ARTICLE
https://doi.org/10.22239/2317-269X.02191

Profile of biological material accidents among medical undergraduates and residents

Perfil dos acidentes com exposição a material biológico entre residentes e estudantes de medicina

Fernanda Sucasas Frison[I,*]

Herling Gregório Aguilar Alonzo[II]

Inajara de Cássia Guerreiro[III]

[I] Faculdade de Ciências Médicas, Universidade Estadual de Campinas, Campinas, SP, Brasil

[II] Departamento de Saúde Coletiva, Faculdade de Ciências Médicas, Universidade Estadual de Campinas, Campinas, SP, Brasil

[III] Centro de Saúde da Comunidade, Universidade Estadual de Campinas, Campinas, SP, Brasil

* **E-mail:** ffrison@unicamp.br

Received: Apr 21, 2023
Approved: Apr 4, 2024

How to cite: Frison FS, Alonzo HCA, Guerreiro IC. Profile of biological material accidents among medical undergraduates and residents. Vigil Sanit Debate, Rio de Janeiro, 2024, v.12: e02191. https://doi.org/10.22239/2317-269X.02191

ABSTRACT

Introduction: Resident physicians and medical students who suffered occupational accidents involving biological risks can present serious health problems. **Objective:** To describe occupational accidents involving exposure to biological material among medical undergraduates and residents at the State University of Campinas from 2011 to 2020. **Method:** This was a retrospective case series study conducted from the records of work accidents involving exposure to biological material that occurred among medical undergraduates and residents. Data were analyzed using the Statistical Analysis System (SAS) software, version 9.4. To check the association between the use of personal protective equipment and exposure route, the method Generalized Estimating Equations was used. **Results:** A total of 1,121 notifications were analyzed, of which 78.5% involved medical residents and 21.5% involved medical undergraduates. Most exposures were due to percutaneous injury (80.1%), the needle with lumen was the main causative agent (37.6%), and 49.0% accidents occurred during surgical procedures or sutures. The operating room and emergency unit had the highest number of accidents. It was evidenced association between accidents that occurred with exposure to the mucous membranes of eyes and non-adherence to eye protection (p<0, 0001). Residents suffered more accidents in the first two years of residency (66.3%), whereas in medical undergraduate students, the prevalence was between the fifth and sixth year of the program (81.9%). **Conclusions:** Awareness and early education regarding the issue of safety in the work environment should be a priority in medical education, because they provide students with the necessary knowledge to protect themselves from occupational biological hazards.

KEYWORDS: Accidents; Occupational; Occupational Exposure; Internship and Residency; Occupational Health; Education Medical Undergraduate

RESUMO

Introdução: Os médicos residentes e os graduandos do curso de medicina, ao sofrerem um acidente de trabalho com material biológico, podem apresentar sérios agravos à saúde. **Objetivo:** Descrever os acidentes de trabalho com exposição a material biológico entre os estudantes e residentes de medicina da Universidade Estadual de Campinas, no período de 2011 a 2020. **Método:** Estudo retrospectivo de série de casos, realizado a partir das fichas de notificação dos acidentes de trabalho com exposição a material biológico, ocorridos entre os residentes e acadêmicos de medicina. Os dados foram analisados no *software* Statistical Analysis System (SAS), versão 9.4, para verificar a associação entre o uso do equipamento de proteção individual e a via de exposição foi utilizado o método das Equações de Estimação Generalizadas. **Resultados:** Foram analisadas 1.121 notificações, 78,5% envolveram os residentes médicos e 21,5%, os estudantes de medicina. A via de exposição percutânea foi a mais frequente (80,1%), a agulha com lúmen o principal causador (37,6%), e 49,0% dos acidentes ocorreram em procedimentos cirúrgicos ou suturas, principalmente, no bloco cirúrgico, seguido da unidade de emergência. Houve associação entre os acidentes que ocorreram com exposição à mucosa ocular e a não

adesão aos óculos de proteção (p < 0,0001). Os residentes sofreram mais acidentes nos primeiros dois anos do programa (66,3%), enquanto os estudantes de medicina, no quinto e sexto ano do curso (81,9%). **Conclusões:** A conscientização e a educação precoces com relação à questão da segurança no ambiente de trabalho devem ser prioridade no ensino médico, pois possibilitam aos discentes o conhecimento necessário para se protegerem dos riscos biológicos ocupacionais.

PALAVRAS-CHAVE: Acidentes de Trabalho; Exposição a Agentes Biológicos; Residência Médica; Saúde dos Trabalhadores; Educação de Graduação em Medicina

INTRODUCTION

An accident at work is a sudden event occurring during work activity that can cause direct or indirect bodily injury, functional disturbance, damage to health, impairment of functional capacity, or even death[1]. It therefore has an impact on the morbidity and mortality of the population[2].

In Brazil, care for workers' health and safety is established by the Federal Constitution (FC) of 1988, and the actions developed by the Ministries of Labor and Employment, Social Security, and Health, together with health, hygiene, and safety standards, are intended to protect employees from the risks inherent in their work[3].

