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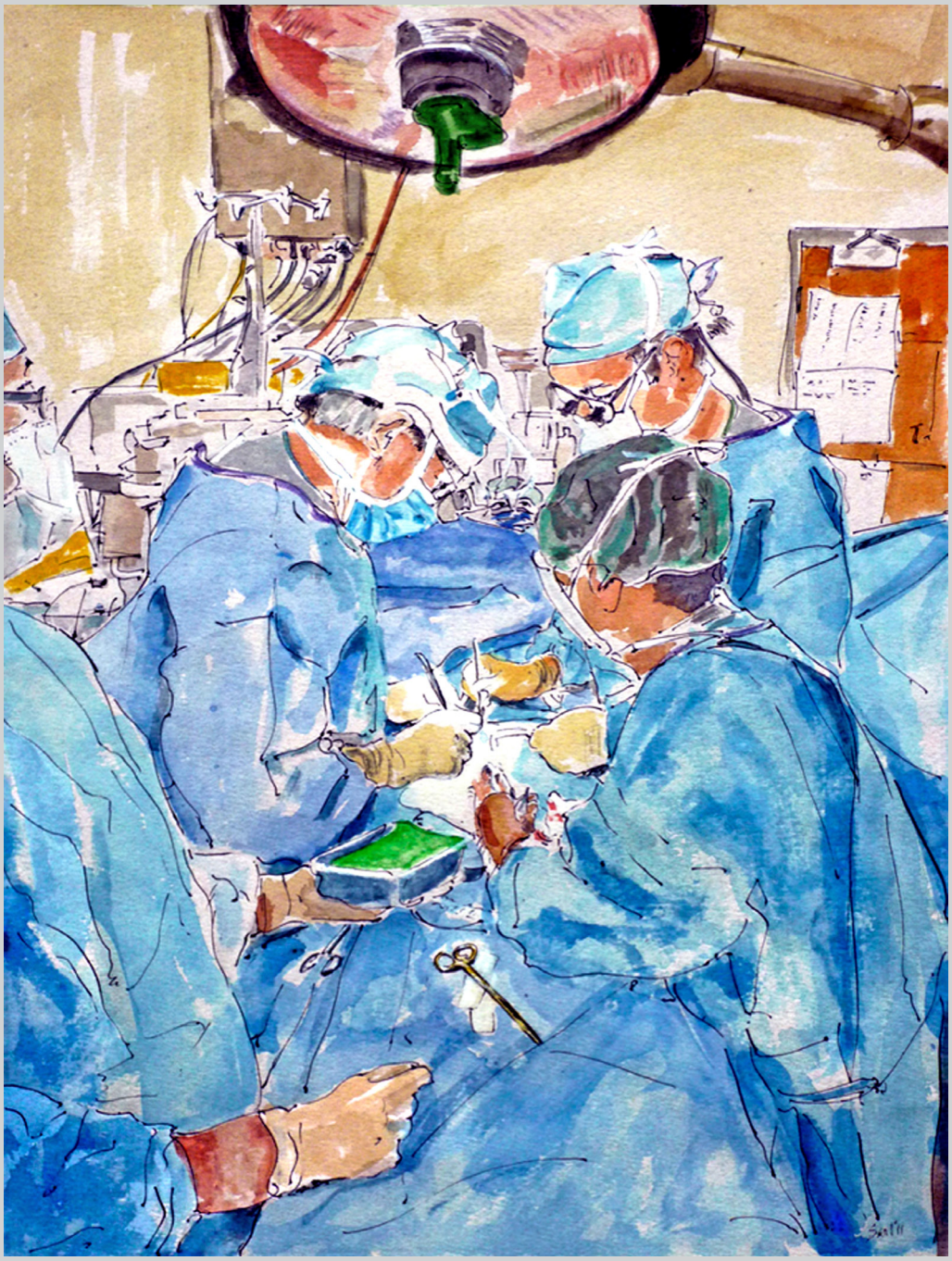

Dr. Andrew Seal

"Self-portrait from my last operation before retiring as a general surgeon", 2011 / Watercolor and ink on paper

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CONTENT

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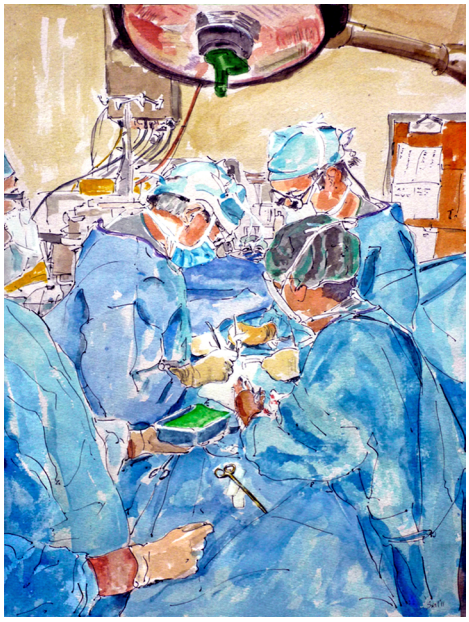
COVER IMAGES



Dr. Andrew Seal

"Self-portrait from my last operation before retiring as a general surgeon", 2011. Watercolor and ink on paper.

EDITORIAL | Yeditepe Journal of Health Sciences, 14(2):26–7

Hear, See, Touch: The Core of Medical Practice

Dear Colleagues,

In our August issue, we include a review article on neural modulation strategies in neuroscience and two research articles: one on a gender-oriented approach to human papillomavirus (HPV) vaccination among preclinical medical students, and one on sexual offenses against sexual inviolability in Türkiye, including judicial statistics and forensic examination coverage..

In this issue, our cover painting comes from the other side of the world: *Self-portrait from my last operation before retiring as a general surgeon*, by Dr. Andrew Seal, a Canadian surgeon and scholar who paints on a range of subjects and, as you will see on the inside cover, has a good eye for photography. I found his paintings and photographs through his blog. Dr. Seal has spent a lifetime teaching medicine, and with his permission, I would like to pass his thoughts about medical education on to our readers.

