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# WOMEN IN NATURAL SCIENCE: CHALLENGES AND SOLUTIONS

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## ABSTRACT

**Objectives:** The primary goal of this study is to investigate and understand the challenges surrounding women's empowerment, particularly in the context of Science, Technology, Engineering, and Mathematics (STEM) disciplines. The objectives include identifying the reasons behind the underrepresentation of women in STEM, analyzing the consequences of this gender gap, and proposing potential solutions to address these issues.

**Methods:** To achieve the stated objectives, a thorough examination of the factors contributing to the lack of women's participation in scientific activities within STEM disciplines was conducted. The research methodology involved a comprehensive review of existing literature, statistical analyses, and case studies to gather insights into the root causes of the gender gap. Additionally, the study explored successful strategies and initiatives aimed at promoting women's engagement in STEM fields.

**Results:** The findings of this scientific article reveal the multifaceted challenges faced by women in STEM disciplines, contributing to their underrepresentation. The results highlight the persistent gender gap at higher levels of education despite achieving gender parity in primary education. Furthermore, the study presents an in-depth analysis of the consequences of this underrepresentation and sheds light on the need for urgent interventions to foster inclusivity in scientific activities.

**Conclusion:** In conclusion, this research underscores the strategic importance of addressing the issue of women's empowerment in STEM for long-term development. The study advocates for targeted initiatives and policies to eliminate the identified causes of underrepresentation. The proposed solutions are discussed in the context of their potential positive impact, emphasizing the significance of promoting diversity and gender equality in scientific fields. Ultimately, the

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conclusion emphasizes the need for collaborative efforts to create a more inclusive environment for women in STEM disciplines.

**Keywords:** women, natural science, research, STEM subjects, work, family responsibilities, education.

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# MULHERES NAS CIÊNCIAS NATURAIS: DESAFIOS E SOLUÇÕES

## RESUMO

**Objetivos:** O objetivo principal deste estudo é investigar e compreender os desafios que envolvem o empoderamento das mulheres, particularmente no contexto das disciplinas de Ciência, Tecnologia, Engenharia e Matemática (CTEM). Os objetivos incluem a identificação das razões por trás da sub-representação das mulheres em CTEM, a análise das consequências desta disparidade de gênero e a proposta de soluções potenciais para abordar estas questões.

**Métodos:** Para atingir os objetivos declarados, foi realizado um exame minucioso dos fatores que contribuem para a falta de participação das mulheres em atividades científicas dentro das disciplinas CTEM. A metodologia de pesquisa envolveu uma revisão abrangente da literatura existente, análises estatísticas e estudos de caso para reunir insights sobre as causas profundas da disparidade de gênero. Além disso, o estudo explorou estratégias e iniciativas bem-sucedidas destinadas a promover o envolvimento das mulheres nos campos CTEM.

**Resultados:** Os resultados deste artigo científico revelam os desafios multifacetados enfrentados pelas mulheres nas disciplinas de CTEM, contribuindo para a sua sub-representação. Os resultados destacam a persistência de disparidades de gênero nos níveis mais elevados de educação, apesar de se alcançar a paridade de gênero no ensino primário. Além disso, o estudo apresenta uma análise aprofundada das consequências desta sub-representação e lança luz sobre a necessidade de intervenções urgentes para promover a inclusão em atividades científicas.

**Conclusão:** Em conclusão, esta pesquisa ressalta a importância estratégica de abordar a questão do empoderamento das mulheres em CTEM para o desenvolvimento a longo prazo. O estudo defende iniciativas e políticas direcionadas para eliminar as causas identificadas de sub-representação. As soluções propostas são discutidas no contexto de seu potencial impacto positivo, enfatizando a importância de promover a diversidade e a igualdade de gênero em áreas científicas. Em última análise, a conclusão enfatiza a necessidade de esforços colaborativos para criar um ambiente mais inclusivo para as mulheres nas disciplinas CTEM.