The implementation of sanitary, epidemiological, and occupational health surveillance actions were included in the scope of the Unified Health System (SUS) through Organic Health Law No. 8.080, of September 19, 1990, in which, in order to guarantee workers' health, it is essential for the state, companies, society, and the employee themselves to act, contributing to the adoption of measures to control health problems in the workplace[4].

Health services are unhealthy work environments due to the physical, chemical, biological, ergonomic, mechanical, and psychosocial risks to which health care workers (HCW) are exposed during the course of their work[5]. Based on data from the Occupational Safety and Health Observatory, from 2012 to 2022, the economic sector with the highest number of notifications of accidents at work, including those involving biological material, was hospital care, with 603,631 cases[6].

The notification of work accidents involving exposure to biological materials (WAEMB) in Brazil has been mandatory since 2004 and is carried out through the Notifiable Diseases Information System (SINAN)[7]. Epidemiological investigation should be carried out as soon as the case occurs, contributing to health surveillance, with knowledge of the reality, analysis of risks and damage to the exposed population, while helping to identify problems and take control measures aimed at the health and safety of workers[8].

In an ecological survey carried out in the country between 2010 and 2016, 331,603 WAEMB were reported on SINAN, 73.42% of which were among HCW[9]. The state of São Paulo reported the most, followed by Minas Gerais and Rio de Janeiro[9].

Workers, including resident doctors, who are *latu sensu* postgraduate students, and medical undergraduates, are potentially exposed to biological fluids in patient care, coming into contact with blood, fluids (cerebrospinal, synovial, pleural, peritoneal, pericardial, articular, and amniotic), respiratory secretions, urine, among others[10,11]. Occupational exposure to biological agents can occur through percutaneous means, non-intact skin (dermatitis, superficial wounds), mucous membranes (eyes, mouth, nose, genitals), bites, or scratches with blood[10,11,12]. Different pathogens pose a risk of occupational infection to HCW, with the highest incidence caused by hepatitis B virus (HBV), hepatitis C virus (HCV), and human immunodeficiency virus (HIV)[10,12].

The available literature on biological risks and occupational exposure in the workplace among HCW has been widely explored and disseminated, but studies on resident doctors and medical undergraduates are less well researched.

It should be borne in mind that the frequency of WAEMB in the country, as well as the statistics on occupational diseases, injuries, and deaths, is higher than has been reported, mainly due to the underreporting of these accidents, which makes it difficult to understand the real magnitude of the problem, as well as its consequences[9,13,14].

The adoption of biosafety measures involves educational and behavioral actions, which contribute to reducing the number of WAEMB and ensure that activities are carried out with an adequate degree of safety, through a set of measures to prevent, control, reduce, or eliminate the risks inherent in biological agents and materials, which can compromise human health and the environment[8,15,16].

Among the recommended biosafety practices is adherence to standard precautions (SP), which reduce worker exposure to biological material and its pathogenic derivatives. These include: hand washing; proper disposal of sharp instruments, chemical, and toxic waste; use of retractable needle devices and needle protection systems; use of personal protective equipment (PPE); and immunization against diseases[15,16]. In addition, the proper management and handling of health service waste (HSW), including sharp materials, is fundamental to reducing environmental and health risks[17].

The adoption of measures to protect workers' health and prevent diseases should not be analyzed in separate, but should take into account the monitoring of the environment, processes, and working conditions, the risk factors detected, and the control of exposure to biological agents[8].

The prevention of occupational diseases and the identification of factors associated with the occurrence of WAEMB should be of interest to health systems, with active participation and efforts between the government, employers, and HCW, ensuring health and safety at work[7,8,9]. Analyses of scientific productions that address issues related to the circumstances of WAEMB and the organization of work contribute to the development of control measures for workers' health, the analysis of risk situations, the development of intervention strategies in work environments and processes, as well as serving as a warning to HCW and institutions in the management of biological risk.

In view of the above, the aim of this study was to describe the WAEMB among medical undergraduates and residents at the State University of Campinas (Unicamp) between 2011 and 2020.

METHOD

This is a descriptive, exploratory, retrospective case series study, based on the compulsory notification forms of WAEMB that occurred among medical residents and undergraduates, from January 2011 to December 2020, at the Unicamp hospital complex.

Unicamp is in the municipality of Campinas, in the state of São Paulo. Its health area has two tertiary referral hospitals, four specialized centers, and several outpatient clinics, where procedures are carried out, mainly of high complexity, along with teaching, research, and extension activities.

Every year, the Faculty of Medical Sciences has approximately 720 students in the medical course and 672 doctors in the Medical Residency programs, including 47 specialties, 36 areas of concentration, and six additional year programs[18].

Since 2011, WAEMB cases among HCW (including undergraduate and graduate students) that occur at the institution have been attended to and reported by the Biological Risk Program of the Community Health Center (CECOM). As of December 31, 2020, there were 2,466 WAEMB registered, of which 880 (35.7%) involved residents and 241 (9.8%) medical undergraduates, who make up the subjects of this study. No notification form was excluded from the analysis.