“My belief is that the art of medicine is about hearing as well as listening, about seeing as well as looking, about caring as well as treating and about feeling as well as touching. Perhaps, in no greater way is trust between a doctor and a patient expressed than in the laying on of hands. Touching is one of the most intimate acts that we perform as physicians. It is sacred, a defining moment, for in its action our patients know how much we care. They permit us to palpate, to percuss, to incise. My earliest memories as a medical student were watching the manner in which my teachers would touch their patients. The gentle holding of the hand, the taking of the pulse, the steady palpation to reveal the site of pain, the handshake of greeting that, with its strength, tells the patient, I am here, and this moment is yours. This universal image of a student and a teacher communicating with their patient is one that I believe captures the essence of the art of medicine and one that I expressed to the students at the end of a graduation address I gave some years ago:

Listen and you will hear.
Look and you will see.
Touch and you will feel.
Treat and you will care.
Practice your art with compassion
And live your lives with passion.
Be a student always
And a teacher ever,
And your lives will be as fulfilled
And meaningful as any who have gone before
And any who are yet to come.”

Published August 30, 2026 **Correspondence** Gülderen Yanıkkaya Demirel **DOI** 10.36519/yjhs.2026.1327

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Advancements in medical science, the internet, and artificial intelligence, alongside the evolution of diagnostic tools, have fundamentally transformed medicine beyond its traditional paradigm. Nevertheless, we must remain mindful that we care for individuals who are someone's parents, children, or siblings, and we should extend the same level of care to them as we would to our own families.

We need more research articles to reach our goal of being listed in national and international indexes. Please keep up the support and submit your research articles for our next issue, which will be published in December.

Stay healthy,

Gülderen Yanıkkaya Demirel
Editor-in-Chief

REVIEW ARTICLE | Yeditepe Journal of Health Sciences, 14(2): 28–33

Neural Modulation Strategies in Neuroscience

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Abstract

Chemogenetics is a powerful and versatile neuromodulation strategy that enables remote, reversible control of defined cell populations through the use of engineered receptors and pharmacologically inert small-molecule ligands. This review synthesizes the current state of chemogenetic technologies, focusing on Designer Receptors Exclusively Activated by Designer Drugs (DREADDs) and emerging ion-channel-based actuators, and outlines their molecular mechanisms, ligand pharmacology, and recent technical innovations. We examine the broad applications of these tools in disease modeling, behavioral neuroscience, and experimental therapeutics, as well as in biomedical contexts beyond the central nervous system. Particular attention is given to the role of chemogenetics in mapping and causally dissecting neural circuits, where it provides precise and reversible modulation of neuronal activity to elucidate the cellular substrates of behavior.

Comparisons with other neuromodulation techniques—such as optogenetics and electrical stimulation—are discussed, together with practical considerations including ligand selection, delivery strategies, and long-term applications. Finally, we highlight the translational trajectory of chemogenetic technologies, emphasizing ongoing advances that are bringing gene therapy-based neuromodulation closer to clinical application in neurology and psychiatry.

Keywords: Chemogenetics, DREADD, neuromodulation, neural circuits, behavioral neuroscience, gene therapy

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INTRODUCTION

Chemogenetics is an advanced neuromodulation strategy that is often described as a molecular "switch." In this method, cells are engineered to express artificial receptors that can be selectively activated by a chemical compound that, under normal physiological conditions, has no biological effect. This design effectively reverses the conventional pharmacological paradigm: instead of designing drugs that target naturally occurring receptors, chemogenetics constructs receptors that selectively respond to a chosen synthetic molecule. The conceptual roots of chemogenetic research date back to the early 1990s, when Strader and colleagues showed that G protein-coupled receptors (GPCRs) could be engineered to recognize non-natural ligands rather than their endogenous neurotransmitters (1,2). These initial studies demonstrated that receptor-ligand specificity could be rationally redesigned, paving the way for today's chemogenetic platforms. Modern adaptations of this idea, most notably the DREADD (Designer Receptors Exclusively Activated by Designer Drugs) system, now provide neuroscientists with a powerful approach for selectively controlling the activity of defined neural populations (3).

FROM RASSLS TO DREADDS: CHEMOGENETIC RECEPTOR DESIGN

One of the main goals of chemogenetics in neuroscience is to reach a level of anatomical and cellular precision that traditional pharmacological tools could not easily offer. By restricting the expression of designer receptors to selected neuronal subtypes, researchers can either silence or activate specific circuits without affecting other brain regions. Unlike systemic drug treatments, which broadly act on all cells carrying the natural receptor, chemogenetic modulation is confined to the targeted population. Furthermore, it is reversible and noninvasive: the receptors are typically delivered through viral vectors or transgenic approaches, and neural activity is modulated simply by administering the activating compound, avoiding the need for implants or tissue lesions. These advantages have made chemogenetics a key technique for mapping causal relationships between neural circuits and behavior (4). Over the past decade, it has been widely adopted to dissect neural circuitry underlying behaviors, perceptions, and pathologies in species ranging from fruit flies to non-human primates (5,6). By enabling researchers to turn specific neural circuits "on" or "off" like a switch, chemogenetics bridges the gap between correlational observations and causal interrogation of brain function.

At the heart of these methods are engineered receptor-ligand pairs. The DREADD family of modified GPCRs remains the most widely applied. These receptors are designed to lose responsiveness to endogenous neurotransmitters but can be activated by an otherwise inert drug, usually clozapine-N-oxide (CNO) (7). Importantly, DREADDs remain functionally silent in the absence of the ligand, minimizing interference with normal cellular physiology. This represented a major improvement over the earlier generation of receptors, known as RASSLs (Receptors Activated Solely by Synthetic Ligands), which showed spontaneous activity even in the absence of ligand binding (8). With DREADDs, neuronal activity can thus be precisely toggled only when and where the experimenter delivers the activating molecule.

Subsequent receptor engineering expanded the chemogenetic toolkit. A notable advance was the κ-opioid-derived DREADD, termed KORD, which is selectively activated by salvinorin B, an inactive metabolite of the hallucinogen salvinorin A. The KORD couples to inhibitory G proteins (Gi) and can be co-expressed with an excitatory DREADD in the same neurons, permitting bidirectional modulation with two different drugs (9).

ION CHANNEL-BASED CHEMOGENETIC ACTUATORS: THE PSAM/PSEM SYSTEM

Beyond GPCRs, chemogenetic systems based on ion channels have been developed to directly alter membrane excitability. One prominent example is the PSAM/PSEM system (Pharmacologically Selective Actuator Module / Pharmacologically Selective Effector Molecule) introduced by the Sternson group (10). The PSAMs are chimeric ligand-gated ion channels. They combine a modified ligand-binding domain, such as one derived from the α7 nicotinic acetylcholine receptor, with the ion-conducting domain of another receptor, such as the 5-HT3 or glycine receptor. Their synthetic ligand (PSEM) selectively opens the engineered channel (10). Depending on the channel used, PSAMs can depolarize or hyperpolarize neurons, offering either excitation or inhibition with high specificity.

