Viewing bonsai resulted in a significant increase in parasympathetic nervous system activity, a substantial decrease in sympathetic nervous system activity, and a significant increase in the feeling »comfortable and relaxed«.

DISCUSION

This review has identified the advantages of greenery in a hospital setting. Interestingly, Kim and Ahn [18] used two spatial regression models to show that the associations between greenery (i.e. trees/green spaces) and asthma are highly significant. However, Ali Khan and colleagues [21] found that patients in a ward with greenery had more vigorous psychological moods regarding recovery from surgery and more positive emotions and feelings about their hospital stay. They also felt that atmosphere in the ward as more calming, pleasant and satisfying. In addition, focus group discussions with doctors and nurses in the ward confirmed the questionnaire findings that i) leafy plants and flower arrangements create a nurturing environment in the ward, ii) reduce patients' stress, iii) improve patients' health and mental state and iv) bring a pleasant atmosphere to the hospital environment. These findings confirm the therapeutic value of horticultural activities, especially for surgical patients in a stressful hospital environment. The study by Beukeboom, Langeveld, and Tanja-Dijkstra [19] also confirms that patients exposed to natural plants and those exposed to plant posters reported lower levels of stress compared with patients who had no greenery in the hospital environment. Further analyses showed that these small but significant effects of exposure to nature were partly mediated by the perceived waiting room functionality.

These findings confirm the therapeutic value of horticultural activities, especially for surgical patients in a stressful hospital environment.

In the study by Qi, Yan, Lau, Tao [20] it was found that the waiting rooms in pediatric clinics currently do not to meet the essential needs of patients in areas such as mother and infant rooms, children's play areas and drinking water facilities. There are widespread problems with creating natural environments, such as views on natural scenery out of the window and indoor green plants. Six factors were found to have significant positive impact on overall satisfaction with the waiting area, describing 69.7% of the changes in the respondents' level of satisfaction with the waiting environment. Interestingly, Raanaas, Patil, Hartig [22] also found that a blocked view appeared to negatively affect physical health change in women. In contrast, obstructed vision appeared to negatively affect mental health in men. Pulmonary patients with a panoramic view showed more significant improvement in mental health than coronary patients with such a view. Those who had a panoramic view of nature often chose to stay in their bedroom when they wanted to be alone than those who had an obstructed view. Song et al. [24] also found that viewing bonsai significantly increased parasympathetic neural activity and decreased sympathetic neural activity by physiological measurements. These results are partially consistent with the findings of previous studies on the effects of viewing leafy plants, fresh flowers and bonsai in a hospital setting [25].

Patients who viewed the green surface had fewer postoperative complications, required less pain medication and had a hospital stay that was almost 9 % shorter than those who viewed the brick wall.

Totaforti [26] argues that the global health challenges of the 21st century require a new way of thinking and a change in the organization of health services, with an approach that takes into account human needs in their entirety rather than in a strictly therapeutic sense. Numerous studies show that humanizing healthcare facilities and contact with nature can empower patients and have a positive impact by reducing stress and pain and improving emotional well-being. As healthcare facilities continue to move towards more sustainable business models, with a focus on energy efficiency and environmental care, the popularity of installing vegetative roofs is likely to increase [27].

As has been pointed out in the past, the healing power of green spaces is a significant advantage of installing vegetated roofs in healthcare facilities. In a study [28] the recovery time of surgical patients looking out the window at a brick wall was compared with those looking at green areas. Patients who viewed the green surface had fewer postoperative complications, required less pain medication and had a hospital stay that was almost 9 % shorter than those who viewed the brick wall. As the Association of American Medical Colleges [29] notes, gardens also serve the purpose of expanding the healing environment by providing natural light, fresh air, space to move around and space for patients to exercise.

The therapeutic garden is becoming increasingly popular as a non-pharmacological approach in the modern healthcare system.

Howarth, Brettle, Hardman, Maden [30] found highly positive effects of gardens and gardening on health, well-being and improved functional biometric outcomes based on a scoping review involving 77 studies. Interventions ranged from garden visits, gardening and therapeutic activities. Findings showed associations between gardens and improved mental well-being, increased physical activity and reduced social isolation. Perez, Alexander and Bailey [31] note that the appearance of plants is beneficial: their leaves remove toxins, dust and microorganisms from the air and produce the negative ions from their leaves. The overall evidence that charged ions affect mood is unconvincing, although their benefits are strongly promoted in advertising.

Thompson [32] notes that there is increasing evidence that exposure to plants and green spaces, particularly horticulture, is beneficial for mental and physical health and could reduce pressure on hospitals. Health professionals should therefore encourage their patients to use green spaces and work in gardens and should put pressure on local authorities to provide more open spaces and more trees, which would also help prevent air pollution and climate change. Therapeutic gardens have been used in hospitals for millennia and were strongly advocated by Florence Nightingale as they help improve the environment for patients, visitors and staff [33]. The therapeutic garden is becoming increasingly popular as a non-pharmacological approach in the modern healthcare system. It is a type of healing garden used primarily as a physical therapy or horticultural therapy programme, which may include both horticultural and non-horticultural activities. These activities are very helpful in treating patients, reducing stress in health care workers and patients, improving hospital outcomes, increasing work efficiency and reducing medical costs [34]. Korpela and colleagues [23] report that evidence shows that looking out the window at nature mitigates the negative effects of workplace stress; the more natural elements present, the lower the negative effects of workplace stress on intention to leave. A laboratory study that recorded brain waves and blood volume pulses found that people were less nervous or anxious when looking out of a window at nature than when looking out of a window at the city or no window. The amount of contact with nature during work breaks is also associated with less perceived stress and better self-rated health. Research has shown that while plants in the office seem to improve creative task solving, they interfere with simple tasks, such as proofreading or sorting, which require constant focus on the task at hand.

Research has shown that while plants in the office seem to improve creative task solving, they interfere with simple tasks, such as proofreading or sorting, which require constant focus on the task at hand.

Geimer-Flanders [35] notes that complementary and alternative medical practices can be combined with evidence-based conventional medicine to promote an optimal healing environment and overall well-being for patients.

We emphasize the transition from therapeutic gardens as curative to sensory gardens with therapeutic elements that would address all sensory and motor systems according to universal design principles. This ensures health (physiological, social, psychological components), comfort and well-being.

The results of our study provide opportunities to implement biophilic concepts in the current design of the hospital environment [2, 36-38]. Specifically, the design of healthy hospitals should start from site characteristics, where strengths and weaknesses are defined. Advantages such as existing green areas, natural habitats and water (lakes, rivers) should be preserved, optimum insolation of the building should be ensured, and this should be linked to the building design. Disadvantages such as proximity to industry and busy roads with increased noise and pollutant emissions can be avoided by ensuring optimal building and room orientation, setbacks, and by incorporating natural green barriers. Potential excessive solar gain, and thus overheating of the building, can be regulated by selecting trees that block the sun's rays in summer and let them pass through in winter.

From a sanitary technical and hygienic point of view, closed transparent systems and indoor elements with vegetation can also be designed to let in direct light.

