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Poľský, český a slovenský študenti k otázke určovania pohlavia

Polish, Czech and Slovak Students on the Issue of Gender Determination

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Abstract

Sexual development is determined by many factors acting during the prenatal period, such as exposure to androgens, sex chromosomes and brain structure; and sexual differentiation of the sex organs which occurs much earlier (i.e. in the first two months of prenatal development) than sexual differentiation of the brain (i.e. in the second half of prenatal development).

A study aimed at identifying students' knowledge regarding disorders of sex determination was conducted using the diagnostic survey method and questionnaire technique at three universities – in Poland, the Czech Republic, and Slovakia. A total of 450 students participated in the study (172 from Poland, 99 from the Czech Republic, and 179 from Slovakia). The research sample was selected based on the assumption that there are differences in awareness of sexual development among Polish, Czech, and Slovak societies.

The analysis of the results revealed that students' knowledge of "sex determination" is insufficient, with Czech students being the most aware of disorders of sexual differentiation. The findings demonstrate an urgent need to address the education of students – especially those in pedagogical/teacher-training programs – in the biological and social aspects of human sex determination. To meet the challenges of social norms and conditions, it is necessary to recognize that knowledge in this area is essential in today's world, and universities should provide education in social competencies related to shaping ethical attitudes toward the causes of atypical human development.

Keywords: Sex determination. Biological sex. Gender. Gender identity. Sex hormones. Students. Knowledge. Education. Health. Social norms.

Introduction

Capturing the category of gender and its manifestations in the human body is not always obvious. It is also difficult to determine where sex (the body) begins and where gender (socialisation) ends. The question arises as to whether it is possible at all to separate the human body from social norms in terms of sexuality. Medical discourse examining human body does not distinguish between sex and gender norms (Danon, 2015). The understanding of gender began to change when society began to perceive gender as a reflection not only of biology but also of cultural choices (Dolgin, 2018). Gender identity, or the personal experience of one's own gender, may correlate with the sex assigned at birth or may be completely different from it. For most people, sex and gender identity are consistent with each other (National Centre on Parent, Family and Community Engagement, 2019). A newborn with atypical genitalia presents a complex clinical challenge and requires the involvement of a team of specialists. Thanks to the work of researchers, significant progress has been made in understanding the causes of disorders of sex development, describing individual cases, identifying both short- and long-term health complications, as well as in the development of appropriate clinical interventions (Markosyan and Ahmed, 2017). There are nearly 80 single-gene aetiologies for isolated or syndromic disorders of sex development. The main categories include genes affecting sex determination (e.g., gonadal dysgenesis) and those involving sex differentiation (e.g., sex hormone synthesis). The combined prevalence of disorders of sex development ranges from 1:1003 to ~1:4500 to 5000 live births (Délot et al., 2017; Ernst et al., 2018; cited in: Lee et al., 2006; Rolston et al., 2017; Siddique, 2017).

Issues related to body image and human rights in terms of identity, including gender identity, can be subject to various judgements and ideologies. Defining and interpreting biological sex and cultural gender is difficult when dealing with individuals with disorders of sex determination at the chromosomal, hormonal, gonadal, genital or brain level. Atypical biological sex development is known in biological sciences and medical-legal discourse. However, in socio-cultural and educational contexts, this issue is often marginalised, distorted and pathologised. This situation persists despite the belief that social attitudes support the concept of diversity and openness to difference.

Based on the above assumptions, it was decided that it would be reasonable to assess public knowledge about sex determination disorders. The study focused on small subsets of the wider population, specifically students – young adults. The selection of the research sample was dictated by the fact that students are a group that very well combines the views of young people and adults – they have relatively recently graduated from secondary school, but at the same time will soon enter adult life, e.g. professional life. It was assumed that science students have greater knowledge and awareness of the mechanisms of human sex determination than humanities students.