Because they act through direct ion flow rather than second-messenger signaling, their effects can develop more rapidly than those of GPCR-based DREADDs. Moreover, recent PSAM variants activated by ultrapotent ligands (analogues of varenicline, a clinically used nicotinic partial agonist) have shown effective modulation of neural activity in rodents and primates. The use of a drug like varenicline (which has good brain penetration and an established safety profile in humans) as the actuator molecule highlights the translational appeal

Table 1. The comparison of major chemogenetic platforms and optogenetic neuromodulation.

Platform	Actuator/stimulus	Main mechanism	Temporal profile	Main advantage	Main limitation
RASSL	Engineered GPCR + synthetic ligand	GPCR signaling	Minutes-hours	Historical foundation of receptor engineering	Basal activity and limited ligand selectivity
DREADD	Engineered GPCR + designer ligand	Gq, Gi, Gs, or related signaling	Minutes-hours	Prolonged, minimally invasive modulation	Ligand pharmacokinetics and limited temporal precision
KORD	Engineered κ-opioid receptor + salvinorin B	Gi signaling	Minutes-hours	Multiplexed bidirectional control	Requires a separate ligand system
PSAM/PSEM	Chimeric ligand-gated ion channel + PSEM	Direct ionic conductance	Faster than GPCR-based systems	Rapid excitation or inhibition	More restricted actuator-ligand repertoire
Optogenetics	Opsin + light	Direct ion conductance or pumping	Milliseconds	Precise temporal control	Implantation, light penetration, and heating limitations

RASSL: Receptors activated solely by synthetic ligands, **DREADD:** Designer receptors exclusively activated by designer drugs, **KORD:** κ-opioid receptor, DREADD, **PSAM/PSEM:** Pharmacologically selective actuator module / pharmacologically selective effector molecule, **GPCR:** G protein-coupled receptor, **Gq, Gi, Gs**: G protein signaling classes.

of ion channel-based chemogenetics (11). Together, advances in receptor engineering—from third-generation DREADDs to next-generation chemogenetic ion channels—have greatly diversified the mechanisms by which researchers can influence neural circuits.

TARGETED DELIVERY OF CHEMOGENETIC ACTUATORS: VIRAL VECTOR STRATEGIES

The successful use of neural modulatory systems relies heavily on gene-delivery strategies. Since chemogenetic actuators are not endogenous proteins, viral vectors—particularly adeno-associated viruses (AAVs)—are used to express them in target neurons. These AAV vectors are well suited to this purpose as they infect post-mitotic cells, sustain long-term expression, and do not integrate into the genome (12). Different AAV serotypes display distinct cell-type preferences, making differentiated targeting possible. This can be further improved by specific promoters, such as CaMKII (Calcium/Calmodulin-Dependent Protein Kinase II) for excitatory neurons or GFAP (Glial Fibrillary Acidic Protein) for astrocytes (13,14).

Using serotype selection, promoter targeting, and precise stereotaxic injection of viruses, researchers can express chemogenetic actuators in a specific, genetically identified population of cells in a given anatomical location. Stereotaxic delivery of viral vectors, together with cell-type-selective genetic tagging, allows chemogenetic expression in a particular group of neurons within a certain brain region. In addition, retrogradely transported AAV variants make it possible to target neurons and their projections, not just their location (15). Recent progress in viral-vector engineering, such as improvements in AAV, lentiviral, and herpes simplex virus (HSV), has made chemogenetic tools much more precise. These advances allow for a level of specificity and anatomical targeting that is hard to reach with traditional lesion methods or electrode-based approaches (16). Combining genetic targeting with customized viral delivery is a key method in chemogenetic experiments, ensuring that drug effects are limited to the targeted neural circuit.

CHEMOGENETICS AND OPTOGENETICS: COMPLEMENTARY STRATEGIES

Optogenetics and chemogenetics are two similar techniques that serve the same system but have different scopes and modulations. Optogenetics enables the initiation and cessation of neuronal firing in milliseconds through light-induced ion exchange by inducing rhodopsin expression (17). Short pulses of light can stop or start activity in the neural circuit (18). Unlike chemogenetics, it functions independently of how the body processes the drugs. In chemogenetics, the ligand's effect on the receptor, its half-life, and its activity are also important (9).