Climbing plants and pergolas can already be part of the active living shade on the building, as well as orientation of the building and active spaces towards the views of greenery outside, and incorporating green systems (green roof, green wall) into the envelope. These envelopes have numerous environmental, social, health and economic benefits. They also have a water collection and purification function. Parts of the building envelope functionally connect and extend to the external surfaces and form part of the healing garden. They integrate water and plants into the indoor environment, especially in common and communication areas. From a sanitary technical and hygienic point of view, closed transparent systems and indoor elements with vegetation can also be designed to let in direct light. All this becomes part of the bioclimatic design of buildings [2, 36-39].

The possible risks of plants should be considered to prevent health-related infections in the hospital environment.

CONCLUSION

To ensure the well-being of patients, healthcare staff and visitors in the hospital environment, there has been a growing stream of research addressing the impact of vegetation on patient health outcomes and the well-being of occupants. Based on the evidence-based approach, the healing and therapeutic effects of greenery in the hospital environment have been identified.

The recommend biophilic design concept increases occupant connectivity to the natural environment through: i. the use of on-site vegetation, ii. with implemented green building envelope systems (green walls and roofs), and iii) the introduction of indoor plants. The possible risks of plants should be considered to prevent health-related infections in the hospital environment.

JOURNALISM ETHICS CONSIDERATIONS

Ethical issues (Including plagiarism, informed consent, misconduct, data fabrication and/or falsification, double publication and/or submission, redundancy, etc.) have been completely observed by the authors.

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CONFLICT OF INTEREST

The authors report no conflicts of interest. The manuscript has not been published and is not under consideration for publication elsewhere.

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A study on implementation and perception of preventive hygiene measures

Gregor Jereb

ABSTRACT

The Covid-19 pandemic required the implementation of various preventive hygiene measures to contain the spread of the SARS-CoV-2 virus. Various non-pharmaceutical interventions (NPI) were introduced worldwide. The Covid-19 pandemic has had a significant impact on people's daily lives. Again, relatively simple hygiene measures have proven to be very effective and useful. The main objective of the present study was to find out how people implement the proposed individual prevention measures and how they perceive the administrative measures implemented during the pandemic. The paper presents the results of a web-based, non-representative cross-sectional study conducted between October 15 and November 17, 2020 in Slovenia during the Covid-19 lockdown. The completion of the survey coincided with the peak of the coronavirus pandemic, so it was to be expected that awareness of the importance of hand hygiene as well as other preventive measures was high among respondents. We find that people have changed their hygiene habits during the pandemic. Habits differ both between individual NPIs and between groups of respondents (age, gender and occupational structure of respondents). There are still opportunities to improve knowledge and attitudes towards hand hygiene and to implement all other NPIs.

Keywords: Hygiene preventive measures, NPIs, Covid-19, compliance

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INTRODUCTION

The Covid-19 pandemic, which officially broke out in Wuhan, China, at the end of 2019, has once again shown that we have limited strategies and measures to prevent outbreaks of emerging diseases. The SARS-CoV-2 virus spread from person to person primarily through respiratory droplets and close contact. Non-pharmaceutical interventions (NPI) have been introduced worldwide as public health measures to prevent and/or control virus transmission in the population [1]. Once again, simple hygiene measures have proven to be a very effective weapon in the fight against epidemics. The so-called non-pharmaceutical intervention measures (NPI) include measures at individual, environmental and population level [2]. Physical distancing, respiratory and hand hygiene, face masks, face shields, goggles and gloves are basic prevention measures at the individual level. At the environmental level, cleaning and ventilation can be used. Last but not least, there are preventive measures at the population level, such as limiting close physical interpersonal contact, isolation and quarantine, protecting vulnerable populations, introducing social bubbles, introducing work from home wherever possible, closing non-essential businesses and schools, implementing confinement measures and travel restrictions. Although the implementation of NPIs can have some negative effects on individuals, communities, the economy and the environment [3], their impact in containing the pandemic outweighs their negative effects. To achieve positive results, a multi-level response, including the simultaneous implementation of various hygiene measures, should be implemented [4].

Simple hygiene measures have proven to be a very effective weapon in the fight against epidemics.

During the global spread of the SARS-CoV-2 virus, numerous studies investigated the effectiveness of hygiene prevention measures [5-8]. In their observational study, Francis et al. [9] reported a correlation between protective measures (face masks, physical distancing, avoiding crowded places and frequent hand washing) and Covid-19 infections. Several studies emphasize the importance of hand hygiene [10], including among healthcare workers [11].

Although the results of several studies support the introduction of preventive hygiene measures and their consistent implementation, inconsistent application and low compliance can unfortunately often be observed in practice. According to Tang et al. [12], individual commitment varies depending on various demographic variables. Individual commitment is an important factor leading to better or worse compliance with all preventive hygiene measures. Although mandatory government measures play an important role in epidemic control, people's behavioral changes cannot be ignored. Duan et al.[13] suggest increasing the population's risk perception to promote the population's adoption of the recommendations for protective measures.

The main objective of the present study was to find out how people implement the proposed individual preventive measures and how they perceive the implemented administrative measures during the pandemic.

The Covid-19 pandemic has severely affected people's daily routines. Preventive hygiene measures have been taken all over the world (including in Slovenia) to minimize the spread of the virus among the population. The main objective of the present study was to find out how people implement the proposed individual preventive measures and how they perceive the implemented administrative measures during the pandemic.

METHODS

The paper presents the results of a web-based, non-representative cross-sectional study conducted between October 15 and November 17, 2020 in Slovenia during the Covid-19 pandemic. The data was collected using an online questionnaire via the 1KA survey tool. Answering the questionnaire was voluntary and the anonymity of the study participants was guaranteed. Respondents completed the questionnaire in around five minutes. The link to the questionnaire was distributed by e-mail and via the social networks Facebook and Instagram. 1,827 respondents clicked on the survey address, 989 started answering, of which 868 completed the questionnaire correctly. The statistical procedures (descriptive statistics and frequency distributions) were carried out using SPSS 20.0 software.

As the survey was conducted during the pandemic lockdown, access to respondents was restricted; therefore, the questionnaire was randomly distributed to respondents. Of the 868 respondents who completed the survey and were included in the further analysis, the majority were women (77.5%), of whom 42.3% were health professionals or students of health-related degree programs. The age structure of the respondents is heterogeneous, with an average age of 29.6 years. Due to the sampling procedure, the sample included in the study is not representative of the Slovenian population (age, gender and professional structure of respondents). Nevertheless, the results give us a very good insight into the population's implementation and understanding of preventive measures during a pandemic and their perception of governance in response to the health crisis.

Nevertheless, the results give us a very good insight into the population's implementation and understanding of preventive measures during a pandemic and their perception of governance in response to the health crisis.

In the near future, it would be advisable to repeat a similar study with a population-based sample. It is also important to emphasize that the survey results contain self-reported information on hygiene habits. These conclusions should therefore be verified with an observational study in the future.