**Palavras-chave:** mulheres, ciências naturais, pesquisa, temas CTEM, trabalho, responsabilidades familiares, educação.

## 1 INTRODUCTION

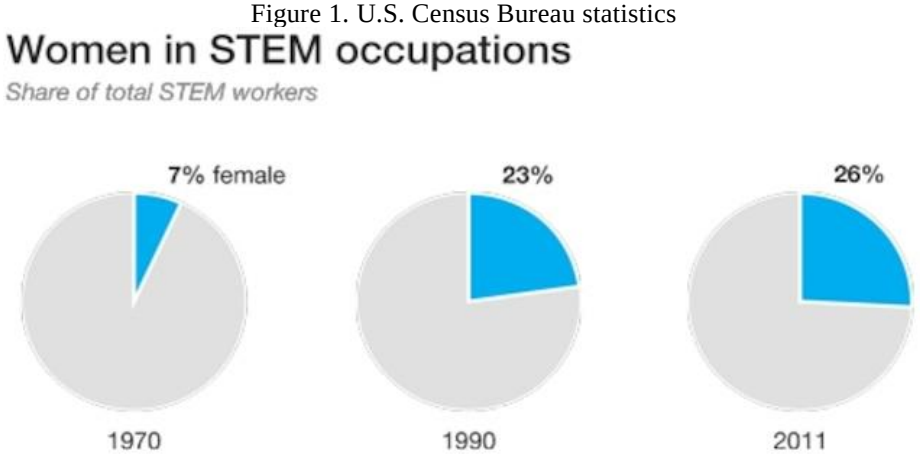
Women's empowerment is one of the strategic challenges for sustainable development. Many countries have achieved gender parity in primary education, but a significant gender gap exists at higher levels of education. While the number of women graduating from universities with higher degrees is increasing, women scientists are

grossly underrepresented in Science, Technology, Engineering and Mathematics (STEM). Systemic barriers prevent women from pursuing research-oriented careers and gender disparities exist in employment, academic promotions or senior ship, funding opportunities and publications. Further, the efforts and working hours that most women spend in teaching, mentoring, collaboration and other academic activities are more than men do with lower pay [1]. Worldwide, women are underrepresented in first and last authorship, and in multiple authorship, women represent less than one-third of the authors in publications [2].

## 2 THEORETICAL FRAMEWORK

According to U.S. Census Bureau statistics, women in fields commonly referred to as STEM (science, technology, engineering, mathematics) made up 7 per cent of that workforce in 1970, a figure that had jumped to 23 per cent by 1990. But the rise essentially stopped there. Two decades later, in 2011, women made up 26 per cent of the science workforce [3].

Figure 1. U.S. Census Bureau statistics




Source: U.S. Census Bureau statistics

Only one-fifth of physics PhD's in this country were awarded to women, and only about half of those women are American; of all the physics professors in the United States, only 14 per cent are women. The numbers of black and Hispanic scientists are even lower; in a typical year, 13 African-Americans and 20 Latinos of either sex receive Ph.D.'s in physics [4].

## 3 METHODOLOGY

The proportion of women among researchers and inventors is increasing. According to the last statistics of ELSEVIER, the proportion of female scientists in the EU is 41%, however, among inventors women represent only 12%. Nevertheless, 19% of the EU patent applications list a woman among their authors – a higher proportion than Australia, Japan and the UK. One of the biggest remaining problems is leadership, especially in engineering where women researchers are significantly outnumbered by men (24%). It is evident that women researchers are still increasingly underrepresented as they move up the stages of an academic career. In 2014, only 20% of heads of higher education institutions were women [5].

Only 15 per cent of the Indian research and development workforce are women in India, while the global average is 30 per cent, says the National Task Force on Women in science report [6]. But, the magnitude of gender differences in science is quite significant in India. The picture is no different in science and technology teaching institutions.

