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SCIENTIFIC INTEGRITY IN BIOMEDICAL RESEARCH IS A GLOBAL PROBLEM

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Science contributes to globalization by creating new knowledge and technologies that can be shared and applied across different regions and cultures. The Regional Cooperation for Health, Science and Technology (RECOOP HST) Association combines the scientific output of partner organizations at the local and regional levels and uses it at the global level to prevent and eliminate major public health problems. Since research integrity (RI) varies among participating research organizations from the U.S.A. to Ukraine, RECOOP HST recognizes that high-quality research and outcomes, as measured by published papers, require a common understanding of scientific integrity and bioethics. During the last 15 years, RECOOP HST has organized workshops to educate scientists about the most devastating forms of research dishonesty: fabrication, falsification or plagiarism, which destroy trust and respect among scientists. Different types of research misconduct require different methods of detection and investigation. Now, with the rapid development of artificial intelligence (AI), various plagiarism-checking software has appeared. However, detecting fabrication and falsification is not so easy. In addition, AI should not be used to replace human reviewers, as there is currently insufficient evidence to support AI application in peer review. Two main approaches that RECOOP HST has taken to prevent misconduct and promote RI are evidence-based education and mentoring of students. Mentoring should take the form of informal discussions with students about responsible conduct of research and serving as a role model. Key strategies for promoting integrity include the development of institutional policies and the monitoring of activities with appropriate auditing of data.

K e y w o r d s: scientific and research integrity, plagiarism, fabrication, falsification.

Science contributes to globalization by creating new knowledge and technologies that can be shared and applied across different regions and cultures. The Regional Cooperation for Health, Science and Technology (RECOOP HST) Association explores and enhances the local scientific outputs of the partner organizations, creates a critical mass of scientifically sound innovative research at the regional level and exploits research outcomes at the global level to improve the prevention and treatment of major public health problems. RECOOP HST projects are driven by common research interests, well-established communication among scientists, open discussions initiated by team leaders and training of young scientists [1]. In the last 10 years, RECOOP HST scholars have produced 151 peer-reviewed journal articles.

Since research integrity (RI) differs in the participating research organizations from U.S.A. to Ukraine, the leaders of the RECOOP HST research teams recognized that high-quality research and results, as measured by published papers, require a common understanding of scientific integrity and bioethics [2, 3]. Misconduct has been reported to be more prevalent in developing countries than in developed ones [4]. A possible explanation for this difference is that developing countries are slower to adopt measures to curb misconduct, such as establishing policies and educational programs to promote responsible conduct of research (RCR).

RECOOP HST has never run its own investigation on RI; however, according to a systematic review and meta-analysis of 21 survey studies concerning the prevalence of misconduct performed by D. Fanelli: 2% of respondents admitted to their own misconduct (fabrication or falsification) and 34% confessed to questionable research practices (QRP), while more than 14% acknowledged misconduct by their colleagues and about 72% reported witnessing colleagues engaging in questionable practices [5]. In 1992, the International Center for Academic Integrity (ICAI) was established by Don McCabe, a professor at Rutgers University, who realized that the way to eradicate cheating in academic and scientific institutions was to start at the very beginning – with the students. The ICAI study, conducted at 24 U.S. high schools with 70,000 participants, found that 64% of students cheated on a test, 58% admitted to plagiarism and 95% admitted to participating in some form of academic dishonesty (cheating on a test, plagiarism or copying homework) [6]. Dr. L. Bouter also states that the problem of research fraud is significant, with a prevalence of 4% for both fabrication and falsification and over 50% for QRP. This leads to the so-called "replication crisis," i.e., poor reproducibility of results. On average, when studies are repeated, their results are the same only half of the time. To solve the replication crisis and improve the validity and trustworthiness of research, open science practices (open methods, codes and data) should be adopted on a large scale [7].

RECOOP HST recognized the problem, implemented a common set of ethical rules, trained RECOOP HST participants and ensured that science is not only honest locally, but also follows the same ethical standards in the eight member countries: Czech Republic, Croatia, Hungary, Poland, Romania, Slovakia, Ukraine and the United States [8].