RESULTS AND DISCUSSION

The completion of the survey coincided with the peak of the coronavirus pandemic, so it was to be expected that awareness of the importance of hand hygiene and other preventative measures was high among respondents. Basic preventive measures such as hand hygiene were heavily featured in the public media during the coronavirus pandemic. Therefore, several preventive hygiene measures were included in the questionnaire, namely: hand hygiene, self-quarantine, physical distancing, respiratory hygiene and face masks, room ventilation and awareness of government prevention measures.

Although the survey was conducted in the middle of the second wave of the coronavirus pandemic, 6.9% of respondents still do not wash (or disinfect) their hands when they get home, even though the vast majority of them (97.9%) say they wash their hands frequently.

Hand hygiene

Although the survey was conducted in the middle of the second wave of the coronavirus pandemic, 6.9% of respondents still do not wash (or disinfect) their hands when they get home, even though the vast majority of them (97.9%) say they wash their hands frequently. More than three quarters of respondents (77.7%) stated that they had already washed their hands when they got home before the pandemic (80.8% of women and 66.7% of men). However, 68.1% (67.8% of women and 69.1% of men) stated that they washed their hands more often after the pandemic than before the pandemic.

The results show that hand hygiene habits have improved and, more importantly, that the hygiene habits of many people have changed. Morii et al. [14] also reported an increase in hand hygiene compliance among hospital visitors during a pandemic, mainly due to the role of the public media.

More than half of the respondents stated that they had changed their hand washing habits during the pandemic. It seems that more and more people understand the role and importance of hand washing when entering the home environment. Improvements during a pandemic can also be seen elsewhere: Guzek et al. [15] reported improvements in Polish teenagers and Mościcka et al. [16] in Polish women. However, the proportion of participants in our study who reported poor hygiene practices is still too high. Other researchers report similar findings [7, 10].

It seems that more and more people understand the role and importance of hand washing when entering the home environment.

Although hand disinfection with alcohol before entering the store or other public buildings was mandatory during our study, it is quite interesting that only 54.2% of respondents always disinfected their hands, of which 56.1% were women and 47.7% were men (Table 1). Even fewer respondents reported using alcohol-based hand sanitizer when leaving the store (40.1%, including 42.9% women and only 29.9% men).

Table 1: Frequency of use of alcohol-based hand sanitizers on different occasions

	Never	**Rarely**	**Often**	**Always**
Before entering the store	3.8%	14.1%	27.9%	54.2%
When leaving the store	8.2%	22.2%	29.4%	40.1%
Before entering other public buildings	3.6%	17.2%	31.6%	47.6%
When entering home building	34.3%	39.5%	14.1%	12.1%

The results also show that the respondents' knowledge and attitude towards hand hygiene is rather poor, especially regarding the use of alcohol-based hand sanitizers. Most of them (75.3%) do not know the correct composition of hand sanitizers. Respondents have also rarely (70.8%) checked the composition of the hand sanitizer they use. The majority of respondents are either not well informed or do not know how and when to use hand sanitizer. Only 19.1% of respondents know that hands should be clean and dry before using hand sanitizer. After using an alcohol-based hand sanitizer, a further 14.5% of respondents would dry the alcohol off their hands with a paper towel. The extent of alcohol-based hand sanitizer use is also rather worrying. After the pandemic, only half (50.8%) of respondents washed their hands with soap and water when they got home; everyone else swapped soap and water for alcohol-based sanitizers.

Only 19.1% of respondents know that hands should be clean and dry before using hand sanitizer.

Many respondents (37.3%) also mistakenly believed that their hands were clean for minutes or even hours after using alcohol-based hand sanitizers. Insufficient knowledge was also found regarding the correct use of disposable gloves. Almost a third of respondents incorrectly believed that their hands remained clean after using gloves and did not need to be washed (or sanitised), while almost ¼ of respondents estimated that they did not know how to remove gloves correctly.

Physical distancing (self-quarantine, isolation, physical distance)

According to the ECDC guidelines (2020), physical distancing includes several measures, including (i) maintaining distance between people, (ii) closing public spaces and public transportation, (iii) closing workplaces and (or) encouraging work from home, (iiii) closing schools (education at all levels), (v) protecting high-risk groups and vulnerable populations, and (vi) isolation (including self-isolation), quarantine and movement restrictions (international or domestic).

Almost a third of respondents incorrectly believed that their hands remained clean after using gloves and did not need to be washed (or sanitised), while almost ¼ of respondents estimated that they did not know how to remove gloves correctly.

The questionnaire contains four questions on physical distancing. The first two questions relate to whether the participants stay at home at the first sign of a cold or in case of illness (self-isolation). In case of illness, the majority of respondents stay at home (82.1% always and 13.9% often), while this is not the case at the first signs of a cold (47.4% always isolate themselves, 34.3% often and 18.3% rarely or never). It is quite alarming that participants with a medical background responded similarly to everyone else and no significant difference was found. The questionnaire also includes participants' perceptions of the use of crowded indoor public spaces. In times of increased respiratory infections, 88.5% always or at least frequently avoid crowded indoor spaces. Only 24.6% of respondents follow the recommendation to maintain social distancing.

Respiratory hygiene and face masks

Most preventive measures during the Covid-19 pandemic followed the traditional cold warnings. This included respiratory hygiene. In our survey, 71.3% of respondents always consistently adhered to respiratory hygiene recommendations (covering nose and mouth with a disposable tissue when sneezing, coughing, blowing nose and, if no disposable tissue is available, covering nose and mouth with elbow). According to self-reporting, women (74.6%) are better than men (59.5%). Participants with a medical background (80%) are better than others (65%). Worryingly, 28.7% of respondents follow the cough etiquette occasionally, rarely or even never. Tang et al. [12] reported higher compliance to cough etiquette (91.1%) than was measured in our study, while Machida et al. [7] reported similar compliance (58.7%).

It is alarming that many of the respondents wore the mask for several days or even weeks in a row before washing the cloth mask (36.8%) or replacing it with a new mask if it was a disposable mask (42.3%).

Wearing a face mask is another component of respiratory hygiene. It is alarming that many of the respondents wore the mask for several days or even weeks in a row before washing the cloth mask (36.8%) or replacing it with a new mask if it was a disposable mask (42.3%). A significantly higher proportion of respondents with a medical background (32%) used a disposable mask and changed it regularly compared to the others (15%), although 45% of respondents in this group also used a disposable mask for several days. The results suggest that respondents (regardless of medical background) do not believe in the effectiveness of face masks, although several studies have shown that wearing masks can prevent the spread of Covid-19 [17-21].

According to the WHO [22], face masks are not a stand-alone protective measure, but should be used as part of various comprehensive measures to reduce the transmission of respiratory pathogens. In addition, they should be worn correctly and changed regularly. The results of our survey also showed that only 70.7% of respondents knew how to remove the mask from their face correctly. Here too, respondents with a medical background performed significantly better (87%) than respondents without a medical background (60%). As face masks were mandatory at the time of the study, it is rather surprising that 11.1% of respondents stated that they did not or only rarely wear a face mask in closed public places, which is another indicator of mistrust of the mask as a sufficient preventive measure. Face masks are not generally accepted by the public and can do more harm than good if used incorrectly. It would be appropriate to reconsider the current masking policy. A review of masking guidelines is also recommended by Landelle et al. [4].