Just 30% of the world's researchers are women. While a growing number of women are enrolling in university, many opt-out at the highest levels required for a research career. But a closer look at the data reveals some surprising exceptions. For example, in Bolivia, women account for 63% of researchers, compared to France with a rate of 26% or Ethiopia at 8% [7].

All of us – the general public, the media, university employees, students and professors – have ideas of what a scientist and a Nobel Prize winner looks like. That image is predominantly male, white and older – which makes sense given that 97% of the science Nobel Prize winners have been men. Female researchers have come a long way over the past century. But there's overwhelming evidence that women remain underrepresented in the STEM fields of science, technology, engineering and math [8].

## 4 RESULTS

### 4.1 WHY WOMEN DON'T CHOOSE STEM?

While the reasons are multiple, the most important one is mindset, which has been targeting women right from their cradles. Barring a small section of society, most people including parents, teachers, and educational institutions not only take no steps to encourage girls to pursue science but contribute towards the contrary directly or

indirectly. A very small percentage of girls are able to overcome this deterring environment, develop an interest in science and pursue it.

The number of institutions offering arts and commerce outnumber those offering science. This raises a need for greater investment. A majority of women's colleges offer arts and commerce rather than science.

It is certainly more challenging for women pursuing science to excel due to the various hurdles they face and the bias against them in almost all institutions. When it comes to peer recognition, women are at a loss as they muster less support.

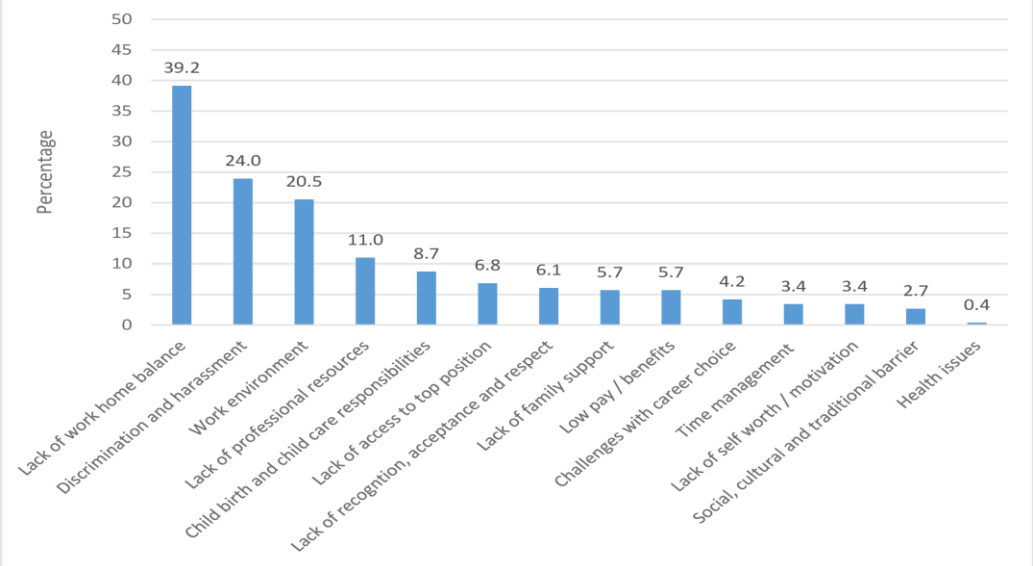
Moreover, in developing countries, the gender disparity in STEM is a multifactorial issue that includes familial, social, cultural and institutional factors that cannot be ignored or overlooked. Ultimately, lower representation of female scientists in STEM fields translates into fewer female role models for girls and limited mentoring opportunities. Studies on the number of females in top positions in academic institutions suggest that unintended and subconscious gender bias is common and can result in barriers for women to be promoted, credited for their achievements, nominated for leadership positions or viewed as leaders [9] .