The research topic appears to be important from the point of view of social development and contemporary beliefs about openness to all forms of diversity, as well as the existence of messages (e.g. in the media) about gender and gender identity that are not scientifically justified. Although many teachers agree that issues related to biodiversity should be part of education at various levels, few take action to include them in their curricula, e.g. in the form of supplementary content. Meanwhile, LGBTQ issues are being increasingly addressed in the media, and young people who participate in or follow various events related to human rights in the field of gender and gender identity often lack knowledge about the basic biological processes involved in sex determination. Therefore, research is needed regarding comprehension and attitudes of different social groups in order to diagnose what contemporary society actually knows about human biological development.

Research methodology

The research aimed to assess the knowledge of students from three Central European countries (Poland, the Czech Republic and Slovakia) on sex hormones covering five thematic areas (menstrual cycle and fertility, hormone therapy, EDCs, the endocrine system, sex determination and disorders). The aim was also to compare respondents' answers between countries and identify areas of greatest knowledge gaps.

The research was conducted using a diagnostic survey method and a questionnaire technique. As the research tool a 50-points questionnaire containing true/false/don't know was prepared in Polish and then professionally translated (forward-backward method) into Czech and Slovak. The content of the statements was taken from current textbooks and peer-reviewed scientific articles in the fields of biology, endocrinology, pedagogy and from WHO reports. The surveys were distributed from April to September 2024 via the Google Forms platform. Before completing the form, respondents were informed about the purpose and anonymity of the study.

The study was conducted at three universities: in Poland, Slovakia and the Czech Republic. A total of 450 students participated in the study (172 from Poland, 179 from Slovakia and 99 from the Czech Republic). The students represented 3-year bachelor's degree programmes (373 people, including 134 from Poland, 161 from Slovakia and 78 from the Czech Republic), five-year master's degree programmes (37 people, including 8 from Poland, 18 from Slovakia and 11 from the Czech Republic) and two-year supplementary master's degree programmes (40 people, including 30 from Poland and 10 from the Czech Republic). Most participants studied pedagogy (323, including 101 from Poland, 138 from Slovakia and 84 from the Czech Republic). The remaining respondents studied chemistry, mathematics, biology, nursing and psychology, both in teaching and non-teaching specialisations.

Respondents answered a series of statements divided into topic, including the menstrual cycle, hormone therapy, endocrine-disrupting compounds (EDCs), the general functioning of the endocrine system, and sex determination. Respondents' answers were coded (1 – 'yes', 0 – 'no', 9 – 'I don't know'). The article presents a comparison of the distribution of respondents' answers regarding sex determination disorders.

Research results

In terms of biological sex determination and related gender differences, students were asked questions covering topics in genetics, embryology, endocrinology and medicine, such as: the role of sex chromosomes in sex determination (XX female, XY male, with the proviso 'in most cases'); the course of early embryonic development (identical gonadal primordia in both sexes and the presence of Wolffian and Müllerian ducts, the role of the SRY gene in male development); ovarian function (production of gametes and steroid hormones); the function of the testes and 5a-dihydrotestosterone (DHT) in the development of the male excretory tract and external sex organs; the role of testosterone, dihydrotestosterone and oestrogens in the differentiation of sex organs in female foetuses; the consequences of a lack of testosterone from the testes during foetal life; the mechanism of brain development in women and men and the development of sex organs; the definition of hormonal sex (dependent on the ratio of male and female hormones); the definition of intersexuality (ambiguity of biological sex, e.g. Klinefelter syndrome, Turner syndrome, androgen insensitivity, chimerism, etc.).

Among the issues that caused students the most difficulty were those related to knowledge of the process of sex differentiation in foetal life, sex differentiation of the brain, hormonal sex, sex chromosomes and intersexuality.

Knowledge regarding the process of sex differentiation in foetal life concerned key facts in the field of embryology. When asked about the presence of sex ducts in the embryo, which differentiate into male or female sex organs, and the role of the SRY gene in this differentiation, 58% of Polish students answered correctly ('yes'), 51% of Slovak students, and 65% of Czech students; with almost 40% of Czech students selecting the answer 'I don't know', which may suggest that they were less confident in their knowledge of sex embryogenesis (Table 1). A fairly high level of correct answers ('yes' – 37% of Polish, 44% of Czech and 56% of Slovak students) concerned the function of an ovary (it produces reproductive cells and acts as an endocrine gland) (Table 1).