Researchers must conduct all of their activities in accordance with strict ethical principles and in compliance with federal, state and institutional regulations and policies. The mission of Research Integrity & Compliance Services is to provide support and training to faculty, students and staff to ensure compliance with these standards. Research compliance programs provide a comprehensive framework of detailed and formal rules that individuals within the research community voluntarily choose to follow or, conversely, may fail to follow, resulting in a violation. Key components of research compliance programs include regulations, policies, guidelines, procedures, rules, laws and codes. Integrity focuses on self-control and an internal control function comprising the two components of moral judgment and character.

Research compliance has several aspects: biosafety, chemical safety, radiation safety, animal subjects protection, human subjects protection, employee protection, fiscal compliance, conflict of interest elimination and research misconduct.

In the United States, the Office of Research Integrity (ORI) plays a crucial role in overseeing and directing RI activities within the U.S. Public Health Service Commissioned Corp (PHS) on behalf of the Office of the Assistant Secretary for Health. However, it is important to note that ORI's purview excludes the regulatory RI activities conducted by the Food and Drug Administration. ORI is responsible for ensuring RI and operates under the umbrella of the Department of Health and Human Services. The primary mission of ORI is to establish and enforce policies, procedures and regulations designed to prevent research misconduct. Through this oversight role, ORI helps maintain the credibility and ethical standards of research activities conducted under the auspices of the PHS. ORI performs reviews; monitors investigations conducted by applicant and awardee institutions, intramural research programs and the Office of Inspector General of the Department of Health and Human Services (HHS); as well as provides technical assistance to institutions responding to allegations of research misconduct. In addition, ORI recommends research misconduct findings and administrative actions to the Assistant Secretary for Health for decision, subject to appeal, and assists the HHS Departmental Appeals Board in presenting cases to the Office of the General Counsel. ORI also administers programs for maintaining institutional assurances, responding to allegations of whistleblower retaliation, approving intramural and extramural policies and procedures, and responding to Freedom of Information Act and Privacy Act requests. In addition to its regulatory and oversight functions, ORI is actively involved in educational initiatives. The office supports and implements programs designed to teach and promote RCR. In this way, ORI contributes to the development of a research community that is not only aware of ethical standards, but is also equipped with the knowledge and tools to integrate responsible practices into their work [9]. The ORI has counterparts in other countries. This is a testament to their exceptional impor-

tance in sustaining RI. This international partnership works to promote a global research environment that prioritizes ethical conduct, collaboration and the advancement of knowledge within an ethically sound framework.

The International Committee of Medical Journal Editors (ICMJE) is a small group of general medical journal editors and some other related organizations whose members meet annually to improve the quality of medical science and its reporting. They work to enhance their "Recommendations for the Conduct, Reporting, Editing and Publication of Scholarly Work in Medical Journals." Comments on the Recommendations from other nonmember participants are encouraged [10].

In Ukraine, the issues of monitoring research misconduct are in the process of development. Currently, this question is regulated by Article 42 of the Law of Ukraine "On Education" [11], which gives the definition of research misconduct: academic plagiarism, self-plagiarism, fabrication, falsification, cribbing, deceit, bribery, biased assessment. It is also guided by Article 32 of the Law of Ukraine "On Higher Education" [12], which assigns responsibility for the prevention of scientific misconduct to higher education institutions and specialized academic councils. In Ukraine, the vast majority of plagiarism occurs mainly in works for obtaining scientific degrees. In the case of proven plagiarism, the law requires punishment not only of plagiarists, but also of their research supervisor, members of the specialized academic council and the university itself. To monitor RI and compliance with the abovementioned laws, the National Agency for Quality Assurance in Higher Education (NAQA) under the Ministry of Education and Science of Ukraine was established in 2016. The Resolution of the Cabinet of Ministers №1197 from November 17, 2021, authorizes both NAQA and the Ministry of Education and Science of Ukraine to consider complaints about violations of academic integrity. Currently, there are no clear criteria for what constitutes plagiarism, so the same quotation errors may be considered plagiarism in one paper and "poor academic quality" in another. For now, the main work on fabrication, falsification or plagiarism (FFP) disclosure is being done by NGOs such as Disergate (closed informal community without legal status), which is trying to improve RI in Ukraine.