A database was built, taking into account the following variables: gender, age group, color, presence of pregnancy, specialty and year of medical residency, year of medical graduation, use of PPE at the time of the accident, known source patient, part of the body affected, route of exposure, causative agent, type of organic material involved, circumstance and location of the accident in the workplace, and evolution of serological follow-up (discharge without seroconversion and abandonment). All the notifications included in the study were closed.

For the analysis, the selected data was entered into a Microsoft Excel 2016 spreadsheet and statistically analyzed using the Statistical Analysis System (SAS) software version 9.4, to check the absolute and relative frequencies shown in the tables. The Generalized Estimating Equations method, recommended for longitudinal data analysis, was used to verify the association between PPE use and the route of exposure. The estimates were calculated by maximum likelihood. The significance level adopted for the statistical tests was 5.0%.

The ethical aspects of the research were followed, according to the guidelines of Resolutions No. 466, of December 12, 2012, and No. 510, of April 7, 2016, of the National Health Council, and were approved by the Unicamp Research Ethics Committee, under opinion No. 3.510.458/2019.

RESULTS

A total of 1,121 WAEMB notifications were recorded and analyzed, of which 880 (78.5%) involved medical residents and 241 (21.5%) medical undergraduates, aged between 16 and 41, the majority (944; 84.2%) in the 20-29 age group, and 170 (15.2%) between 30 and 39. Regarding gender, there was a predominance of females, with 611 (54.5%), two of whom reported pregnancy. As for self-declared color, white had the highest number of records (1,059; 94.5%), followed by yellow (39; 3.5%), black/brown (17; 1.5%), and in six cases there was no information (0.5%).

Table 1 shows that 1,094 (97.6%) of the source patients involved in the accidents were known. The main organic material involved was blood, with 1,019 (90.8%), for both residents and medical undergraduates. As for the location of the accident, the operating room (63.3%) was the place where medical residents had the most accidents, while the emergency unit (51.5%) was the place where medical undergraduates had the most accidents.

The main causative agent was the needle with a lumen, responsible for 37.6% of events, followed by the needle without a lumen, with 30.8%. The part of the body affected, or the site of the injury was the finger in 843 (75.2%) cases and the eye in 161 (14.4%). It was found that in the majority of accidents the route of exposure was percutaneous, in 898 cases (80.1%), and the ocular mucosa in 161 (14.4%). Specifically, in the case of percutaneous exposures among residents, in 90 (12.5%) the perforation was caused by another professional during care.

As for the circumstances of the WAEMB, it was found that most accidents (550; 49%) occurred during surgical procedures/sutures, 142 (12.7%) during venipuncture or arterial puncture, and 100 (8.9%) when handling sharp materials before disposal, while the lowest frequency occurred when connecting or disconnecting the needle from the equipment/syringe, with 1.3% of accidents.

Table 2 shows the relationship between the route of exposure in the accident and the PPE items being used. The use of gloves was reported by 95.0% of those injured through percutaneous exposure; in the case of exposure through the mucous membrane of the eye, 90.0% reported not wearing goggles at the time of the accident; and face protection was the least used PPE in all types of exposure. There was a statistical association between the route of exposure through the ocular mucosa and the use of

Table 1. Distribution of cases of accidents involving exposure to biological material among medical undergraduates and residents, Health Area of the State University of Campinas, 2011-2020.

	Medicine resident (N = 880)		Medical undergraduate (N = 241)		Total (N = 1.121)	
	N	%	N	%	N	%
Known source patient						
Yes	859	97.6	235	97.5	1,094	97.6
No	21	2.4	6	2.5	27	2.4
Organic material involved						
Blood or blood products	802	91.2	217	90	1,019	90.9
Solutions that may contain blood	23	2.6	14	5.8	37	3.3
High-risk secretion	23	2.6	9	3.7	32	2.8
Low-risk secretion	18	2.0	0	0.0	18	1.6
Formalized biopsy	7	0.8	0	0.0	7	0.6
Clean or washed material	3	0.3	1	0.4	4	0.4
Ignored	4	0.4	0	0.0	4	0.4
Accident scene						
Operating room	557	63.3	65	27.0	622	55.5
Emergency unit	79	9.0	124	51.5	203	18.1
Hospitalization unit	109	12.4	46	19	155	13.8
Outpatient clinics	82	9.3	4	1.7	86	7.8
Intensive care unit	31	3.5	1	0.4	32	2.8
Pathology laboratory	22	2.5	1	0.4	23	2.0
Part of the body affected						
Finger	670	76.1	173	71.8	843	75.2
Eyes	117	13.3	44	18.3	161	14.4
Hand	48	5.5	16	6.6	64	5.7
Forearm and wrist	13	1.5	2	0.8	15	1.3
Mouth	8	0.9	2	0.8	10	0.9
Others	24	2.7	4	1.7	28	2.5
Exposure route						
Percutaneous	717	81.5	181	75.1	898	80.1
Ocular mucosa	117	13.3	44	18.3	161	14.4
Unbroken skin	20	0.3	6	2.5	26	2.3
Healthy skin	15	1.7	5	2.0	20	1.8
Oral mucosa	8	0.9	2	0.8	10	0.9
Others	3	0.4	3	1.2	6	0.5
Circumstance of the accident						
Surgical procedure/suture	478	54.3	72	30.0	550	49.0
Venipuncture/gasometry	75	8.5	67	27.8	142	12.7
Handling sharp materials before disposal	78	8.8	22	9.1	100	8.9
Anesthetic procedure	51	5.8	21	8.7	72	6.4
Intracath passage	45	5.1	7	2.9	52	4.7
Needle replacement	26	3	24	9.9	50	4.4
Patient and airway handling	25	2.9	9	3.7	34	3.0
Administration of medication	20	2.3	2	0.8	22	2.0