Table 1. Distribution of respondents' answers to statements concerning the presence of sex lines in the embryo and the role of the SRY gene in this differentiation; the role of male and female hormones in female foetal development; the importance of testosterone in the development of primary male sex characteristics (Poland vs Czech Republic vs Slovakia) (%).

Statement	**PL „yes"**	**PL „no"**	**CZ „yes"**	**CZ „no"**	**SK „yes"**	**SK „no"**
2. In the early stages of embryonic development, the gonadal primordia remain identical in both sexes. Each foetus initially has both Wolffian ducts, which develop into male organs, and Müllerian ducts, which develop into female organs (under the influence of hormones, they are transformed accordingly). The SRY gene located on the Y chromosome is responsible for male development.	57,6	8,1	64,6	9,1	51	29
3. The ovary produces reproductive cells and functions as an endocrine gland; steroid hormones (progesterone, androgens, oestrogens) are synthesised in it.	37,2	10,5	44,4	6,1	56	9
5. As a result of the action of oestrogens produced in the placenta, with no simultaneous action of androgens, Wolffian ducts begin to disappear. Therefore, it appears that ovarian sex steroids do not influence the differentiation of sex organs in female foetuses, and that ovarian function is not important for the development of external sex organs. Their development is due more to the absence of male hormones – testosterone and dihydrotestosterone – than to the presence of oestrogens.	30,8	15,7	25,3	25,3	20	21
4. Testosterone produced by the testicles causes Wolffian ducts to form seminiferous tubules. The hormone 5a-dihydrotestosterone (DHT) induces the development of external male sex organs.	20,3	9,9	26,3	9,1	20	10,3
6. If the testes fail to produce testosterone during embryonic development, the foetus will not undergo typical male differentiation	28,5	10,5	28,3	17,2	16	19

Source: own research

When asked about the role of male and female hormones in the development of the female foetus, 31% of students from Poland, 25% from the Czech Republic and 20% from Slovakia provided the correct answer. Only a small number, around 5–10%, gave the wrong answer. However, the most common response was 'I don't know' (50–70% of respondents) (Table 1). Regarding the statement that testosterone causes Wolffian ducts to form seminiferous tubules and DHT induces the development of external male sex organs, 20% of Polish students, 26% of Czech students and 20% of Slovak students answered correctly. (Table 1). In turn, only 16-28% of participants answered correctly when asked about the importance of testosterone in the development of primary male sexual characteristics; the remaining students mainly chose the answer 'I don't know' (as many as 61% in Poland, 65% in Slovakia, and 55% in the Czech Republic) (Table 1). This indicates that many students have misconceptions about female sexual development and do not associate it with a lack of male hormones.

The statements concerning the mechanism of brain masculinisation (aromatisation of testosterone to oestrogen in the brain) and the fact that it occurs later than gonadal differentiation (second trimester vs. second month) were quite specific. Less than half of the students (37–42%) correctly recognised that testosterone can be converted into oestrogen by aromatase in the brain and that the exact mechanism of brain development in women and men requires clarification; on the other hand, a fairly large percentage of students in Poland (50%), the Czech Republic (50%) and Slovakia (36%) answered 'I don't know' (Table 2). In addition, 58% of Poles, 68% of Czechs and 50% of Slovaks confirmed that sexual differentiation of the brain begins in the second trimester, i.e. after the development of the sex organs, which differentiate in the second month, so given that the processes occur at different times, it is possible that they are initiated by different pathways. In turn, 23-42% of students chose the answer 'I don't know', so in this case, they were less familiar with the subject of brain sex differentiation (Table 2).

When asked whether hormonal gender depends on the ratio of male and female sex hormones – with males having more androgens than oestrogens and females having more oestrogens than androgens – the results were similar – approx. 66-67% of respondents in Poland and Slovakia and 76% in the Czech Republic answered correctly with 'yes'. Few people disagreed (6-8%), but about 16-26% had no opinion. It can therefore be concluded that the concept of hormonal sex is relatively well known to most students (probably due to human biology classes, where various definitions of sex are discussed) (Table 2).