RECOOP HST follows the U.S. definition of research misconduct by ORI, which defines research misconduct as "fabrication, falsification or plagiarism in proposing, performing or reviewing research, or in reporting research results." Fabrication refers to the creation of fictional data or results for experiments, including the invention of non-existent human participants or animals. Falsification involves manipulating research materials, equipment and processes, or altering and omitting data or results in a way that leads to an inaccurate representation in the research record. Plagiarism is the use of someone else's ideas, processes, results or words without proper acknowledgment or credit [13]. One of the recently published examples of plagiarism comes from the editorial Plagiarism Reimagined by Dr. R. A. North. In his short but rather interesting article, he describes several cases of plagiarism where he found entire paragraphs copied from the paper that he and his co-author Dr. M. Tonini had published several years earlier [14]. To stop the spread of research misconduct, strict regulations should be applied. For this purpose, strong laws against plagiarism must be enacted, because this violation not only takes away someone's work, but also a part of his/her creativity, talent, innovation, originality and time [15].

During the last 15 years, RECOOP HST has organized several workshops to educate scientists about FFP types of dishonesty in research. FFP are devastating because they destroy trust and respect among scientists.

In addition to FFP, there are other legal violations. The most common types of research misconduct are abuse of confidentiality, conflicts of interest, legal violations, unscrupulous peer review and failure to report unethical practices. Abuse of confidentiality means the disclosure of private information to a third party without the permission of its owner. Although it may not affect the validity of the data obtained, such abuse undoubtedly jeopardizes the RI. Another major threat to integrity is financial conflicts of interest. When clinical researchers have a financial motive in the results (the corruption of the entire process by money from commercial sponsors), it opens the door to widespread distortion of science [16].

Self-citation without necessity and clear attribution constitutes dishonesty in presentations/publications. Reusing your own work is only acceptable in two instances: (1) if it is necessary for your paper; and/or (2) if you have clearly indicated or cited your previous work in the text. Legal violations vary

from country to country, but the main ethical issues in conducting research are: (a) lack of informed consent, (b) harm to the patient, (c) breach of anonymity and confidentiality, (d) violation of privacy and (e) unlawful disclosure of confidential information or images. Failure to report unethical practices compromises the integrity of research. Ethical reporting is a process of transparency. Ethical conduct is the intent to provide honest, accurate and complete information. Reporting is necessary when misconduct threatens the health of people and the reputation of the responsible organization or institution.

Different types of research misconduct require different ways to detect and investigate them. With the rapid development of artificial intelligence (AI), various plagiarism detection software have appeared. However, detecting fabrication and falsification is not so easy. For example, world-famous medical journal The Lancet changed its editorial policy, when in May 2020 they were forced to retract the article about clinical trials of hydroxychloroquine for the treatment of COVID-19, because the data about death rates resulting from the drug contradicted the official data [17].

AI in peer review is useful for several publishing tasks: recommending appropriate journals for an article, providing initial quality control for submitted papers, finding appropriate reviewers for submitted papers or grant proposals, and reviewing and evaluating reviews, including post-publication quality assessment. In addition to plagiarism detection, statistical verification also appears to be a promising area of AI application for publishers, and expanding the capabilities of such software would be valuable. However, AI should not be used to replace human reviewers, as there is currently insufficient evidence to support AI's application in peer review [18].

Today, it is necessary to develop a production-ready plagiarism detection system that meets the following criteria: (a) distinguish between deceptive and non-deceptive intertextual relationships to solve the problem of unfair penalization of test-takers from certain language backgrounds; and (b) bridge the gap between existing tools at the research stage and a workable plagiarism detection system at the production stage [19].