The results of our survey also showed that only 70.7% of respondents knew how to remove the mask from their face correctly.

Ventilation

For infection control, indoor ventilation is another non-pharmaceutical measure recommended by several institutions, including ECDC [2] and GAeF [23]. Increasing the number of air exchange per hour can reduce the risk of indoor transmission of infectious diseases. As expected, the participants in our study did not ventilate their homes sufficiently. Only 60.7% ventilate thoroughly several times a day, all others ventilate occasionally (31.4%), rarely (6.9%) or even never (1.0%), which applies to all respondents regardless of gender, education or medical background. Tang et al. [12] reported similar compliance with indoor ventilation (54.7%) among their respondents from Taiwan, Japan and North America.

Only 60.7% ventilate thoroughly several times a day, all others ventilate occasionally (31.4%), rarely (6.9%) or even never (1.0%), which applies to all respondents regardless of gender, education or medical background.

Perception of government measures

We were also interested in (i) how respondents assessed the course of the pandemic at the time of the survey, (ii) what they thought of the government measures introduced, (iii) to what extent they agreed with the measures implemented (iiii) and whether they felt safe taking the preventive measures (Table 2).

Table 2: Respondents' opinions on the course of the pandemic, preventive measures and fear

	Completely agree			Mostly agree	Neither disagree nor agree	Completely disagree
	Female	Male	Total			
Current situation regarding the spread of the coronavirus is critical.	40.8%	39.0%	40.4%	36.4%	14.5%	8.7%
Are the current preventive measures too strict?	17.9%	22.1%	18.8%	34.6%	19.6%	27.0%
To what extent do you agree with the preventive measures currently implemented to combat the pandemic?	17.3%	19.0%	17.7%	53.9%	11.6%	16.7%
Adhering to the restrictions and preventive measures makes me feel safe.	17.6%	15.4%	17.2%	45.7%	23.0%	14.1%

It is interesting to note that more than half (53.4%) of respondents believe that the measures introduced are too strict. This is probably one of the reasons for the rather poor implementation of prevention measures at an individual level. 16.7% of respondents do not agree with the proposed measures at all. Nevertheless, the majority of respondents agree that the situation is serious and critical (40.4% completely agree and 36.4% mostly agree). We found no significant differences in the responses in terms of respondents' gender, education or medical background.

It is interesting to note that more than half (53.4%) of respondents believe that the measures introduced are too strict.

CONCLUSIONS

We can see that people have changed their hygiene habits during the pandemic. However, the knowledge and attitude towards hand hygiene as well as the implementation of all other NPIs can still be improved. Despite the limitations resulting from the sample selection, the results point to the need to educate the population. In addition, and more importantly, new approaches and strategies for NPI implementation need to be developed to improve compliance.

It is important to emphasize that only the combination of different NPIs with high compliance is likely to lead to positive results in future epidemics/pandemics. In addition, basic hygiene measures should be accepted and implemented on a daily basis even during the period when respiratory infections are not occurring.

In addition, basic hygiene measures should be accepted and implemented on a daily basis even during the period when respiratory infections are not occurring.

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Risk management and risk communication of an illegal use of sulphites in meat preparations

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ABSTRACT

This paper presents a case study on the management of a food fraud associated with health risks: the illegal use of sulphites in meat preparations and minced meat in Slovenia in 2019. The purpose is to highlight the shortcomings of existing systems for ensuring food safety in case of food frauds and highlight challenges for improvements.

Sulphites are food additives but also have significant allergenic potential, hence they may cause serious reactions in sensitized consumers. Labelling of foods treated with sulphites is mandatory, and their use in meat and meat preparations in Europe is not allowed. However, certain food business operators may intentionally add sulphites into meat preparations to improve the sensory properties; besides being a food fraud, this exposes unaware consumers to health risks.

The case started with the notification of an allergic-like reaction by a consumer following the consumption of a meat product. While the public authorities reacted by intensifying controls on markets and retailers, the analysis of risk management and risk communication aspects showed a number of shortcomings: slow response time; lack of recall of sulphite-treated meat products and of an in-depth risk assessment.

The evaluation of this case study identified violations of food law regulations and consumer protection legislation. Effective risk management requires an interdisciplinary approach, integrating timely and targeted official control and risk communication throughout the food chain to protect consumers from unfair practices. Consistent, effective, and transparent communication among all actors who share responsibility in ensuring food safety is necessary to achieve improvements.

This serious case of food fraud with actual risks to consumer health provided an opportunity for lessons to be learnt regarding managing health hazards from intervention to prevention.

Keywords: risk management, risk communication, food additives, sulphites, food fraud, consumer protection

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INTRODUCTION

Food additives are intentionally added to food for a technological purpose in the processing and preparation of food products [1]. The use of certain additives is authorized in a certain quantity and only for one or more certain food categories – considering food intake, characteristics of foodstuffs and scientific knowledge, to ensure that use is safe also for a consumer with a high intake of the food(s) for which the additive is intended. When scientific evidence does not support safe use, then using certain additives in given food categories is not allowed [2]. Food additives enable food safety and quality to be preserved [3] and their use is motivated by the need for longer shelf life and increased production of high quality and safe food at an affordable price [4]. While food additives are assessed by EFSA and strictly regulated in the EU, the use of additives is often perceived by a consumer as "non-natural" in foods and potentially hazardous [5], [6], [7].

Sulphites are allergens and may cause symptoms of allergic reaction and intolerance in sensitized individuals, such as asthmatic reactions and bronchospasms, occasionally severe hives, flushing, bradycardia and gastrointestinal symptoms [9], [10], [11].

Usually, sulphites are added to many foods and beverages (fish, potatoes, wine, dried fruits, etc.) to prevent oxidation and bacterial growth, thus achieving longer shelf life. In Europe sulphur dioxide (SO_2) and sulphites in foods and beverages at concentrations of more than 10 mg kg–1 or 10 mg L–1 expressed as SO_2equivalents are subject to mandatory labelling [8]. Their incorrect use may entail health risks. Sulphites are allergens and may cause symptoms of allergic reaction and intolerance in sensitized individuals, such as asthmatic reactions and bronchospasms, occasionally severe hives, flushing, bradycardia and gastrointestinal symptoms [9], [10], [11]. According to [12], serious adverse reactions occur in 3 to 10% of the asthmatic population exposed to these food additives and include dermal, gastrointestinal, and respiratory symptoms. Bronchoconstriction is the most common adverse reaction and can lead to an asthma attack [9]. In addition, other serious symptoms may include urticaria, hypotension, angioedema, and anaphylactic other reactions [9], [13].

The recent conclusion by EFSA, supported by reports of sensitivity/intolerance reactions in humans, confirms that the use of sulphites is a potential safety concern [14].