Table 2. Distribution of respondents' answers to statements concerning the mechanism of brain masculinisation, the moment of sexual differentiation of the brain and sex organs, and hormonal sex differentiation (Poland vs Czech Republic vs Slovakia) (%).

Statement	PL „yes”	PL „no”	CZ „yes”	CZ „no”	SK „yes”	SK „no”
7. Testosterone can be converted into oestrogen by aromatase in the brain. The exact mechanism of brain development in women and men requires clarification (genetic, epigenetic, hormonal, environmental, cultural and social factors are responsible for this).	38,4	11	42,4	7,1	37	27
8. Sexual differentiation of the brain begins in the second trimester, i.e. after the development of the sex organs, which differentiate in the second month. These processes occur at different times, so it is possible that they are initiated by different pathways.	58,1	7	69,7	7,1	50	8
9. Hormonal gender depends on the ratio of male and female sex hormones – males have more androgens than oestrogens, while females have more oestrogens than androgens.	66,2	7,9	75,8	7,7	67,2	6

Source: own research

The statement that the presence of sex chromosomes manifests itself in a specific sex and largely determines it (XX in women, XY in men) seems very straightforward, yet the results were quite surprising. Polish and Slovak students almost unanimously answered ‘yes’ (84% PL and 80% SK), while in the Czech Republic only 44% answered “yes”, with as many as 48% choosing ‘I don't know’ and 8% ‘no’. This may mean that some Czech students were aware of exceptions to this rule (e.g. DSD syndromes) and therefore hesitated or answered ‘no’ – the statement said ‘in most cases’, which is true, but may have confused them somewhat, although the high percentage of ‘I don't know’ in the Czech Republic suggests rather uncertainty about the wording (Table 3).

On the other hand, the question about intersexuality (definition and examples) was well understood by Polish and Slovak students (about 70% said ‘yes’), while Czech students performed a bit poorer (58% said “yes” and as many as 35% said ‘I don't know’). Despite considerable terminological difficulties, most respondents understood the concept and considered the statement to be true, which indicates that they were familiar with the topic of intersex to some extent – perhaps from classes or the media. Only a few (about 5–8%) denied it (which could mean a misunderstanding of the definition) (Table 3).

Table 3. Distribution of respondents' answers to statements concerning the presence of sex chromosomes and intersexuality (Poland vs. Czech Republic vs. Slovakia) (%).

Statement	PL „yes”	PL „no”	CZ „yes”	CZ „no”	SK „yes”	SK „no”
1. The presence of sex chromosomes manifests itself in a specific sex and largely determines it (XX in women, XY in men).	84	7	44	8	80	7
10. Intersexuality is the ambiguity of biological sex (disorders/dysfunctions of sex development). It includes, for example, Klinefelter syndrome, Turner syndrome, sex chimeraism, androgen insensitivity syndrome, conditions caused by gene mutations (e.g. in the SRY gene) and chromosomal aberrations, genital organ dysfunction (e.g. malfunction of testosterone-secreting Leydig cells) or impaired development (gonadal dysgenesis).	70,3	9	58	7	70,4	11

Source: own research

The data collected – Discussion

Students from all three countries have a solid basic knowledge of biology and human physiology with regard to sex hormones. In areas typically covered in school curricula, such as the role of oestrogens and androgens, most respondents gave correct answers. At the same time, however, the more detailed or interdisciplinary the issue, the more often they indicated a lack of knowledge in a given area. This applies in particular to embryology (e.g. mechanisms of sex differentiation during the foetal period) and advanced topics in developmental endocrinology.