Continue

Continuation						
Pathology laboratory procedures	21	2.4	1	0.4	22	1.9
Connecting or disconnecting a syringe/equipment needle	10	1.1	4	1.6	14	1.3
Others	51	5.8	12	5.0	63	5.6
Causative agent						
Needle with lumen	297	33.7	125	51.9	422	37.6
Needle without lumen/suture/mandrel/steel thread	293	33.3	52	21.6	345	30.8
Droplet/aerosol	160	18.2	57	23.6	217	19.3
Surgical instrument/scalpel blade	97	11.0	3	1.2	100	8.9
Others	33	3.8	4	1.6	37	3.3

Source: Prepared by the authors, 2023.

Table 2. Distribution of cases of accidents with biological material according to life of exposure and use of personal protective equipment, Health Area of the State University of Campinas, 2011-2020.

	Ocular mucosa (N = 161)		Oral mucosa (N = 10)		Healthy skin (N = 20)		Unbroken skin (N = 26)		Percutaneous (N = 898)		Total* (N = 1,115)		P-value**
	N	%	N	%	N	%	N	%	N	%	N	%	
Apron													
No	55	34.2	7	70.0	06	30.0	13	50.0	399	44.4	480	43.0	0,0951
Yes	106	65.8	3	30.0	14	70.0	13	50.0	499	55.6	635	57.0	
Gloves													
No	10	6.2	3	30.0	05	25.0	13	50.0	45	5.0	76	6.8	0,0016
Yes	151	93.8	7	70.0	15	75.0	13	50.0	853	95.0	1039	93.2	
Mask													
No	69	42.8	9	90.0	11	55.0	15	57.7	484	53.9	588	52.7	0,1578
Yes	92	57.1	1	10.0	09	45.0	11	42.3	414	46.1	527	47.3	
Goggles													
No	145	90.1	7	70.0	17	85.0	23	88.5	654	72.8	846	75.9	<0,0001
Yes	16	9.9	3	30.0	3	15.0	3	11.5	244	27.2	269	24.1	
Face shield													
No	160	99.4	10	100.0	19	95.0	26	100.0	877	97.7	1092	97.9	0,2063
Yes	1	0.6	0	0.0	1	5.0	0	0.0%	21	2.3	23	2.1	

* The other exposure route (six cases) was disregarded for the analysis.
** Generalized Estimating Equations Method.
Source: Prepared by the authors, 2023.

goggles as PPE ($p < 0.0001$), and the use of gloves in accidents involving non-intact skin ($p < 0.0016$).

Table 3 shows the year in which they were in medical residency and undergraduate medical studies when they suffered the WAEMB. It was found that, among residents, there is a decrease in WAEMB as the years of training progress, in contrast to the profile of medical undergraduates, where the trend increases as the course progresses. Residents had more accidents in the first two years, with 529 (66.3%) of the cases, while for undergraduates, most of the events occurred in the fifth and sixth years of the course (exclusive internship years), with 177 (81.9%) of the total.

Regarding the residents' areas of training, 37 medical specialties were recorded, the five most frequent, with 558 (63.4%) of the cases, being: tocogynecology, with 124 (14.0%); general surgery, with 106 (12.0%); anesthesiology, with 91 (10.3%); ophthalmology and orthopedics, with 80 cases each (9.0%); and clinical medicine, with 77 (8.7%).

Table 4 shows the number of accidents reported per year, with a downward trend from 2011 to 2018, which comes to a halt in 2019 with a 19.0% increase in accidents compared to 2018, especially among residents. The drop recorded in 2020 coincides with the first year of the coronavirus pandemic (COVID-19), and it is not possible to state the real reasons for this decrease, but

Table 3. Distribution of cases of accidents with biological material among residents and medical undergraduates according to the year of residency or graduation, Health Area of the State University of Campinas, 2011-2020.

Year of residence** or graduation***	Medical resident (N = 798)		Medical undergraduate (N = 216)		Total* (N = 1,014)	
	N	%	N	%	N	%
First year	313	39.3	0	0.0	313	30.9
Second year	216	27.0	15	7.0	231	22.8
Third year	172	21.6	16	7.4	188	18.5
Fourth year	72	9.0	8	3.7	80	7.9
Fifth year	25	3.1	69	31.9	94	9.3
Sixth year	0	0.0	108	50.0	108	10.6

* Information is missing from 25 medical undergraduate files and 82 medical resident files.
** Medical residency, depending on the specialty, up to 5 years.
*** 6-year medical degree course.
Source: Prepared by the authors, 2023.