The risks associated with the use of AI-generated research are increasing dramatically and pose a serious challenge to the scientific and medical communities. AI chatbots are rapidly evolving and can produce professional texts that evade plagiarism checkers [20]. Human reviewers were shown to misidentify 32% of AI-generated abstracts as genuine and 14% of human-generated abstracts as fake. However, AI technologies tend to have unique writing styles and verb constructions that can be detected by some AI detectors [21]. To mitigate the rise of AI-assisted fabrication in medical research, new and appropriate detection technologies, such as automated plagiarism detectors, must be developed and incorporated into the peer review process of journals. In addition, as part of the submission process, editors should require authors to confirm that raw data are available for verification.

The revolutionary and sudden rise of ChatGPT as a powerful generative technology signals a new age of AI-assisted plagiarism that poses an existential threat to higher education, calling into question the reliability of its assessment practices and potentially devaluing the degrees it awards. The current study investigated the potential of AI-based classifiers for detecting AI-generated text as anti-plagiarism tools that can help educators manage the potential misuse of ChatGPT as a source of AI-assisted plagiarism. Two automated classifiers, GPT-2-trained (GPT2-Output Detector) and RoBERTa-based (Crossplag AI Content Detector), were tested to discriminate between human-generated and AI-generated essays. Both detectors showed high efficiency in detecting AI texts with an accuracy of almost 90%. GPT-2 Output Detector was more sensitive to human-generated texts and was able to detect them more accurately. At the same time, Crossplag was more sensitive to machine-generated texts and had fewer false negatives. These results show that using the powerful capabilities of AI against itself can be a viable resource for AI text recognition. To deal with the limitations of each detector, it is recommended to use a double check. Also, taking into account false positives (misclassifying human-written text as machine-generated), educators should not base their decisions solely on the analysis of the detectors, and should use other traditional approaches to ensure the academic integrity of the work submitted by students [22].

It is worthwhile to focus research efforts on developing decision support systems that present diverse information for informed plagiarism evaluation, rather than fully automating the process through purely technical means. A holistic assessment requires consideration of plagiarism regulations, the context of code similarity generation and the intent of the individual. This integrated approach

underscores the importance of plagiarism detection research in computer education conferences, unlike software and programming language forums [23].

There is still no consensus on what constitutes RI training. The goals, scope and techniques of RI courses are often diverse. They range from a focus on preventing misconduct and its consequences to a focus on promoting good research practices among students and junior researchers. Identifying and evaluating training components using a reliable evaluation framework that has proven useful in educational research helps clarify the type of information needed to promote RI at the individual, institutional and societal levels. By comparing different RI trainings using the taxonomy for research integrity training, practitioners can gain essential information and think critically about how to improve future RI efforts [24].

High-profile cases of misconduct and poor reproducibility of research over the past decade have demonstrated that RI is in crisis. To foster RI, institutions can apply different approaches using markets (through incentives), bureaucracies (through formal rules) and network processes (through commitments and mutual agreements), which should be balanced. The example of the Science Committee at Tilburg University showed how these three modes of governance were effectively combined to promote RI. Network processes represented: (1) developing RI rules and procedures in collaboration with researchers from all departments, rather than adopting them in a hierarchical and top-down approach, and (2) organizing audits to discuss with researchers how to improve the rules and educate them on how to handle data [25].

Most scientists recognize the importance of addressing the problem of RI violation and are taking steps to eliminate it. Therefore, when research misconduct occurs, the following actions may be taken including: retraction of papers/abstracts; notification of granting agencies and previous institutions or affiliated universities; public notification; suspension/termination of research activities and employment; repossession of space, equipment, materials and legal action, if appropriate.