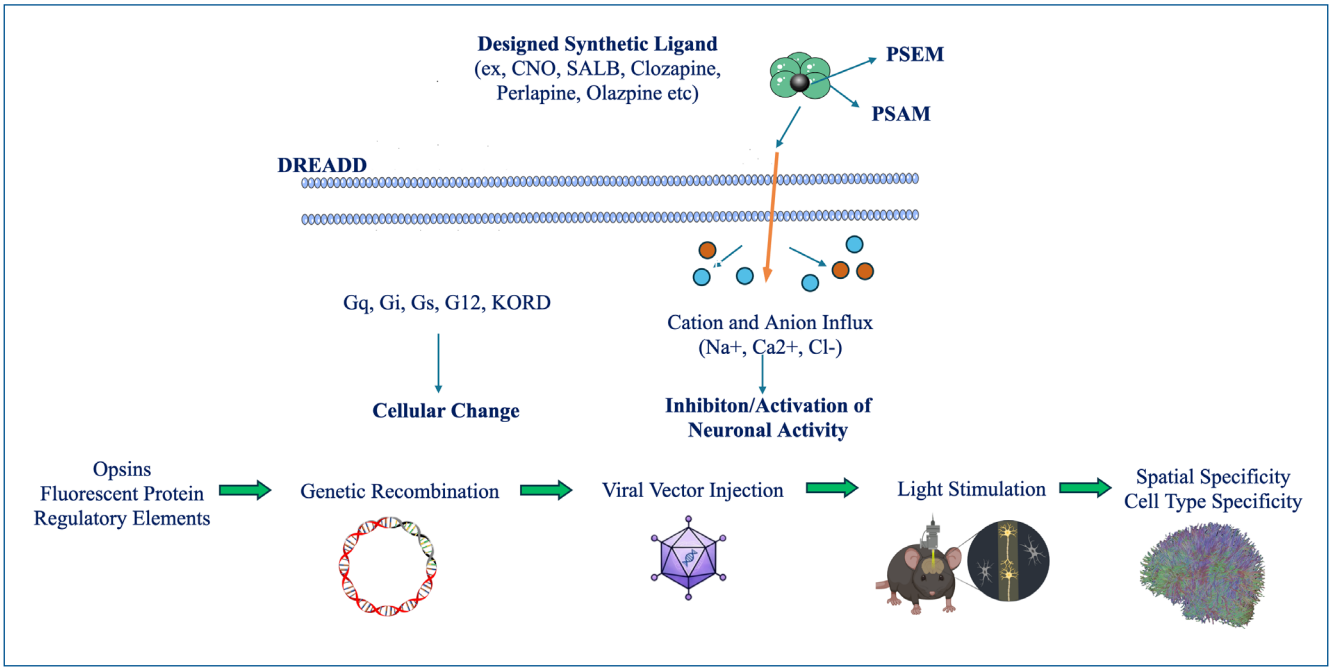

FIGURE 1. Molecular mechanisms and applications of chemogenetic neuromodulation compared with optogenetics.

Chemogenetics acts as a molecular "switch" in which engineered receptors are selectively activated by otherwise inert synthetic ligands, reversing the conventional logic of pharmacology. Two principal platforms are shown. The designer receptors exclusively activated by designer drugs (DREADD) system is built on modified G protein-coupled receptors that no longer respond to endogenous neurotransmitters but are activated by designer ligands such as clozapine-N-oxide (CNO), salvinorin B (SALB, the actuator for the κ-opioid-derived KORD), clozapine, perlapine, or olanzapine. Depending on the coupled G protein (Gq, Gi, Gs, G12, or KORD), ligand binding engages second-messenger cascades that drive relatively slow but sustained cellular and metabolic changes. In parallel, the ion-channel-based pharmacologically selective actuator module / pharmacologically selective effector molecule (PSAM/PSEM) system uses chimeric ligand-gated channels: binding of the synthetic PSEM ligand opens the engineered channel and permits direct cation and anion flux (Na^+, Ca^{2+}, Cl^-), producing rapid excitation or inhibition of neuronal activity through direct membrane conductance rather than second-messenger signaling. Because chemogenetic actuators are not endogenous proteins, they are delivered by viral vectors—chiefly adeno-associated viruses (AAVs)—whose serotype selection, cell-type-specific promoters, and stereotaxic injection confer expression restricted to genetically defined neurons in a chosen anatomical region. Optogenetic workflows depend on genetic recombination of opsins, fluorescent proteins, and regulatory elements, viral delivery, and localized light stimulation to achieve spatial and cell-type specificity, but the need for implanted fibers limits access to deep structures and clinical translation (23).

Optogenetics is more suitable for experimental designs where rapid circuit activation and inhibition, high-frequency stimulation, and controlled timing are required. Optogenetic systems also have some practical drawbacks. Due to the absorption and scattering of light in deep tissues, fiber-optic cable implantation is necessary in the region (19). This limits the naturalness of the behavior (20). This also limits its applicability in clinical settings. Long-term implants, power supplies, and the fact that the light source emits heat raise safety concerns, which is a subject of ongoing research (21). On the other hand, chemogenetic systems, because they do not require implantation, have fewer device-related safety flaws.

In practice, chemogenetic experiments can be designed to minimally influence behavioral patterns. The receptor ligand can be administered by injection, oral gavage, or by mixing it into drinking water (22). In this respect, it is an important strategy for long-term behavioral studies and monitoring of chronic responses, and modulation can be achieved without over-manipulation of behavior. In chemogenetics, the main limitation is timing. The response is affected by the pharmacological agent and how it is absorbed, cleared, or distributed.

Furthermore, DREADDs are distinguished by their mechanisms of action. The DREADDs activate G-protein signaling via second-messenger pathways and gene expression that brief optogenetic currents do not. Because of this, chemogenetic methods are especially useful for studying plasticity and long-term changes in circuits (23). Overall, optogenetics and chemogenetics should be seen as complementary tools. Optogenetics is best for fast, precise control, while chemogenetics offers simpler experiments, works well in deep brain areas, and allows for longer-lasting effects. When used together, they provide a range of control, from millisecond accuracy to

hours-long influence, allowing researchers to choose the best method for their specific question.

CHEMOGENETIC APPROACHES IN DISEASE AND BEHAVIOR RESEARCH

Chemogenetic systems are being used in an increasingly widespread approach to researching disease and neural circuit mechanisms. This is because chemogenetic systems offer the possibility of reversible control in a specific neural population, often without being in a race against time. The DREADDs are used to modify the activity of a specific pathway in a particular neural population and to observe or objectively record the resulting behavioral consequences through standardized behavioral tests. By enabling experimental setups such as the eradication of a neural population with minimal harm to surrounding populations, they allow for more targeted and better-defined results than chemical damage applications.

For example, in Parkinson disease models, one of the most intensively studied areas of the dopaminergic system and pathology is the basal ganglia. By chemogenetically exciting underactive dopaminergic neurons in these areas and altering the activity of related pathways, improvements in motor function have been observed (24–26). For instance, engaging Gs-coupled DREADDs in D1-expressing striatal neurons increases direct-pathway drive and mitigates motor impairments, illustrating the therapeutic logic of restoring pathway balance rather than broadly altering neurotransmission (26). In epilepsy models, inhibitory DREADDs have been used to reduce spontaneous seizure production from hippocampal and cortical overactive neurons (27,28).

In Alzheimer disease, transient stimulation of the basal forebrain has been shown to improve cognitive function. At this point, it was shown that applying the specific neural tone of the stimulated population could reverse the deficits (29). Taken collectively, these applications shift disease models from static descriptions to empirically testable systems where circuit dysfunction and symptoms can be directly correlated through manipulation.
Chemogenetics, by opening up a pathway for neuronal modulation through reversible and specific selection in the behavioral field, has contributed to behavioral neuroscience. In this way, vital issues such as nutrition, affect, motivation, and reward, which are also relevant to neuropsychiatry, are able to be explored in greater depth. For example, a chemogenetic study in hypothalamic circuits revealed a novel circuit pattern in hunger signaling, showing that activation of agouti-related peptide (AgRP) neurons promotes eating even during satiety, while their inhibition suppresses eating behavior. Conversely, chemogenetic activation of Pro-opiomelanocortin (POMC) neurons, which are a modulatory nucleus within the arcuate network, promotes satiety (30).