A randomized double-blind study conducted by Moss Racusin et al studied gender preferences while hiring laboratory researchers. This study showed that given equally qualified male and female applicants, science faculty members would show preferential evaluation and treatment of the male applicants for a managerial post. When compared to female applicants, the male applicants were rated as significantly more competent and hirable, offered a higher starting salary and more career mentoring. Both female and male faculty were equally likely to exhibit bias against the female candidate [10].

In an effort to adapt themselves to their work environment, female workers and scientists may have to make compromises that may impact their self-respect and even health. Challenging workloads both at home and at work can affect women's mental and physical health and often due to inequity in domestic chores with partners, it reduces marital bliss. High workload also affects work commitment and promotions, impacting women's career growth [11]. The health of working women is more affected as compared to men due to the double burden of unpaid caregiving work and paid work. Added to this is the stress of reduced chance of finding and keeping a job as a woman ages [12]. Political marginalisation of female workers and the unpaid nature of domestic work, together with rigid gender norms and stereotypes, often undermine women's physical and intellectual

capabilities, assisting society in viewing her maternity and home care as predominant functions [13].

Figure 2. The common challenges faced by female scientists at work are lack of work-home balance, discrimination, harassment at workplace and a hostile work environment [14].




**N=263, Responses are not mutually exclusive**

Source: Prepared by Authors (2023)

The next most commonly employed coping strategy is support for childcare. Childcare support could be provided informally by family members or formally by organized childcare services. Pregnancy, breastfeeding and socially driven caretaking of children put women in a disadvantaged position when she has to balance work and family life [15]. Child-care centers are often not found near the workplace, and are costly with long waiting lists. These lead women to work part-time, change residence or change employment. All of these factors might affect her career [16]. Paid maternal and child-care leave allows nurturing of the child and the mother can resume work with less guilt. However, such leave is variable by region and occupation [17]. Even in developed countries, women are more likely to work before birth (66%) than after the birth period (46–49%). This is due to child-care reasons. Even among employed women, taking leave after birth is more frequent due to child-care needs [18]. The availability of child-care facilities assists mothers in achieving adequate work-life balance and helps in early childhood development [19]. Strengthening both formal and informal childcare support systems will help female scientists cope with the perceived challenge of child-care responsibilities.

## 5 DISCUSSION

### 5.1 WHAT TO DO? SUGGESTIONS AND RECOMMENDATIONS

Hence, there is still enough space for improvement and some changes and reforms that can be done at all levels to achieve gender equality. Therefore, we suggest ideas, insights and recommendations which can possibly enable towards the creation of a balanced science and research environment for both women and men. We believe that it is very important to be vocal about what needs to be done to retain female in science after graduation and support them in their career development and path.

All country's initiatives and directives should continue in their initiatives and action plans and gender equality strategies in the research and innovation policies. The developed countries could possibly play an important role in achieving gender equality in all states and public institutions. Equal opportunities in the labour market go hand in hand with this.

***Transparency in the recruitment process***. In order to ensure more women in leading positions transparency in the recruitment process really matters. Since there are still cultural trends in our society which have been formed for many years, it is necessary to ensure that scientists are hired, especially to leading positions based on their experiences, education and skills regardless of gender. Thus we cannot omit the importance of the composition of the recruitment board which should be gender balanced. The survey suggests that very few men recognize the hostilities endured by their female colleagues. Most men surveyed (80%) said their company creates a good environment to integrate male and female workers. However, over half (56%) of these respondents said: “in hindsight, they have been patronizing towards female colleagues; they acknowledge women have fewer opportunities to advance in the IT sector (60%); and that women may feel intimidated working with men and their team (58%)” [20].