In 2022 EFSA carried out a re-assessment of the additives in the sulphur dioxide-sulphite group and concluded that, due to significant gaps in the toxicological data set, the previous temporary acceptable daily intake (ADI) (0.7 mg SO_2/kg body weight/day) has to be withdrawn. EFSA derived a reference point of 38 mg SO_2/kg body weight/day, based on neurobehavioral endpoints in rats, and a margin of exposure of 80 for safety assessment: the exposure scenarios raise safety concerns especially for high consumers of sulphite-added foods. EFSA also re-stated the need for better data on the origin, mechanisms, and dose-response of sulphite-related human hypersensitivity, as these are definitely relevant for a more robust assessment. The recent conclusion by EFSA, supported by reports of sensitivity/intolerance reactions in humans, confirms that the use of sulphites is a potential safety concern [14].

In accordance with Regulation (EC) No 1333/2008, the use of sulphites (E220-228) in meat preparations, minced meat and fresh meat production is not permitted [1].

Food legislation requires mandatory labelling of allergens [8] with the aim of ensuring consumers' rights to safety, to be informed, and to make appropriate choices [15], [8]. In accordance with Regulation (EC) No 1333/2008, the use of sulphites (E220-228) in meat preparations, minced meat and fresh meat production is not permitted [1]. Their unlawful use gives the product a more attractive appearance, thus "masking" insufficient freshness [16], [17].

Although sulphites as allergens are subject to mandatory labelling [8], scientific articles report on unauthorized use of sulphites in EU Member States including Slovenia [18], [16], [19], [20], [17], [21], [22].

Food frauds occur when a Food Business Operator (FBO) intentionally deceives consumers about the quality and/or content of the food to gain an, usually economic, advantage for itself. Food frauds cover a broad range of cases including intentional substitution, addition, tampering or misrepresentation of food, food ingredients or food packaging, labelling, product information or false or misleading statements made about a product for economic gain; these unfair practices, may adversely affect the nutritional quality and/or safety of food, hence, consumer health [23], [24].

The consumer community is vulnerable to food frauds, also because of insufficient awareness about the increasingly complex nature of industrial food processing for number of reasons. Food science, or even the basis of food hygiene and nutrition, are generally not taught sufficiently in schools. On the other hand, consumers have no direct means for the verification of their expectations and have to rely completely on the food legislators and responsible authorities - enforcement agencies [25]. Studies show that the consumers are most worried about food and drugs adulteration, swindles and food contamination [26], [7], [5]. The perception of risk by average consumers may be greatly different from the perception of experts, as it is based on an ensemble of a range of beliefs, intuition, attitudes, judgments, feelings, opinions and culture, all of which differ widely among the population [27], [28], [29], [30]. The expert perception of risk is based on evidence, subject to the challenge of new research data and may include a risk-benefit approach [31]. Far from dismissing as irrelevant consumer perception, these considerations highlight the role of evidence-based risk communication and awareness raising in the consumer community as an important support to risk management.

Studies show that the consumers are most worried about food and drugs adulteration, swindles and food contamination [26], [7], [5].

Different hazards as well as different levels of risk require special consideration and specific ways of risk management and communication [32], [33] to build trust in and support to the agri-food safety system. Risk management strategies may use regulatory, advisory, and/or technological approaches, and take into account factors such as the size of the exposed population, required and available resources, costs of implementation, and the degree of scientific uncertainty of the risk assessment [34]. Food fraud as intentional act requires different approach as food safety issues that occur unintentionally.

This paper presents an important alert for the illegal use of sulphites in meat preparations and minced meat in Slovenia. The aim of the case study is to highlight the shortcomings of existing systems for ensuring food safety in case of food frauds and highlight challenges for improvements.

This paper presents an important alert for the illegal use of sulphites in meat preparations and minced meat in Slovenia.

METHODOLOGY

Collecting information

The Minister of Agriculture, Forestry and Food has ordered a Decision on appointing a Committee for internal audit of official control in the case of additives in meat preparations and informing consumers (Committee). Members of Committee were state employees of Ministry from different areas of expertise (veterinary medicine, food technology, law and management).

The Committee started to work 17 October and finished 15 November 2019. The main tasks of the Committee were:

- to investigate and evaluate all circumstances, procedures and facts during official control of sulphites in meat preparations;

- to investigate and evaluate way of informing and communicating with the public in this case;

- to prepare a report on findings.

Committee had access to all documentation in regional units of Competent Authority in Slovenia, for each case of official control regarding sulphites in meat preparation. During internal audit different actions have been implemented to collect all information, facts and to identify all circumstances:

- checking all documentations: inspection records and other relevant documentation was examined to determine whether the inspection procedure was conducted in accordance with the provisions of EU food legislation and with inspection legislation;

- interviews with responsible inspectors to understand decisions and measures required by inspectors during official control;

- meetings of the members of the Committee to exchange views and opinions on findings.

After checking and evaluating all documentation for each case, Committee performed interviews with responsible inspectors to clarify all possible gaps and uncertainties with the aim of verifying official control procedures.

This approach of investigation provided all relevant information and findings for Committee to prepare the final report for the Minister.

RESULTS

Alert identification and risk management

The alert started with a telephone notification by a consumer to the competent authority - Administration for Food Safety, Veterinary Sector, and plant Protection (Administration) in December 2017, regarding health problems related to the consumption of meal, prepared from minced meat. However, this first information received no response. Consequently, the consumer sent a written complaint to the competent authority in March 2018 with a reference to the previous telephone conversation and clearly described all the health problems that occurred after consuming a meal with minced meat (severe headache, burning sensation in the throat and stomach, stomach pain and vomiting). At that time the competent authority had not received any other complaints or information about untoward health effects from consumers after consuming meal, prepared from meat and minced meat.

In April 2018, food inspectors carried out official inspections at retail butcher shops in Ljubljana, Slovenia's capital, where the use of the illicit additive in meat preparations was not established. Inspectors looked at premises and at the possible presence of unauthorized additives, but did not take samples of meat preparations, and findings were recorded on an official note, without official minutes. No feedback was provided to the consumer, despite his request for information about his compliant.

In May 2019, the competent authority received a notification by telephone that indicated the use of this additive in the meat products sold in a national retail chain. Based on this report, an inspector carried out an emergency inspection at this supermarket in June 2019 and examined two samples: a sample of a meat preparation and a sample of minced meat, both of which were positive for sulphites.

The person responsible for the supermarket's retail meat sales admitted using sulphites; nevertheless, the inspector merely made a written note about it, but no sampling was performed.

The inspector informed the responsible person of the internal control of the retail chain but did not issue any further inspection orders or inform the director of Competent Authority. At the same time, in June 2019, the inspector also performed an official check at a supermarket in Ljubljana from another retail chain. The person responsible for the supermarket's retail meat sales admitted using sulphites; nevertheless, the inspector merely made a written note about it, but no sampling was performed. The meat preparations still in the display case were destroyed by the FBO in accordance with the legislation. The inspector did not order any corrective measures or penalties; in addition, no order or request was issued to the FBO to recall the meat products already sold on that day, or the previous days.

Five samples were taken in the eastern region of Slovenia: four samples of meat preparation for 'čevapčiči' (traditional minced meat dish) and one sample of fresh salmon with skin: one sample of meat preparation was positive for sulphites.