Furthermore, the chemogenetic approach has also played a significant role in exploring how specific neuronal populations of specific neurotransmitters are involved in emotional and motivational processes. Activation of serotonergic dorsal raphe nuclei was found to enhance anxiety-like behaviors in different paradigms. The context-dependent nature of this response was indicative of bidirectional modulation (31). Silencing dopamine neurons in the ventral tegmental area (VTA) produces behavioral phenotypes such as decreased motivation, while excitation can increase reward seeking and link dopamine dynamics to goal-directed drive (32).

Although chemogenetic applications generate slower modulation compared to optogenetic systems, they offer advantages such as better performance in deep structures, providing robust and reversible modulation, and not requiring implanted fiber and cabling for modulation. This genetically tagged and pharmacologically flexible combination provides mapping of a specific neural circuit, recording of its behavioral outputs, and their processing within a disease-specific framework.
In short, chemogenetic systems combine molecular biology, genetic engineering, and neuroscience principles and allow for observation of the behavioral responses of functional neural networks in living models through manipulations. As vector platforms, ligand design, and targeting strategies continue to mature, chemogenetics is likely to remain a core methodology for circuit neuroscience and a conceptual scaffold for future, less invasive neuromodulatory therapeutics.

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RESEARCH ARTICLE | Yeditepe Journal of Health Sciences, 14(2): 34–9

A Gender-Oriented Approach to Human Papillomavirus Vaccination: A Cross-Sectional Study Among Preclinical Medical Students

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Abstract

Objective: The first line of defense against cervical cancer is human papillomavirus (HPV) vaccination. The perception that HPV vaccination is primarily intended for women hinders progress in the fight against HPV. This study aimed to examine preclinical medical students' gender-based perspectives on the current HPV vaccination program and to assess the potential impact of gender-based approaches to cervical cancer prevention programs on their knowledge of HPV vaccination recommendations.

Materials and Methods: This descriptive cross-sectional study assessed preclinical medical students' awareness of HPV vaccination recommendations. The HPV Knowledge Scale was administered to eligible preclinical students. Incomplete questionnaires were excluded from the analysis.

Results: A total of 448 questionnaires were analyzed, corresponding to an 88.3% response rate. Regarding the recommendation of the HPV vaccine for males aged 11–26 years, only 34.8% of male students (n=46) and 31.0% of female students (n=98) correctly identified this indication. For females aged 11–26 years, the proportion of correct responses was higher, at 60.6% (n=80) among male students and 69.3% (n=219) among female students.

Conclusion: Improving medical students' knowledge of vaccination programs is an important step toward achieving primary prevention, a key objective of public health practice. Our findings demonstrate that preclinical medical students have lower awareness of HPV vaccination recommendations for males than for females, indicating an urgent need to strengthen gender-neutral HPV vaccination content in undergraduate medical education.

Keywords: Gender, HPV, vaccination

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INTRODUCTION

Beyond its fundamental role in cervical oncogenesis, human papillomavirus (HPV) infects a broad range of mucosal and cutaneous epithelial tissues. High-risk genotypes, particularly HPV-16 and HPV-18, play a role in the molecular pathogenesis of a wide range of malignancies, including oropharyngeal, anal, and penile cancers. The virus may integrate into the host genome, leading to overexpression of E6 and E7 oncoproteins (1). While global health discourse largely focuses on the burden of cervical cancer, the burden of HPV-associated oropharyngeal squamous cell carcinomas in men underscores the need for a gender-neutral approach to HPV prevention and vaccination. Effective HPV prevention requires recognition of its diverse oncogenic manifestations and should move beyond a female-centered clinical perspective (2).

Cervical cancer remains the fourth most common cancer globally among women after breast, colorectal, and lung cancers, according to the latest estimates from the World Health Organization (WHO) and the Global Cancer Observatory (GLOBOCAN), with the vast majority of cases attributed to persistent infection with high-risk HPV genotypes. Vaccination represents a primary prevention strategy and a highly cost-effective public health intervention for reducing the burden of HPV-related disease (3). However, due to systemic barriers to accessing vaccination and screening programs, approximately 90% of cervical cancer-related deaths occur in low- and middle-income countries.

In response to this global inequality, the WHO launched the Cervical Cancer Elimination Initiative in 2020 (4). This global strategy aims to achieve specific targets by 2030, including fully vaccinating 90% of girls by 15 years of age. As of 2021, more than 100 countries, including the United States, the United Kingdom, Germany, Australia, Belgium, Sweden, and New Zealand, had incorporated the HPV vaccine into their National Immunization Programs (NIPs) (5).

The Turkish Ministry of Health announced in November 2022 that the HPV vaccine would be included in the national program. However, as of 2026, the vaccine has still not been integrated into Türkiye's National Immunization Program for the entire target population and remains largely outside the scope of universal social security reimbursement, except for limited pilot applications. Regarding vaccine availability in Türkiye, the quadrivalent human papillomavirus vaccine (Gardasil®, Merck & Co., Rahway, NJ, USA) and the bivalent human papillomavirus vaccine (Cervarix®, GlaxoSmith-Kline, Brentford, UK) were launched in 2007 and 2008, respectively, followed by the approval and launch of the nonavalent vaccine (Gardasil 9®) in 2019 (6). Beyond structural barriers, healthcare provider recommendations, individual knowledge, perceptions of vaccine effectiveness, and socioeconomic status remain important determinants of vaccination uptake (7). In this context, understanding gender-related differences in knowledge of HPV vaccination recommendations is important for developing equitable vaccination strategies.

The concept of 'feminization' in public health refers to the process by which a disease, risk factor, or preventive intervention becomes predominantly associated with women, potentially obscuring its relevance to men (8). In the context of HPV, this conceptual framing has historically emerged from the early emphasis on cervical cancer prevention, which may have contributed to a gendered perception of HPV and its prevention. Such a perception may affect awareness of HPV vaccination recommendations for males and females, including among future healthcare professionals.

Medical students are an important target population for assessing knowledge of HPV vaccination because their understanding of vaccination recommendations may influence their future counseling and preventive healthcare practices. Therefore, this study aimed to assess preclinical medical students' knowledge of HPV vaccination recommendations from a gender-sensitive perspective, with particular emphasis on differences in awareness of recommendations for males and females.

MATERIALS AND METHODS

Study Design and Setting

This descriptive cross-sectional study aimed to evaluate medical students' knowledge of the HPV vaccination program, focusing on gender-specific vaccination recommendations. The primary objective was to assess students' awareness and identify knowledge gaps regarding gender-neutral HPV vaccination.