***Women and girls’ education and training.*** To achieve gender equality for female scientists it is necessary to provide them with an effective training and education they need to be able to compete at all levels and in all scientific domains. Despite the fact that personality development is highly subjective, education is essential for overall development, from how you think to how you act. Speak up and introduce yourself. Education is a driving force in the development of a person's personality. It exposes a person to a variety of viewpoints, allowing them to develop a clear and broad vision. It entails a more solution-oriented approach, as well as improved comprehension and

analysis abilities. It also teaches people to be disciplined. Our education shapes our values, beliefs, and attitudes. It can improve a person's self-esteem [21].

***Good examples and soft tools.*** There are many institutions and universities around the world which have implemented gender action plans and internal strategies to achieve gender equality. Positive examples such as these might be followed by other institutions and universities. Furthermore, the use of soft tools (for example a label HRS4R) might also be useful.

***University leadership engaged.*** University leadership should be fully engaged and should be aware of the importance of gender equality and also the importance of necessary measures that are able to create a welcoming environment for female scientists (maternity leave, work-life balance). Whether she is a woman working in a STEM-related field or wants to be one, taking online courses and earning certification can help her prepare for success in an ever-changing industry. For example, “Simplilearn’ provides a valuable collection of flexible, online learning courses developed in collaboration with prestigious partners such as Caltech, Purdue University, IBM, AWS, and Microsoft, among others.

***Gathering data and evidence/Monitoring.*** It is significant to gather evidence and data on gender equality showing that the gender agenda should be taken more seriously. Data and statistics reflect the state of play which is not favourable for women in science and innovation and their representation in leading positions. Subsequently, these data may contribute towards evidence-based policymaking.

***Role models and mentoring.*** Mentors and role models can have a positive impact on female scientists and on girls who want to step in a scientific career. This is also very important in society and modern culture where stereotypes are still present. Along with good mentors, the support of family and friends is essential. Mentorship has an immeasurable impact on encouraging more women in technology. Mentors are required at all levels, including elementary, middle, high school, college, and the workplace. Girls Who Code and other organizations have a positive impact on young girls. Girls Who Code has served over 500,000 girls, women, and nonbinary people, and its alumni choose computer science majors at a rate seven times higher than the national average [22]. Companies can also create programs to connect women and promote upskilling for STEM-related jobs.

***Work-Life balance.*** It is not enough to say that we need more women in science and more women in leading positions. We have to try to change the conditions female scientists have. All States, organizations and universities should show women that they are willing to support them, for example with their maternity leave or childcare, among others. These issues are not exclusive to women of course, but they do affect women more.

***Equal treatment.*** Having a good support system in place and making sure that every person is treated fairly is a very important step to keeping women in academia and increasing their participation in leading positions. According to a new study of over 3,000 university faculty members, tenure-track women in Science, Technology, Engineering, and Math (STEM) fields receive lower salary increases associated with their research productivity than men. The research paper called "Higher Research Productivity = More Pay? Gender Pay-for-Productivity Inequity Across Disciplines", was conducted by a team of investigators currently at the University of Houston, the University of California Merced and the University of Colorado, Boulder [23]. Faculty who produce more influential research publications should ideally receive more favourable evaluations and larger pay raises, which are based in large part on faculty research productivity at many research universities. Furthermore, in an equitable system, the relationship between higher pay and greater research productivity should be the same for men and women professors.

## 6 CONCLUSION

Scientific research is more accurate when gender is considered. Whether you're studying seat belt design or heart medication, your research should consider gender and include both male and female subjects.

Women bring unique perspectives to research and scientific conversation. When it comes to research in both the academic and private sectors, gender diversity can have a number of advantages. Diversity adds to the collective intelligence of a research group," enhancing creativity and providing new contexts to understand societal aspects of the research.

We need more STEM professionals. Men significantly outnumber women in the STEM workforce, and in some of these fields, professionals are in short supply. Meanwhile, universities say they're having a hard time retaining women in STEM at the

highest levels. Indeed, more STEM professionals are needed in the workforce. Still, universities are having a hard time retaining and, in some cases, recruiting women for STEM programs.