Table 4. Distribution of cases of accidents with biological material according to the year of occurrence, Health Area of the State University of Campinas, 2011-2020.

Year of the accident	Medical resident (N = 880)		Medical undergraduate (N = 241)		Total (N = 1,121)	
	N	%	N	%	N	%
2011	112	12.7	38	15.7	150	13.4
2012	97	11.0	34	14.1	131	11.7
2013	79	9.0	24	9.9	103	9.2
2014	85	9.7	20	8.3	105	9.3
2015	92	10.4	28	11.6	120	10.7
2016	82	9.3	25	10.4	107	9.5
2017	78	8.9	25	10.4	103	9.2
2018	84	9.5	22	9.2	106	9.4
2019	100	11.3	19	7.9	119	10.6
2020	71	8.1	6	2.5	77	6.9

Source: Prepared by the authors, 2023.

we have hypothesized underreporting and/or a reduction in the number of elective surgeries performed at the hospital complex during the period.

As for the serological status of the source patients, 71 cases were positive for HIV, 79 were reactive for HCV, and seven were positive for HBV. Percutaneous exposure was recorded in: 49 accidents with a source case positive for HIV; 59 with a case positive for HCV; and in six with reactive HBV. HIV chemoprophylaxis was recorded in 106 (9.45%) cases.

In the evolution of the cases, there was no record of serological conversion, and 1,023 (91.3%) of the victims were discharged. Abandonment of outpatient follow-up - which lasts up to a year and is necessary when the source patient is unknown or has HIV, HCV, or HBV infection - was 8.7% (98 cases).

DISCUSSION

The results show a predominance of WAEMB among undergraduate students and medical residents who are female and young adults. The findings corroborate other national studies, with females being the majority of health professionals in the country,[9,10,13,16] and differ in terms of the large predominance of Caucasians among the injured.

There is a significant number of accidents among young people, as expected, and this may be related to less developed technical skills, little experience, and performing procedures without adequate training[10,11,19]. As a result, undergraduate students and medical residents, who are in the process of training, are more vulnerable to accidents. Other data that may show a lack of technical skills are those relating to injuries caused by other professionals.

Considering that the Unicamp hospital complex is a reference in invasive surgical interventions, which involve the frequent handling of sharp instruments and needles, the high number of records of percutaneous exposure, blood as the main organic material involved, and needles (with or without a light) with the highest percentage among the objects causing the accident is justified. Percutaneous injuries caused by contaminated sharp materials represent a greater risk of infection by blood-borne pathogens and are among the most frequent WAEMB in the world[20].

The high frequency of WAEMB due to percutaneous exposure was also found among HCW in the municipality of Canoas, in Rio Grande do Sul (76.8%)[21], in the states of Maranhão (83.4%)[22] and Goiás (89.5%)[23]. In Italy, every day approximately 300 HCW suffer an WAEMB involving a needle or contaminated sharp materials, totaling more than 100,000 accidents per year[24]. Divergent results were found among HCW in the municipality of Cacoal/Rondônia, where there was a low incidence (6.3%) of sharps accidents[16], and these findings may be related to underreporting of this type of accident.

Regarding the sector in which WAEMBs occur, the Surgical Center (SC) concentrates the majority of events among medical residents, and the Emergency Unit among medical undergraduates. This finding is also related to the high percentage of accidents among medical specialties involving surgery. Similar data was found in a study in Italy, in which the gynecology and obstetrics specialties and general surgeons were more involved in sharps accidents[12]. In the case of the Emergency Unit and medical undergraduates, this was also one of the three places with the most accidents reported among students at a University Hospital in the state of Rio de Janeiro[25].

Surgeons in training need to develop skills specific to their profession, such as manual dexterity and extreme care when handling instruments[26]. In a study carried out among general surgery

residents in the United States, it was found that surgeons in training who suffered a needle accident during medical school were 2.6 times more likely to have a new accident with sharp objects during residency, when compared to those who did not suffer an accident during medical school[26].

In addition, the urgent and emergency services or the SC demand physical and emotional responsiveness from the HCW, due to the long working hours, the high number of patients, the need for productivity and agility in the development of activities, frequent contact with patients who are at imminent risk of death, and the constant handling of sharp materials, which favor the risk of accidents[12,27,28].

Medical residency has a workload corresponding to 60 hours a week, with exclusive dedication, over a minimum period of two years, depending on the specialty chosen[18,29]. In turn, medical students are more prone to accidents, especially in the last two years, a fact that was observed in this study. This period corresponds to the compulsory internship, in which there is intensification and improvement of practical activities in the various areas of medicine, through internships in various sectors and health services, therefore, with greater contact with care and procedures, when compared to the first years of the course.