Study Population and Sampling

The study population comprised students enrolled in the Faculty of Medicine of a foundation university in İstanbul, Türkiye, during the 2022–2023 academic year. Data were collected through face-to-face administration of questionnaires to students who voluntarily agreed to participate.

The inclusion criteria were enrollment as an active preclinical medical student (Period 1, 2, or 3) at the study university during the 2022–2023 academic year and provision of voluntary informed consent. Students who were absent on the days of data collection, declined to

participate, or were in the clinical phase of medical education were excluded. Participants were approached in person during scheduled lecture breaks and in common campus areas. The structured paper-based questionnaires were administered in quiet classroom settings to minimize distraction, and completion took approximately 5–7 minutes per participant.

To ensure anonymity and promote honest reporting, no personally identifiable information was collected, and participants were informed that their responses would not affect their academic standing. Surveys with missing data or incomplete responses in the core subdimensions were strictly excluded from the final analysis to maintain data integrity. A formal sample size calculation or power analysis was not performed *a priori*; instead, a census sampling approach was used to invite the entire accessible target population to participate.

Data Collection Tools

Data were collected using a structured questionnaire consisting of two main sections. The first section recorded demographic characteristics, including gender and academic year (Period). The second section employed the Human Papillomavirus (HPV) Knowledge Scale, originally developed by Waller et al. (2013) and validated in Turkish by Demir et al. (2019) (9,10).

The questionnaire consists of 33 items across four subdimensions:

- Subdimension 1: General knowledge about HPV (16 items)
- Subdimension 2: Knowledge regarding the HPV test (6 items)
- Subdimension 3: Knowledge regarding the HPV vaccine (5 items)
- Subdimension 4: Knowledge regarding the HPV vaccination program (6 items)

This study specifically focused on the fourth sub-dimension (knowledge regarding the HPV vaccination program) rather than the overall scale score. The targeted approach was selected because knowledge of vaccination program recommendations, including age-specific eligibility and recommendations for males and females, is directly relevant to equitable HPV vaccine counseling and implementation. Each correct response was assigned a score of 1, whereas incorrect or "don't know" responses were scored as 0, in accordance with the original scoring system.

Ethical Considerations

This study was approved by the Yeditepe University Faculty of Medicine Ethics Committee on April 17, 2023, with decision no. 2023/80-04. All participants provided written informed consent prior to participation.

Literature Search Strategy

To contextualize the representation of gender-specific HPV vaccination research in the literature, a targeted literature search was conducted on the PubMed/MEDLINE database in April 2023. The search strings were "HPV vaccine AND women" and "HPV vaccine AND men", and the search was restricted to titles, abstracts, and keywords. The total number of publications retrieved from each search was recorded as a descriptive benchmark for the discussion.

Statistical Analysis

Data were analyzed using IBM SPSS Statistics version 26.0 (IBM Corp., Armonk, NY, USA). Descriptive statistics were reported as frequencies (n) and percentages (%) for categorical variables. Because the primary study variables were categorical, categorical statistical methods were used. The Pearson chi-square test was used to evaluate differences in responses to HPV vaccination knowledge items between genders. Spearman's rho correlation coefficients were calculated to assess the association between the academic year (Period) and HPV vaccination program knowledge scores. Statistical significance was set at $p<0.05$.

RESULTS

The study population comprised 507 students, of whom 448 completed the questionnaire, yielding a response rate of 88.3%.

Most participants were female (n=316, 70.5%), while male students represented 29.5% (n=132) of the sample. By academic year, Period 3 students constituted the largest group (n=182, 40.6%), followed by Period 1 (n=137, 30.6%), and Period 2 (n=129, 28.8%) students (Table 1). The fourth subdimension of the scale assessed knowledge of the HPV vaccination program across six items, with

Table 1. Sociodemographic characteristics of the study participants.

	Group	n	%
Gender	Male	132	29.5
	Female	316	70.5
Academic Year	1	137	30.6
	2	129	28.8
	3	182	40.6

a maximum possible score of 6. The overall mean score for the study population was relatively low, indicating limited overall knowledge of HPV vaccination policies. Specifically, when analyzing individual item responses, a marked difference was observed between knowledge of HPV vaccination recommendations for women and those for men. For instance, most participants correctly identified that HPV vaccination is recommended for women aged 11–26 years.

No statistically significant difference was observed between male and female students regarding their knowledge of HPV vaccination recommendations for women. Most participants correctly identified that the HPV vaccine is recommended for women aged 11–26 years (n=299, 66.7%). Although the proportion of correct responses was higher among female students (69.3%) than among male students (60.6%), this difference did not reach statistical significance (χ^2=3.173, p=0.075). In contrast, knowledge of HPV vaccination recommendations for men was substantially lower than knowledge of recommendations for females. Only 32.1% (n=144) of participants correctly identified that HPV vaccination is also recommended for men aged 11–26 years. Approximately 65.2% (n=86) of male students and 69.0% (n=218) of female students either gave incorrect answers or stated that they were unaware of this practice (χ^2=0.618, p=0.432) (Table 2).

As students progressed through medical education, a statistically significant increase was observed in the proportion of correct responses regarding HPV vaccination recommendations. For indications related to women, the rate of correct responses increased from 55.9% in Period 1 to 74.9% in Period 3. Spearman's rho correlation analysis revealed a positive but weak correlation between academic year and knowledge of both male and female vaccination indications (p<0.001) (Table 3).

DISCUSSION

The findings of this study provide important insights into knowledge and gender-based gaps regarding the HPV vaccine among preclinical medical students. Despite the increasing global emphasis on gender-neutral vaccination, our results demonstrate lower awareness of HPV vaccination recommendations for males than for females. Our data revealed that the proportion of students correctly identifying the HPV vaccine indication for women was higher than that for men. This finding aligns with the broader sociocultural phenomenon described as the 'feminization of HPV'. Rather than indicating an inherent individual gender bias among the participants, this knowledge gap is more accurately interpreted as a structural reflection of how HPV vaccination has historically been framed within public health policies and healthcare systems, which have heavily emphasized cervical cancer prevention (1,2).

In our study, female students had a higher proportion of correct responses regarding HPV vaccination recommendations for women than male students; however, this difference was not statistically significant. This finding is consistent with a study by Costa et al. in Brazil (11). This trend may be related to the greater clinical and public health visibility of cervical cancer compared with HPV-associated diseases affecting men. However, the misconception that the HPV vaccine is exclusive to women may also reflect the historical emphasis of vaccination campaigns on cervical cancer prevention. Global vaccination campaigns and visual materials have predominantly featured female subjects, potentially reinforcing the perception that HPV vaccination is primarily a women's health intervention.