This means that students' awareness is mainly limited to basic content, while they are not up to date with more current scientific knowledge or less prominent topics. Meanwhile, as Williams et al. (2023), the study of sex hormones and related gender issues requires critical analysis, as cultural stereotypes about sex and gender are present in scientific discourse. However, this is not an easy task, as the categories of women and men themselves are imperfect equivalents of anatomical and physiological factors related to sex. Simply put, these binary categories lack the complexity both within each category and between categories to adequately model the sex-related factors that influence health. One of the main mechanisms determining sex are those related to the action of hormones – especially oestrogens, androgens and progestogens. These hormones, along with a wider range of other sex-related

hormones, contribute to many differences in a wide range of physiological processes and health conditions. Although the concepts themselves are distinct, in practice it is usually emphasised that sex and gender are deeply intertwined. As in the classic nature versus nurture debate, it is usually not a question of one or the other, but more often their dynamic interaction. Furthermore, as Nehm and Young (2008) point out, the understanding of the term 'sex hormone' is often associated with pre-empirical concepts of gender dualism, in particular with the misconception that so-called 'sex hormones' are specific to a given gender and limited to physiological functions associated with that gender. This group of researchers found that in many school textbooks, estrogen is portrayed as exclusive to women, and testosterone as exclusive to men. Moreover, in many texts, these hormones are discussed solely in terms of their physiological roles associated with a specific sex. The authors point out that textbooks continue to promote dualistic models of steroid hormones—one sex, one "sex hormone"—which were scientifically rejected as early as the beginning of the 20th century. They argue that the continued use of the term "sex hormone" reinforces misconceptions about the presence and function of steroid hormones in male and female bodies.

Polish and Slovak students were more familiar with the basics of sex genetics than Czech students. In terms of the basic mechanisms of sex determination (the role of chromosomes, gonadal functions, the definition of hormonal sex, the concept of intersexuality), students' knowledge is relatively good – most have a correct understanding of the genetic and hormonal basis of sex differentiation. The biggest gaps were revealed in the details of embryonic sex development, especially in understanding the 'default' female development in the absence of androgens. Ignorance or uncertainty about the role of the SRY gene, the mechanism of female differentiation (through the absence of androgens), or the effects of testosterone deficiency indicates that these issues have not been sufficiently understood.

In general, the study also showed that students prefer to admit their lack of knowledge rather than maintain misconceptions, which is a good sign – it is easier to fill in the gaps in knowledge than to correct entrenched myths. Nevertheless, such a high percentage of uncertain answers indicates insufficient awareness in the subject of many hormonal issues. Particularly critical is the widespread misunderstanding of the question about the consequences of insufficient testosterone in male sex determination – most students did not know that in such a situation a phenotypically female child would be born. This is a fundamental concept in embryology and should be given appropriate emphasis within the curriculum. In addition, Czech students demonstrated less confidence or knowledge than the others on several occasions (e.g. chromosomes, SRY, brain differentiation) – it is possible that the curriculum there placed less emphasis on these details, or that Polish and Slovak students had more up-to-date knowledge and had studied the subject relatively recently. On the other hand, it is positive that a relatively large number of respondents were

familiar with the concept of intersexuality and were able to correctly identify it. This indicates a growing awareness of the existence of complex cases of disorders and differences in sex development (DSD) in society and medicine. This positive trend can be related to the data provided by Conway (2014), who emphasises that the development of biotechnology has radically changed clinical and research data on disorders of sex development. He emphasises that in the age of genetics, an increasing number of DSD conditions are being identified, and thanks to a larger population of people with DSD diagnoses presenting at specialist centres, these discoveries are enabling doctors and scientists to map the long-term clinical symptoms of a range of conditions; and although knowledge may remain incomplete, understanding of these issues has improved significantly (Conway, 2014). Alkazemi et al. (2020) also report that DSD issues cause ethical, social, and psychosexual problems that can complicate medical decision-making and identify social concerns about DSD management. Their survey indicates that there is a wide variety of social opinions on sex determination disorders, reflecting the levels and ranges of knowledge of different groups depending on gender, race, religion, and respondents' prior knowledge of DSD, with gender identity being the most troubling and misunderstood issue for respondents (Alkazemi et al. 2020).