As for the use of PPE (glove, mask, apron, goggles, face shield), the majority of HCW were using at least one type when the WAEMB occurred. Analysis using the Generalized Estimation Equations method showed that, over time, there was an association between accidents involving exposure to the eye mucosa and non-adherence to protective goggles as PPE, with statistical significance ($p < 0.0001$).

The results presented regarding low adherence to protective goggles are similar to those of other studies, such as the one carried out in a large hospital in the Amazon, where 23.08% of injured HCW were wearing protective goggles[16]. In another study carried out in a public hospital in Porto Velho-RO, 44% of HCW did not use protective goggles during care in the SC, together with a further 22% who reported rarely using the item[30].

The frequency of PPE uses among 1,919 HCW who suffered an WAEMB in the state of Maranhão, from 2010 to 2015, was considered low (41.39%), and the variables schooling (< 12 years of study) and accidents caused by percutaneous exposure caused by needles and/or improper disposal of sharp materials were associated with non-use of PPE[22]. Another study carried out with 79 dental technicians concluded that the greater the age, professional experience, and length of time working, the greater the adherence to PPE[15].

The reasons cited in the literature for HCW not adhering to PPE during care practice include unavailability of the material, lack of attention and training, haste, self-confidence, and technical inability[15,22,30,31].

Safety in the workplace is strengthened by practices such as providing PPE, making it easily accessible, and checking its use[31]. The use of PPE reduces the chances of accidents occurring, but accidents can still happen, as was observed among HCW who wore gloves during percutaneous exposure. It is worth remembering that the analysis of accidents at work is multifactorial and should not be limited to individual behavior[22,25,29].

Studies have shown that the use of gloves as PPE has not provided an effective barrier in certain cases of WAEMB with sharps, since, depending on the quality of the material, they can be easily broken by the instruments[31]. To protect the HCW, PPE needs to be used correctly, a process which involves putting on, using, and removing them with the proper technique, thus avoiding contamination and, consequently, WAEMB[31].

There is a need for greater emphasis and awareness in the training of medical students and residents at universities regarding the teaching of biosafety standards and accident prevention, applying them in care practice, and adequate training for the development of technical skills, with the need for constant supervision in the learning process[32,33].

Studies have shown that the education of medical residents, emphasizing the recognition and awareness of occupational risks and the dangers to which they are constantly exposed in the work environment, such as in operating rooms, has contributed to safety and the reduction of exposures[28,33]. In addition, according to the code of ethics for medical students, undergraduates must be aware of the biosafety procedures established in the internship field and apply them during practical activities[34].

The health service should promote continuing education for HCW and people involved in activities that generate HSW, covering topics such as correct disposal, guidance on environmental and personal hygiene after handling waste, measures in the event of accidents, familiarization with symbols in the practice of segregation, risks in the handling of this waste, and notions of infection control[17].

According to Regulatory Standard (NR) No. 32, the employer is responsible for: providing enough PPE; installing an exclusive washbasin for hand hygiene in places where there is a possibility of exposure to biological agents; training workers before they start work and on an ongoing basis in workplaces where exposure to biological agents occurs; using sharp materials with safety devices; and drawing up and implementing a Plan for Preventing Risks of Accidents with Sharps[35] .

Regarding specific cases of exposure to biological agents, NR-32 also establishes that the injured professional must be cared for, with proper monitoring and diagnostic procedures[35].

The study showed that outpatient follow-up dropout rates were low (8.7%), a result that diverges from that found in a study based on WAEMB records in SINAN from 2006 to 2016 in the city of Goiânia-GO, where the clinical laboratory dropout rate among the 2,104 cases analyzed was high (41.5%)[36].

The limitations of this study include the fact that it was carried out in a local health service, which meant that the findings could not be generalized, the loss of data in incomplete forms,

and the probable cases of WAEMB underreporting, especially in the first year of the pandemic, during night shifts, weekends, and holidays.

CONCLUSIONS

The cases of exposure to biological material among medical undergraduates and residents are a warning sign of the risk of infection and psychosocial damage caused by these HCW. Identifying the real diagnosis of the occurrence of these events is fundamental for recognizing the biological agents and the damage they can cause to public health. In addition, analyzing the risks present in the work environment contributes to the implementation of strategies aimed at the quality of health care, in a way that is safe for HCW, patients, and the environment.

The data from this study showed how important it is to improve the training process for HCW in accident prevention and control, since, based on the knowledge acquired while still at university, they are less likely to have an accident. During the training process, systematic activities on workplace safety should be a priority in medical education, as they provide undergraduate and postgraduate students with the knowledge, skills, and abilities needed to protect themselves from occupational biological risks.

In addition, better management of biological risk in the workplace is possible through systematic training for professionals, with constant supervision, and on an ongoing basis, allowing for the identification of risk factors for the occurrence of WAEMB and analysis of the contexts in which they occurred in health services.

Finally, biosafety standards, when adopted, are important preventive measures against WAEMB, and their adoption involves not only the commitment of the HCW, but also the support of the managers in the health services, through permanent education and better working conditions.