Eventually, the inspections made in May-June 2019 triggered a follow-up. In the second half of August 2019, inspectors began monitoring to determine the presence of sulphites in meat preparations, fresh meat and fish with the aim to evaluate the possibly wider incidence of this unfair practice. Five samples were taken in the eastern region of Slovenia: four samples of meat preparation for 'čevapčiči' (traditional minced meat dish) and one sample of fresh salmon with skin: one sample of meat preparation was positive for sulphites. Based on this positive result, the inspection procedure went on by issuing an oral decision as well as, within seven days, a written decision, and initiated an offence procedure; however, a tracing and recall of the food product was not requested. During this inspection, the inspector also found sulphites in a butcher shop and the retailer admitted the use of the illicit additive and his responsibility. In the same period, outside the monitoring plan, two positive samples of meat preparation were found during an inspection at a hypermarket in the Savinjska region (North Slovenia). The amount of sulphur dioxide ranged from 170 +/- 28 mg/kg to 400 +/- 60 mg/kg, and samples were identified as unsafe food [35].

In September 2019, the official veterinarian from competent authority, acting within a different control plan carried out an inspection, where the responsible person of FBO gave a statement that the use of sulphites has been a common practice for a long time. The inspector duly fulfilled the procedures by issuing oral decision, written decision and final decision within the time limit. However also in this case a requirement for a recall was not issued.

At the same time, in September 2019, the competent authority required additional official control regarding unauthorized use of sulphites in fresh meat and meat preparations. Unfortunately, inspectors did not have clear general guidance and instructions on the notification procedure in cases of finding non-compliant and dangerous foodstuffs. In fact, these instructions were still in the drafting phase. Although the instruction refers to Regulation 178/2002, recall of the food product was not required [36].

Unfortunately, inspectors did not have clear general guidance and instructions on the notification procedure in cases of finding non-compliant and dangerous foodstuffs.

To summarize, the risk management efficiently dealt with identified cases, yet, there was insufficient awareness about the health risks associated with the illicit use of sulphites in frequently consumed foods (minced meat preparation): such insufficient awareness may explain why tracing and recall actions were not triggered as well as why a more systematic investigation on the use of sulphites was not launched.

Risk communication and public perception

Figure 1 provides the timeline of risk management and risk communication regarding illegal use of sulphites in Slovenia in 2019. The responsible Minister was informed about the illegal use of sulphites from a journalist's question received on 4 October 2019. In accordance with Article 24 of the State Administration Act, the Director General of the Competent Authority must report regularly to the Minister on the work of the inspectors and inform them of any important cases [37]. Official information regarding sulphites in meat preparations was only received by the Minister on 7 October 2019, despite the fact, that the Competent Authority received the report on the first two positive results on sulphites in food products on 13 June 2019.

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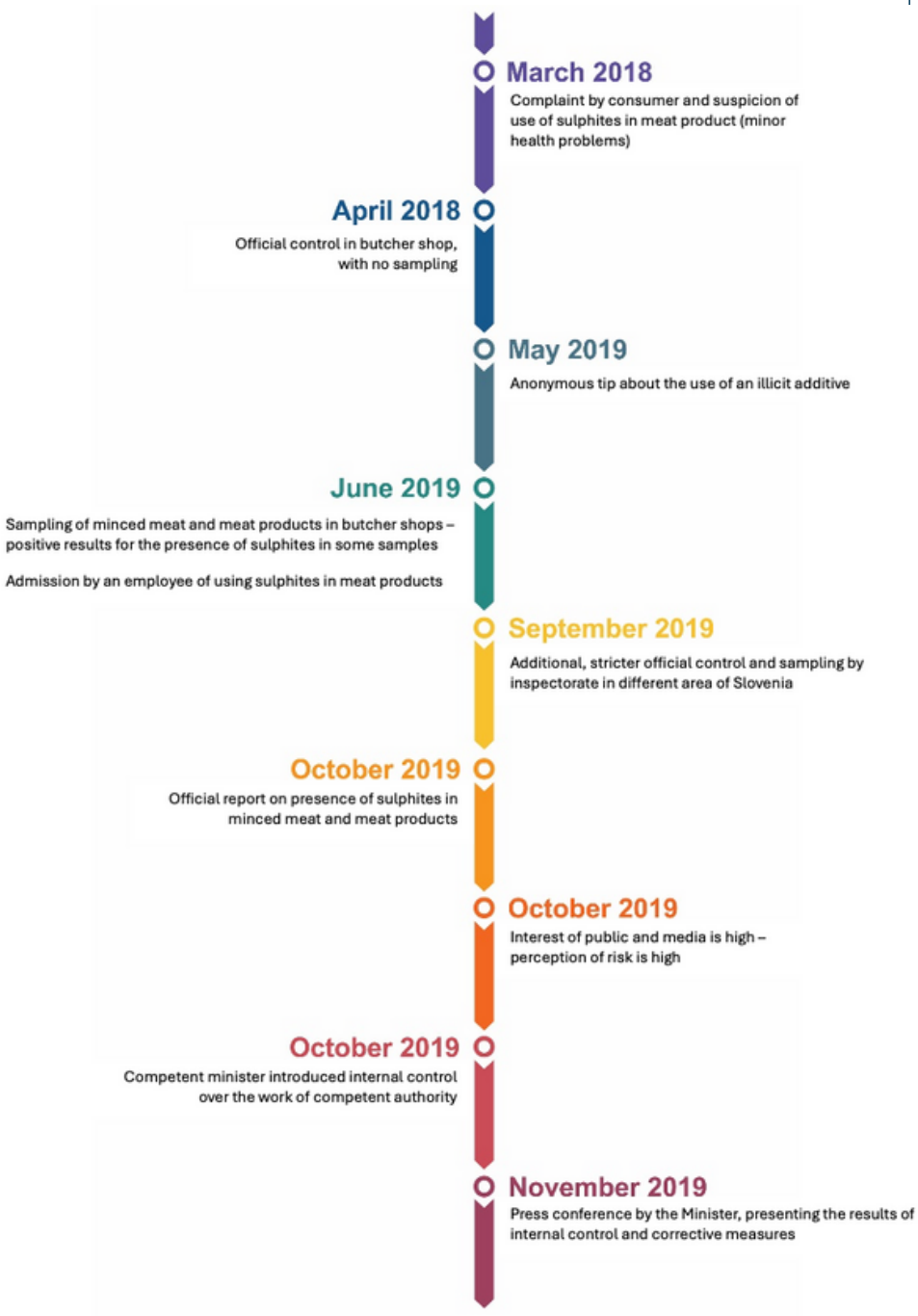
The Public Relations and Promotion Service at the Ministry requested that the public be informed properly, in a transparent and clear way, about all the important facts regarding this case. On 9 October 2019, the report and press release regarding sulphites in meat and meat preparations were forwarded by the Public Relation service to all media and published on the Ministry website.

Figure 1. Timeline of risk management and risk communication regarding illegal use of sulphites in Slovenia in 2019



The competent authority website enables information on unsafe food in the market through the RASFF system. On this website, different notices or news, various information, recommendations, and reports can be published.