Lampalzer et al. (2020) point out that DSD is a collective term for various congenital disorders involving chromosomal, gonadal, and phenotypic sex characteristics. These disorders are accompanied by various uncertainties regarding health, medical, psychosocial, and legal issues, which give rise to controversial discussions. In their opinion, in this context, acceptance of physical differences is an important prerequisite for understanding biological diversity, and psychosocial support for everyday problems and, among other things, hormonal problems of people with DSD seems to be an important means of achieving a better quality of life for them and increasing social awareness (Lampalzer et al. 2020).

Wechsung et al. (2022) clearly indicate that education and the dissemination of up-to-date information on biological discoveries are crucial in the care of people with DSD. The authors identified information management as a priority for access to knowledge; however, in their opinion, there is a lack of information programmes that could help education specialists organise conditions for discussing this type of content. This is important because the approach to diagnosis and care in DSD is constantly changing, so continuous research and new findings are to be expected. Information quickly becomes outdated, hence the need for systematic updating of public knowledge, materials and tools needed to implement new content in the face of changing guidelines or local requirements (Wechsung et al. 2022).

In turn, Lundberg et al. (2018) conclude that all people, regardless of their gender development, must talk about the experience of having a specific body in a flexible and context-appropriate manner, including the possibility of explaining bodily differences in non-pathologising terms. Having knowledge

of the terminology used in the context of DSD allows for flexibility and linguistic correctness when discussing this complex issue. This is especially important because it is not only about language being neutral and descriptive, but also functional and performative. This is essential to strengthen engagement in everyday discourse on gender embodiment in different social contexts, which is taking place within an increasingly politicised debate on harm and human rights (Lundberg et al. 2018).

The differences between countries are generally minor. In most of the topics discussed, the level of knowledge of Polish, Czech and Slovak students proved to be similar. There were no cases where one group consistently dominated or lagged behind in all categories. However, some differences did emerge: Czech students demonstrated slightly better knowledge of classical physiology, but performed poorer in questions about chromosome genetics and sex embryology. Polish and Slovak students had very similar results in many cases – for example, in most questions about sex determination, their 'yes'/'no' response rates were almost identical.

Conclusions and educational implications

A comparative analysis of the knowledge and awareness of students from Poland, the Czech Republic and Slovakia on sex determination reveals several key conclusions. Students are relatively well acquainted with the basic genetic and anatomical issues related to sex determination, but their knowledge of embryological and endocrinological details is much smaller. This highlights the need to place greater emphasis on explaining the mechanisms of sex determination (the role of SRY, „default" female development, examples of DSD). These topics are often treated superficially or omitted altogether, yet the results show gaps in understanding these processes.

The research conducted has shown that student's knowledge of sex determination is insufficient, so there is an urgent need to focus on their education in this area, not only in biological and health terms, but also in social, ethical and cultural terms. These conclusions are consistent with those reached by the authors of this article in their previous research, including Czerwiec (2023), Czerwiec (2015), Czerwiec and Leżucha (2021). In this regard, it is important to maintain, consolidate and deepen fundamental knowledge about the basics of sex genetics, which can be achieved through a more practical approach, e.g. discussions regarding clinical cases of DSD when discussing karyotype-related issues.

In the context of the educational implications of these findings, educational programmes should be expanded to include content on the embryology of sex differentiation, which can be discussed through problem-based learning lessons and activities for students, given the need to develop reasoning skills rather than just memorising the facts. The high percentage of 'I don't know' responses may indicate that learners do not feel comfortable inferring beyond

the material they have clearly memorised. Encouraging pupils and students to reason on the basis of the mechanisms they have learned could reduce this type of uncertainty. In the teaching process, it is important to emphasise the need to ask 'what if...' questions so that pupils and students learn to draw conclusions and feel more confident about their knowledge regarding new situations.

Students' awareness of sex hormones is moderate – good in terms of the basics, poor considering more advanced issues – and similar in Poland, the Czech Republic and Slovakia. The educational programmes of these countries should be updated to keep in pace with developments in the field of education (e.g. about karyotyping) and to better understand and explain more difficult issues (such as sex embryology). The differences in responses between countries also encourage further cultural and programme analysis in order to develop common educational standards or at least exchange good practices in the field of human sexual health education.

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