REFERENCES

1. Brasil. Lei N° 8.213, de 24 de julho de 1991. Dispõe sobre os planos de benefícios da previdência social e dá outras providências. Diário Oficial União. 24 jul 1991.
2. Prudêncio ALM, Marques BG, Aguiar DR, Lima LC, Cabral LD, Quadros RW et al. Perfis socioeconômico e demográfico da morbidade e mortalidade ocupacionais no Brasil no período de 2009 a 2016. Rev Bras Med Trab. 2021;19(1):68-72.
3. Senado Federal (BR). Constituição da República Federativa do Brasil. Brasília: Senado Federal; 1988.
4. Brasil. Lei N° 8.080, de 19 de setembro de 1990. Dispõe sobre as condições para a promoção, proteção e recuperação da saúde, a organização e o funcionamento dos serviços correspondentes e dá outras providências. Diário Oficial União. 19 set 1990.
5. Ohlander J, Kromhout H, Tongeren M. Interventions to reduce exposures in the workplace: a systematic review of intervention studies over six decades, 1960-2019. Front Public Health. 2020;8(67):1-9. https://doi.org/10.3389/fpubh.2020.00067
6. SmartLab Brasil. Observatório de segurança e saúde no trabalho. João Pessoa: SmartLab Brasil; 2023[acesso 7 fev 2024]. Disponível em: https://smartlabbr.org/sst
7. Donatelli S, Vilela RAG, Almeida IM, Lopes MGR. Acidente com material biológico: uma abordagem a partir da análise das atividades de trabalho. Saúde Soc. 2015;24(4):1257-72. https://doi.org/10.1590/S0104-12902015136790
8. Ministério da Saúde (BR). Guia de vigilância em saúde. 5a ed. Brasília: Ministério da Saúde; 2021.
9. Gomes SCS, Caldas AJM. Incidência de acidentes de trabalho com exposição a material biológico em profissionais de saúde no Brasil, 2010-2016. Rev Bras Med Trab. 2019;17(2):188-200.
10. Quixabeiro EL, Hennington EA. Exposições ocupacionais a material perfurocortante em um hospital federal. Rev Bras Med Trab. 2020;18(4):381-9. https://doi.org/10.47626/1679-4435-2020-515
11. Lozano CE, González AG, Cadena LP. Caracterización de los accidentes por exposición a agente biológico en una población de estudiantes de medicina de Bucaramanga. Infectio. 2012;16(4):204-10.
12. Bianco V, Spera AM, Maraolo AE, Parente S, Donno D, Moriello NS et al. Risk of professional accidental exposure to biological agents in health care workers: a retrospective analysis carried out in a Southern Italian tertiary hospital. Infez Med. 2019;27(1):40-5
13. Vieira KMR, Vieira Jr FU, Bittencourt ZZLC. Subnotificação de acidentes de trabalho com material biológico de técnicos de enfermagem em hospital universitário. Rev Baiana Enferm. 2020;34:1-9. https://doi.org/10.18471/rbe.v34.37056
14. Choi LY, Torres R, Syed S, Boyle S, Ata A, Beyer T et al. Sharps and needlestick injuries among medical students, surgical residents, faculty, and operating room staff at a single academic institution. J Surg Educ. 2017;74(1):131-6. https://doi.org/10.1016/j.jsurg.2016.06.003
15. Gonçalves PRV, Martins RJ, Moimaz SAS, Sundefeld MLMM, Garbin AJI, Garbin CAS. Influência dos fatores individuais, relativos ao trabalho e organizacionais na adesão às precauções padrão por profissionais da odontologia. Rev Epidemiol Control Infect. 2016;6(2):44-9. https://doi.org/10.17058/reci.v6i2.6539
16. Soares WKR, Mota WH, Kuster DE, Cavalcante ABL, Sampaio MN, Vieira MM et al. Incidence of accidents with perforocortants in health professionals in a hospital of great port in the legal Amazon. Braz J Health Rev. 2018;1(1):51-69.
17. Agência Nacional de Vigilância Sanitária – Anvisa. Resolução RDC N° 222, de 28 de março de 2018. Regulamenta as boas práticas de gerenciamento dos resíduos de serviços de saúde e dá outras providências. Diário Oficial União. 29 mar 2018.