However, regarding this case, prior to 7 October 2019 there was no notification on the website, nor did the competent authority inform the public about sulphites in meat: nevertheless, there is an applicable Protocol of Communication and Information on Risks in the Republic of Slovenia in the field of ensuring safe food and feed (Protocol). This Protocol, however, was not implemented in practice [38]. Neither the competent authority nor the FBO recalled the unsafe food in the RASFF, which was not in line with Regulation 178/2002.

However, regarding this case, prior to 7 October 2019 there was no notification on the website, nor did the competent authority inform the public about sulphites in meat: nevertheless, there is an applicable Protocol of Communication and Information on Risks in the Republic of Slovenia in the field of ensuring safe food and feed (Protocol).

The media reacted with great interest to the report on the implementation of additional controls on the use of sulphites in meat preparations. News about the results of official controls was published in various media: national and commercial television, national and regional radio stations, different newspapers, websites, and social media. They also raised reasonable questions as to why the public received no information about the presence of sulphites in meat preparations in June, and why the additional, stricter controls were carried out only in September.

Due to high public interest, the competent Minister imposed an internal audit on the work of the competent authority regarding the official controls on possible use of sulphites in meat preparations. The results of the internal audit and subsequent corrective measures were presented by the Minister at a press conference in November 2019, aiming to enhance better and effective official control and to eliminate food frauds. Special focus was placed on improving risk communication to protect public health as well as consumer rights to food safety and to keep the public informed [39]. The media also reported on the press conference, the findings of the internal audit, and corrective measures requested by the Minister.

Special focus was placed on improving risk communication to protect public health as well as consumer rights to food safety and to keep the public informed.

Overall, the case study identified a communication gap between food safety bodies and policy makers, as well as a positive role of media, goading authorities to timely and transparent action to protect the public health.

POLICY IMPLICATION - DISCUSSION

This case study illustrates risk management and risk communication on the illegal use of sulphites: this food fraud represents unintentional harm to consumer's health caused by an intentional act for economic gain. This is one main difference compared to unintentional food safety incidents [40].

Sulphites had been added to food illegally to preserve the appealing red colour of the meat, giving it the appearance of a fresh meat preparation. Meanwhile sulphites are allergens, and the information on their presence in foods is of crucial importance to consumers, while lack of information is detrimental to food safety. The illicit addition of sulphites to meat preparation relates to several violations of core legislations. This practice represents a deliberate misleading of the consumer about the properties and composition of the food, which runs counter to the basic legislation governing food [41], [8] and consumer protection [42]. The FBOs intentionally omitted the labelling of sulphites in meat preparation, knowing that the use of sulphites in this food category is illegal. Thus, the provisions of Regulation (EC) No 1333/2008 and Regulation 1169/2011 stipulating the mandatory labelling of allergens, such as sulphites, were violated. The FBOs also violated the Consumer Protection against Unfair Commercial Practices Act [43], which lays out misleading practices, including the intentional omission of mandatory labelling. Interestingly, in the case of illegal use of sulphites we can recognize all three elements needed for a crime to occur according to the Routine Activity Theory (RAT), i.e., the presence at the same time and in the same place of a suitable target, motivated offender as well the lack of a suitable guardian to prevent the crime [44], [15]. In our case study: the motivated offender as the FBO, the suitable targets as consumers and lack of a suitable guardian as insufficient official control.

The FBOs also violated the Consumer Protection against Unfair Commercial Practices Act, which lays out misleading practices, including the intentional omission of mandatory labelling.

The competent authority issued warnings and other corrective measures regarding this case. In accordance with the Inspection Act, a warning can be imposed as the mildest inspection measure in case of a lower level of risk for consumers. Such a case enables "softer" action if the FBO is aware of its non-compliance and of the need to correct it [45]. The inspector is obliged to make their own decisions regarding procedures and measures to be imposed based on reports of positive samples for sulphites content, the employee recognition of the use of such an additive and the risk assessment, e.g., an exposure assessment based on the detection of unacceptable substances in widely consumed foods, such as meat preparations. In this case, the action taken by the competent authority was too late, occurring only in mid-October 2019.

Where there is a confession of the offender and a positive report on the unsafe sample, this provides evidence of committing a violation of food law [41] and such food product should not be put on the market. Production and selling of unsafe foods are illegal and should be prosecuted by the competent authority [46]. Besides the possible risk for the general population exposed to excessive levels [14], sulphites in food represent a recognized danger to the health of people who are hypersensitive to sulphites. By destroying meat preparations without sampling, official inspectors violated the obligation of securing evidence. As the confessions of the responsible persons were not supported by evidence (no samples taken), the prosecution of this unfair practice and food fraud was not feasible.

When the competent authority identifies non-compliance, it shall take action to ensure that the FBO remedies the situation. Such action shall include monitoring and if necessary, ordering the recall, withdrawal and/or destruction of food [46]. In this case, the inspectors did not act against the FBO by requesting a recall for the sold meat preparations, though they demanded the withdrawal and destruction of the unsold quantity.

By destroying meat preparations without sampling, official inspectors violated the obligation of securing evidence.

The competent authority knew about the first finding of sulphites in five samples of meat preparations from the butcher's shops of retail chains in June 2019. Additional, closer control by the inspectors was carried out for the first time in September 2019. The first official report and informing the public occurred in October 2019 [35]. Consumers were not warned on how to handle meat preparations that they had already purchased: indeed, some consumers who bought meat products in the summer may have frozen a certain unused amount for later use. In this regard, the competent authority informed consumers that the freezing of meat preparations was not a common storage practice [36]. Otherwise, the food label would indicate that it is not suitable for re-freezing. Consumers should have been informed about it, but they were not, which was also pointed out by the Slovenian Consumers' Association; they also emphasized that freezing meat preparations was not an unusual consumer practice [47]. Overall, three problems were identified in regard of consumer's information: i) consumers hypersensitive to sulphites were not informed of the hazardous foods present on the market, neither through the RASFF system nor by relevant statements of the competent authorities in the media; ii) the consumers were not instructed in time to dispose of any purchased and frozen minced meat and meat preparations in the period from June 2019 and October 2019; iii) even the rights of consumers who are not allergic to sulphites have been affected, as all consumers have the basic right to be informed of all the ingredients in the food they consume [8].

Consumers were not warned on how to handle meat preparations that they had already purchased: indeed, some consumers who bought meat products in the summer may have frozen a certain unused amount for later use.

The identified shortcomings in risk management may be due to different causes, such as:
- insufficient communication and co-operation among offices;
- insufficient collection, storage, analysis, and utilization of data at regional and/or central level, as well insufficient awareness about the health risks due to sulphites and lack of basic training of inspectors and other risk managers in risk assessment [34].

Where the product had reached the consumer, the FBO should have effectively and accurately informed the consumers of the reason for its withdrawal and should have recalled from consumers the products already supplied to them, to achieve a high level of health protection.