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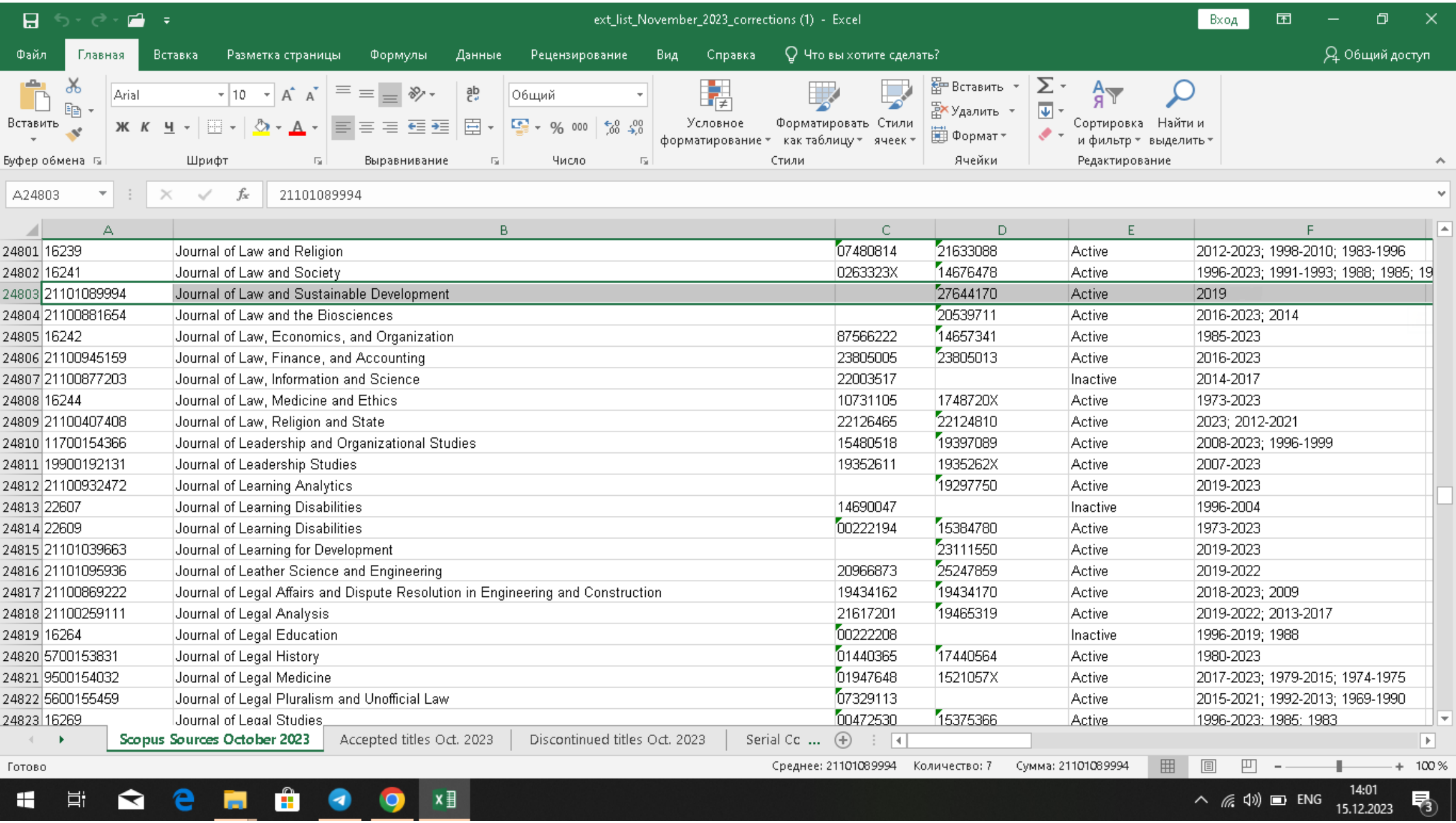


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