The number of retracted scientific papers has increased dramatically in recent years. In the 2023, a new record was set – more than 10,000 research papers were retracted [26]. There are several reasons for this: first, the total number of publications has increased, and second, the scientific community has become better at detecting FFP. The computer platforms Retraction Watch and Pubpeer have made a major contribution to this, as have so-called "data sleuths", such as the Dutch microbiologist Elisabeth Bick. She is the best-known campaigner against research misconduct and the founder of Science Integrity Digest, a blog devoted entirely to scientific integrity and the analysis of cases of real or alleged FFP [4]. Papers are retracted for a number of reasons, including honest errors, but a 2021 study found 17 different ones. "Plagiarism/self-plagiarism, unreliable data/findings and data fabrication/falsification" were more common, making up nearly 79% of the almost 6,900 retractions examined [27]. Over the past decades, investigating allegations of misconduct has become routine. Sometimes the consequences of violating RI are very serious. For instance, Eric Poehlman was imprisoned not only for falsifying data in numerous published articles, but also for using those falsified results to support his applications for federal grants [16].

Two main approaches that RECOOP HST has taken to prevent misconduct and promote RI are evidence-based education and mentoring of students in RCR. RECOOP HST's educational programs have included a variety of elements, such as workshops (Lviv, September 2018) and lectures (Bridges Conferences) that promote the ICMJE's "Recommendations for the Conduct, Reporting, Editing and Publication of Scholarly Work in Medical Journals" [28].

Conclusions. Regardless of the specific frequency of misconduct in RECOOP HST member organizations, FFP remains a paramount concern for researchers because it jeopardizes public trust, integrity and accountability in the field of research. Mentoring should take the form of informal discussions with students about RCR and serve as a role model. Key strategies for fostering integrity include the development of institutional policies, the establishment of compliance and monitoring activities and the proper verification of data. The use of automated plagiarism detection software is also an effective tool for preventing misconduct and promoting ethical behavior.

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НАУКОВА ДОБРОЧЕСНІСТЬ У БІОМЕДИЧНИХ ДОСЛІДЖЕННЯХ Є ГЛОБАЛЬНОЮ ПРОБЛЕМОЮ

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Наука сприяє глобалізації, створюючи нові знання та технології, які можуть поширюватись і застосовуватись в різних регіонах та культурах. Асоціація регіональної співпраці з питань здоров'я, науки та технології (RECOOP HST) об'єднує наукові здобутки партнерських організацій на місцевому та регіональному рівнях, використовуючи їх у глобальних масштабах із метою запобігання та усунення значних загроз суспільному здоров'ю. Оскільки розуміння наукової доброчесності відрізняється в партнерських науково-дослідних організаціях США та України, керівники RECOOP HST дійшли висновку, що за умов оцінки якості самого дослідження та його результатів на основі наукових публікацій необхідно досягти спільного розуміння базових понять наукової доброчесності та біоетики. За останні 15 років RECOOP HST провела декілька семінарів із питань найшкідливіших для довіри та поваги серед науковців явищ недоброчесності, а саме: фабрикації, фальсифікації та плагіату. Різні типи наукової недоброчесності потребують різних способів виявлення та дослідження. Наразі, зі швидким розвитком штучного інтелекту (ШІ) з'явилися різноманітні програми для перевірки робіт на плагіат. Проте, виявлення фабрикацій та фальсифікацій не настільки легке. До того ж ШІ не варто використовувати замість рецензентів, оскільки його перевага в експертній оцінці ще не доведена. Щоб радикально викорінити наукову недоброчесність необхідно прищеплювати розуміння та дотримання правил доброчесної поведінки з ранніх років. Два основних підходи, що застосовуються RECOOP HST для запобігання недоброчесності – це доказове навчання та наставництво студентів. Наставництво має відбуватися у формі неформальних обговорень зі студентами щодо відповідального проведення досліджень та наведенням надихаючих прикладів для наслідування. Ключові стратегії для виховання доброчесності включають розробку відповідної політики на рівні установ, запровадження механізмів нагляду за її дотриманням із належною перевіркою.

Ключові слова: науково-дослідницька доброчесність, плагіат, фабрикація, фальсифікація.

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