Finally, the crucial role of the FBO in ensuring food safety was missing in the risk management of the Slovenian sulphite alert. The FBO should have immediately initiated procedures to withdraw the food from the market. Where the product had reached the consumer, the FBO should have effectively and accurately informed the consumers of the reason for its withdrawal and should have recalled from consumers the products already supplied to them, to achieve a high level of health protection.

Meat preparations represent important sources of SO exposure, especially in adults and young people in many countries [18], [16], [19], [20], [17], [21], [22]. Risk assessors and risk managers should be aware that in today's technological age, a purely reactive response to the various types of food frauds is neither efficient nor effective [48], [49], [50]. In the run for profit in a global, competitive market consumers are easy targets for unlawful acts by importers, producers, wholesalers, or retailers who intend to increase profits with less capital and equipment, while avoiding detection [26], [51], some cases, like the illegally import of bush meats [52] are potentially linked to criminal activities. In any case food fraud is a food-industry issue where the effect is often a public health threat, yet the cause or motivation is economic [40].

In any case food fraud is a food-industry issue where the effect is often a public health threat, yet the cause or motivation is economic.

Any plans and actions to mitigate or prevent the risks associated with food fraud should consider a whole food chain approach. Using a HACCP-like approach, sulphites in meat preparation may be readily identified as a likely hazard in a country like Slovenia, due to widespread consumption of meat preparations like "čevapčiči", the wish to attract consumers with a "fresh meat look" and the easy availability of sulphites. In addition, beyond the traditional food safety scope, some activities against food frauds may require applying methods closer to criminal investigation [33]. In any case food fraud is, indeed, a food-industry issue. It is important to emphasize that although the cause or motivation is economic or financial, the effect is often a public health threat [40].

Using a HACCP-like approach, sulphites in meat preparation may be readily identified as a likely hazard in a country like Slovenia, due to widespread consumption of meat preparations like "čevapčiči", the wish to attract consumers with a "fresh meat look" and the easy availability of sulphites.

Our case study highlighted the key importance of risk communication addressed to policy makers, the media and general public as well as stakeholders (FBOs, consumer associations). Food safety situations that require urgent communication to prevent or reduce the risks of significant harm are often associated with many gaps in knowledge. Where there is uncertainty, this should be acknowledged and explained, together with what is being done by risk assessors and managers to address the uncertainty, and the implications for target audiences [53], [54], [31], [34], [55].

Moreover, risk communication cannot be a pure one-way process. Risk communicators should understand and respect risk perceptions of average consumers.

It is important to recognize and respect differences in perception, which may be due to economic, social, or cultural differences [23], because they could contribute to disagreeing views between experts and the public about managing risk [56], [29].

In general, consumers are more ready to accept information that is consistent with their previous beliefs [6] meanwhile, negative emotions such as fear, confusion and worries about their health are major factors in the public's risk perception during food safety alarms [57], [31], [6], [57]. In the case of chemical hazards, consumers often perceive chemicals in food as high-risk to their health [5] and/or posing unacceptable concerns because they are involuntary, unrecognized hazards presenting an unknown effect on health [58], [59]. The presence of perceived benefits mitigates the risk perception [7], [60].

In the case of chemical hazards, consumers often perceive chemicals in food as high-risk to their health and/or posing unacceptable concerns because they are involuntary, unrecognized hazards presenting an unknown effect on health.

In our case study, there was a low perception of the risks of sulphites among the Slovenian general consumers, and a deficient communication by the food safety authorities (the experts) to the policy makers, as political representatives of the general public. Meanwhile, the media and the consumers association played a goading role that helped to stir a more effective response. In fact, rather than the usual one-way communication, in several instances experts and the public engage in an interactive exchange, as the increasingly relevant field of Citizen Science shows [61]. Our case study shows that public authorities may profit from inputs by media and citizen's organizations in food safety alerts.

Our case study shows that public authorities may profit from inputs by media and citizen's organizations in food safety alerts.

Finally, the case of sulphites in meat products in Slovenia highlights the role of continuous and timely information exchange. There is no such thing as “zero” risk in food safety, or in life more generally, despite the efforts of governments and inspection bodies to prevent food fraud [25]. Nevertheless, all evidence should be collected, and efforts should be made to reduce the risks. This is the reason why the European Commission set up the Food Fraud Network as a network of the Commission, the European Union Agency for Law Enforcement Cooperation (Europol), the liaison bodies designated by the Member States, and where relevant, the European Union’s Judicial Cooperation Unit (Eurojust). Since 2013, EU Member States and some other European countries (Switzerland, Norway and Iceland) exchange information and cooperate in matters where they are confronted with violations of the EU agri-food chain legislation of a cross-border nature. The EU Food Fraud Network allows assisting and coordinating communication between competent authorities and transmitting and receiving requests for assistance. The liaison bodies are required to exchange information necessary to enable the verification of compliance with EU agri-food chain legislation with their counterparts and, in certain cases, with the Commission, where the results of official controls require action in more than one country [62].

There is no such thing as “zero” risk in food safety, or in life more generally, despite the efforts of governments and inspection bodies to prevent food fraud.

At the international level, the International Food Safety Authorities Network (INFOSAN) managed jointly by the Food and Agricultural Organization of the United Nations (FAO) and the World Health Organization (WHO) is an important global network. It includes national food safety authorities and provides an mportant platform for the rapid exchange of information during food safety emergencies and for sharing data and information [40].

SUMMARY AND CONCLUSIONS

This article highlights critical aspects of risk management and risk communication as important stages of ensuring food safety in case of food fraud. Despite the clear and unambiguous legislative rules and provisions, the implementation in practice by the FBOs as well as by the competent authority was not optimal, possibly also due to insufficient awareness of sulphite-related health risks. Other shortcomings concerned insufficient communication between food safety responsible and policy makers as well as here lack of understanding of consumer's risk perception; meanwhile, media and consumer's association had a positive goading role. The traditional food safety approaches may not be the most effective option for detecting or deterring food fraud. Prevention of risks from food fraud requires an interdisciplinary approach with new methods and corrective measures combining criminology with other expert fields: food safety, public health, food science, consumer protection, supply chain management, and social anthropology [33].

Other shortcomings concerned insufficient communication between food safety responsible and policy makers as well as here lack of understanding of consumer's risk perception; meanwhile, media and consumer's association had a positive goading role.

Providing corrective measures against food fraud by the responsible authority needs to be improved by means of clear standard operating procedures, including decision trees for issues requiring a case-by-case approach. Consumer awareness of risks and mitigating measures (such as disposal of frozen foods purchased in a certain period) are of paramount importance to integrate the official measures taken by authorities.

Ineffective, improper risk management in this case reflects a lack of effective training for inspectors as well as a lack of internal risk communication. Late and incomplete notification is unacceptable in ensuring food safety and consumer protection. It shows a clear disregard for the basic principles and objectives of effective risk communication: timeliness, transparency, consideration of consumer perceptions, their legitimate concerns, and fears. Recognizing the hazard, defining the problem, and understanding the nature and level of the risk are crucial before developing prevention, intervention, and response plans in case of food fraud.

Ineffective, improper risk management in this case reflects a lack of effective training for inspectors as well as a lack of internal risk communication.

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