The gender disparity observed in our study may also reflect broader patterns in the scientific and public health discourse surrounding HPV. Although preclinical students in our study are exposed to information on HPV transmission and molecular mechanisms in microbiology, infectious diseases, and reproductive health modules, their knowledge of the specific vaccination recommendations for males appeared to be limited. This disparity suggests that current medical education may benefit from more explicit, gender-neutral coverage of vaccination recommendations, rather than relying primarily on the cervical cancer prevention framework.

Consistent with the findings of Emre et al., our study observed that knowledge of HPV vaccination recommendations increased as students progressed through their academic years (12). To examine this trend in more detail,

Table 2. Comparison of knowledge levels on HPV vaccination indications by gender.

	Male n (%)	Female n (%)	Total n (%)	χ^2	p
Recommended for females	80 (60.6%)	219 (69.3%)	299 (66.7%)	3.173	0.075
Recommended for males	46 (34.8%)	98 (31.0%)	144 (32.1%)	0.618	0.432

Table 3. Spearman's rho correlation matrix of academic period and HPV vaccination knowledge levels.

	Academic Period	Knowledge (Males)	Knowledge (Females)
Academic Period	1.000	.160**	.170**
Knowledge (Males)	.160**	1.000	.396**
Knowledge (Females)	.170**	.396**	1.000

Note: ** Correlation is significant at the 0.01 level (two-tailed).

we used Spearman's rho correlation, which showed a statistically significant positive correlation between academic year and knowledge of both male (p=0.001) and female (p<0.001) vaccination recommendations. However, the weak magnitude of these correlations is also noteworthy. This suggests that knowledge acquisition occurs gradually, but the progression through the current curriculum may be insufficient to ensure comprehensive awareness of gender-neutral HPV vaccination recommendations. The moderate positive correlation (p<0.001) found between knowledge about protocols for men and for women suggests that students who are well-informed about one aspect of vaccination tend to be better-informed about another aspect as well, but the overall baseline level remains low.

One of the main reasons for the low level of knowledge and the reported low HPV vaccination rate (estimated as 3.9%) in Türkiye is the absence of the HPV vaccine in the national vaccination program (13,14). The literature consistently identifies "lack of knowledge" as the leading cause of inadequate vaccination rates worldwide (15,16). Since healthcare provider recommendations are an important determinant of vaccination uptake, identifying and addressing knowledge gaps among future physicians during their training should be considered a public health priority.

This study has several limitations. First, the research was conducted as a single-center study at a private university in İstanbul, which may limit the generalizability of the findings to medical students at other universities and different regions of Türkiye. Second, the cross-sectional design allows for the identification of associations but does not permit the establishment of definitive causal relationships. Additionally, a formal prior power analysis was not conducted, which may limit the statistical power to detect very small effect sizes, although a high response rate from the eligible target population was achieved. Finally, although the response rate was high, self-reported data may lead to potential recall or social acceptability biases. To provide a more comprehensive understanding of gender-neutral HPV vaccination knowledge nationwide, future multicenter studies involving a more diverse sample of medical students are needed.

CONCLUSION

Increasing medical students' knowledge of vaccination programs is a fundamental step toward achieving primary prevention, which is a key objective of public health practice. As future physicians, medical students will play an important role in guiding the community regarding vaccination; therefore, it is essential that they possess comprehensive, evidence-based knowledge of targeted immunization strategies.

While HPV is often perceived as a pathogen primarily associated with women, HPV infection affects individuals of all genders, and men can both acquire and transmit the virus and develop HPV-associated diseases. Our study highlights that knowledge of HPV vaccination recommendations for males was lower than knowledge of recommendations for females among preclinical medical students. For HPV prevention strategies to be effective, vaccination should be approached as a gender-neutral public health intervention rather than solely as a component of women's health. Researchers and clinicians should therefore work to ensure that HPV vaccination is consistently presented as relevant to both sexes.

In conclusion, this study demonstrated that preclinical medical students had lower awareness of HPV vaccination recommendations for males than for females. These findings indicate the need to strengthen gender-neutral HPV vaccination education in undergraduate medical curricula. Future multicenter studies are needed to determine whether similar knowledge gaps exist among medical students in different educational and regional contexts. In the context of public health policies, shifting toward a gender-neutral vaccination discourse remains essential. Integrating the HPV vaccine into the National Immunization Program for both sexes in Türkiye represents a critical step toward achieving global HPV eradication strategies and comprehensive coverage in preventive medicine.

Ethical Approval: This study was approved by the Yeditepe University Faculty of Medicine Ethics Committee on April 17, 2023, with decision no. 2023/80-04.

Informed Consent: Informed consent was obtained from all participants.

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Sexual Offenses Against Sexual Inviolability in Türkiye: Judicial Statistics and Forensic Examination Coverage

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Abstract

Objective: In Türkiye, forensic examination of sexual assault victims is legally required to be performed by a physician, but no specific medical specialty or forensic training is mandated. In practice, it is often performed by obstetrician-gynecologists or general surgeons rather than forensic specialists. This study aimed to describe the relationship between prosecuted sexual offense cases and recorded forensic examinations and to review relevant physician training requirements.

Materials and Methods: Judicial statistics for Turkish Penal Code (TPC) Articles 102, 103, and 104, covering sexual offenses potentially requiring examination, were obtained from the Ministry of Justice's annual yearbooks for 2009–2025. Genital and anal examination counts from the Council of Forensic Medicine were obtained from the same source and were available only for 2009–2021. Prosecution and examination counts were independent aggregate datasets, not linked at the individual case level. The ratio of examinations to prosecutions was calculated descriptively for each year. Core curricula for obstetrics and gynecology, general surgery, emergency medicine, undergraduate education, and forensic medicine were reviewed.

Results: Prosecutions filed under Articles 102–104 rose from 20,566 in 2009 to 31,143 in 2019, then declined to 20,864 in 2025. The genital examination-to-prosecution ratio fell from 18.6% in 2009 to 7.1% in 2021, the last year with published data. The anal examination ratio rose from 1.8% to a peak of 14.2% in 2018, then declined to 4.7% in 2021. Neither obstetrics and gynecology nor general surgery curricula include competencies in forensic sample collection or chain of custody; emergency medicine includes related competencies only at the lowest level, whereas these competencies are addressed at the highest level in forensic medicine curricula.