18. Universidade de Campinas – Unicamp. Faculdade de Ciências Médica: residências em saúde. Campinas: Universidade de Campinas; 2024[acesso 15 fev 2024]. Disponível em: https://www.fcm.unicamp.br/ensino-extensao/residencias-em-saude/residencia-medica
19. Miranda FMA, Cruz EDA, Felix JCV, Kalinke LP, Mantovani MF, Sarquis LMM. Perfil dos trabalhadores brasileiros vítimas de acidente de trabalho com fluidos biológicos. Rev Bras Enferm. 2017;70(5):1117-24. https://doi.org/10.1590/0034-7167-2016-0482
20. Centers for Disease Control and Prevention – CDC. Workbook for designing, implementing, and evaluating a sharps injury prevention program. Atlanta: Centers for Disease Control and Prevention; 2008[acesso 18 jan 2024]. Disponível em: https://www.cdc.gov/sharpssafety/pdf/sharpsworkbook_2008.pdf
21. Soares RZ, Schoen AS, Benelli KRG, Araujo MS, Neves M. Análise dos acidentes de trabalho com exposição a material biológico notificados por profissionais de saúde. Rev Bras Med Trab. 2019;17(2):201-8. https://doi.org/10.5327/Z1679443520190341
22. Corrêa LBD, Gomes SCS, Ferreira TF, Caldas AJM. Fatores associados ao uso de equipamentos de proteção individual por profissionais de saúde acidentados com material biológico no estado do Maranhão. Rev Bras Med Trab. 2017;15(4):340-9. https://doi.org/10.5327/Z1679443520170089
23. Barros DX, Tipple AFV, Lima LKOL, Souza ACS, Nevez ZCP, Salgado TA. Análise de 10 anos de acidentes com material biológico entre a equipe de enfermagem. Rev Eletr Enferm. 2016;18:1-11. https://doi.org/10.5216/ree.v18.35493
24. Manocci A, De Carli G, Di Bari V, Saulle R, Unim B, Nicolotti N et al. How much do needlestick injuries cost? A systematic review of the economic evaluations of needlestick and sharps injuries among healthcare personnel. Infect Control Hosp Epidemiol. 2016;37(6):635-46. https://doi.org/10.1017/ice.2016.48
25. Paiva NTEKM. Acidentes com exposição a material biológico envolvendo estudantes e residentes de medicina: o que aprendemos para ensinar [dissertação]. Rio de Janeiro: Universidade do Estado do Rio de Janeiro; 2018.
26. Sharma GK, Gilson MM, Nathan H, Makary MA. Needlestick injuries among medical students: incidence and implications. Acad Med. 2009;84(12):1815-21. https://doi.org/10.1097/ACM.0b013e3181bf9e5f
27. Bezerra FN, Silva TM, Ramos VP. Estresse ocupacional dos enfermeiros de urgência e emergência: revisão Integrativa da literatura. Acta Paul Enferm. 2012;25(spe2):151-6. https://doi.org/10.1590/S0103-21002012000900024
28. Landford WN, Ngaage LM, Lee E, Rasko Y, Yang R, Slezak S, Redett R. Occupational exposures in the operating room: are surgeons well-equipped. PloS ONE. 2021;16(7):1-16. https://doi.org/10.1371/journal.pone.0253785
29. Sá EC, Gonsalez N, Estevez Junior R, Torres RAT, Gimenes MJF. Relações de trabalho: qual a perspectiva legal da residência médica? Saúde Ética Just. 2018;*23*(2):47-55. https://doi.org/10.11606/issn.2317-2770.v23i2p47-55
30. Freiberger MF, Correia MBR, Pinto EAM, Ferreira EJ. Adesão ao uso de óculos de proteção individual pelos profissionais de saúde em unidade de centro cirúrgico. Rev Cie Fac Edu Mei Amb. 2011;2(2):70-9. https://doi.org/10.31072/rcf.v2i2.95
31. Vasconcelos FCFJ, Barbosa GSL, Mouta AAN, Souza ATS, Rego CS, Hipolito LC. Professional exposure and the use of personal protective equipment: integrative review. Res Soc Develop. 2020;9(8):1-21. https://doi.org/10.33448/rsd-v9i8.5239
32. Souza RT, Bica CG, Mondadori CS, Ranzi AD. Avaliação de acidentes de trabalho com materiais biológicos em médicos residentes, acadêmicos e estagiários de um hospital-escola de Porto Alegre. Rev Bras Educ Med. 2012;36(1):118-24. https://doi.org/10.1590/S0100-55022012000100016
33. Papadopoli R, Bianco A, Pepe D, Pileggi C, Pavia M. Sharps and needle-stick injuries among medical residents and healthcare professional students: pattern and reporting in Italy- a cross-sectional analytical study. Occup Environ Med. 2019;76:739-45. https://doi.org/10.1136/oemed-2019-105873
34. Conselho Federal de Medicina – CFM. Código de ética do estudante de medicina. Brasília: Conselho Federal de Medicina; 2018.
35. Ministério do Trabalho e Emprego (BR). Riscos biológicos: guia técnico. Brasília: Ministério do Trabalho e Emprego; 2008.
36. Sardeiro TL, Souza CL, Salgado TA, Galdino HJ, Neves ZCP, Tipple AFC. Acidente de trabalho com material biológico: fatores associados ao abandono do acompanhamento clínico-laboratorial. Rev Esc Enferm USP. 2019;53:1-9. https://doi.org/10.1590/S1980-220X2018029703516

Authors' Contribution

Frison SF, Alonzo HGA - Conception, planning (study design), acquisition, analysis, data interpretation, and writing of the paper. Guerreiro IC - Acquisition and data interpretation. All the authors approved the final version of the paper.

Conflict of Interest

The authors inform that there is no potential conflict of interest with peers and institutions, political or financial, in this study.