Conclusion: The declining ratio suggests, but does not confirm, a growing share of examinations occurring outside the forensic medicine system. The specialties that may perform these examinations lack standardized forensic training, indicating that training is not systematically required rather than demonstrating that individual physicians lack training. Closing this gap requires structured training and dedicated response centers.

Keywords: Sexual assault, forensic examination, evidence collection, curriculum, clinical competence

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INTRODUCTION

The initial clinical encounter following a sexual assault is both a medical and a forensic event: the examining physician is responsible simultaneously for the patient's immediate care and for the accurate documentation and collection of findings that will underpin the subsequent judicial process. The integrity of this process depends on two interdependent factors, the professional conduct of the examination and its timeliness, since the opportunity to secure biological evidence diminishes rapidly with the passage of time (1). Because this evidentiary opportunity cannot be recreated once lost, the quality of the first examination effectively determines the maximum evidentiary value of the entire subsequent legal process (2).

Sexual violence against women is a global public health concern. The World Health Organization estimates that a substantial proportion of women worldwide experience non-partner sexual violence in their lifetime (3). In Türkiye, judicial statistics also reflect this burden. In 2025 alone, 76,694 case files were concluded under Articles 102–104 of the Turkish Penal Code (TPC), which address sexual offenses (4). Many of these files likely involve a clinical encounter in which a health worker was responsible for examining the victim, although not every file necessarily results in a physical examination. National research spanning more than two decades has documented the substantial psychological and social burden faced by victims following sexual assault (5).

In Türkiye, the examination of a sexual assault victim is governed by the Code of Criminal Procedure (CMK). Article 76 regulates the victim's body examination and sample collection, following the same general procedure as Article 75 for suspects (6). Article 77 adds one condition: a female victim should be examined by a female physician, if requested and where feasible (CMK Article 77). The law specifies a "physician." It does not specify a branch or forensic training requirements. In clinical practice, this gap has a direct consequence. Whichever physician is available at the institution performs the examination. Commonly, this is an obstetrician-gynecologist, a general surgeon, or an emergency physician. The examiner is selected by anatomical jurisdiction, not forensic competency. Article 102 of the TPC distinguishes the base offense from its aggravated forms, with prosecution requirements varying accordingly (7).

The national core curriculum for obstetrics and gynecology specialty training (Tıpta Uzmanlık Kurulu Müfredat Oluşturma ve Standart Belirleme Sistemi [TUKMOS]) confirms this gap. The curriculum defines competencies for genital trauma and for pediatric-adolescent sexual abuse. It defines no competencies in forensic sample collection, sample sequencing, or chain of custody in adult sexual assault cases. Forensic medicine specialists receive specific training in these areas. In practice, most cases may never reach them (8).

The present study had two aims. First, it presents a descriptive analysis of judicial statistics for TPC Articles 102, 103, and 104 in Türkiye from 2009–2025, covering sexual offenses that may involve a genital or anal examination. It compares these data with the number of forensic genital and anal examinations conducted by the Council of Forensic Medicine (CFM) over the same period. This comparison yields the ratio of forensic examinations to prosecutions filed in the same calendar year. Second, drawing on national and international literature, the study discusses what this gap means for evidentiary quality. It argues for structured forensic training for the clinicians who, in current practice, may perform most of these examinations. The design of a specific training curriculum lies beyond the scope of this study. It is addressed in separate ongoing research.

MATERIALS AND METHODS

This study has two components. The first is a descriptive, retrospective analysis of national judicial and forensic statistics. The second is a narrative review of national and international literature. No inferential or significance testing was performed. The aim is to describe patterns, not to test hypotheses about their causes.

Judicial statistics were obtained from the Ministry of Justice, Directorate General for Judicial Records and Statistics. These are published annually as *Justice Statistics* (Adalet İstatistikleri) and are available in full in the Ministry's publication archive (9). Judicial data were available for 2009–2025. Forensic examination counts were also drawn from the same yearbooks, but were available only for 2009–2021.

Articles 102, 103, and 104 of the TPC were included, together comprising the offenses that may involve a genital or anal examination and biological sample collection. Article 105 (sexual harassment) does not typically involve this process, so it was excluded. Genital and anal (livata) examination counts, as reported in the yearbooks, are not disaggregated by victim age or by the specific TPC article under which the case was prosecuted; the denominator was therefore defined at the level of these three articles combined, to match the population represented by the examination counts (10).

Genital and anal examination counts were treated as two separate series, since a single victim may receive

Table 1. Case files and forensic examination counts under TPC Articles 102–104, 2009–2025.

Year	Total case files (TPC 102+103+104)	Decision of no grounds for prosecution	Public prosecution filed	Other* decisions	CFM¥ genital examinations	CFM¥ anal examinations	Genital examination %	Anal examination %
2009	46,495	14,875	20,566	11,054	3,818	360	19	2
2010	58,617	19,778	25,265	13,574	4,877	337	19	1
2011	64,076	21,802	27,017	15,257	3,973	131	15	1
2012	66,504	22,633	28,117	15,754	4,068	475	15	2
2013	68,023	23,778	28,049	16,196	2,192	872	8	3
2014	63,653	23,833	25,252	14,568	2,344	1,474	9	6
2015	63,345	24,325	24,349	14,671	2,204	1,326	9	5
2016	56,945	22,553	20,914	13,478	1,813	1,521	9	7
2017	66,449	29,925	21,110	15,414	2,521	1,938	12	9
2018	90,925	44,299	26,419	20,207	2,881	3,763	11	14
2019	105,667	50,961	31,143	23,563	2,425	2,000	8	6
2020	84,728	41,208	24,214	19,306	1,730	1,326	7	6
2021	93,721	44,740	26,655	22,326	1,896	1,256	7	5
2022	-§	-	-	-	-	-	-	-
2023	86,276	43,132	23,694	19,450	-	-	-	-
2024	84,320	43,474	22,732	18,114	-	-	-	-
2025	76,694	40,002	20,864	15,828	-	-	-	-

* Other decisions include lack of jurisdiction, referral to another court, merger with another case file, and transfer to another unit, as categorized in the Ministry of Justice yearbooks.
CFM: Council of Forensic Medicine of Türkiye, **TPC:** Turkish Penal Code.
§ "-" sign means no available data.
Note: Genital and anal examination percentages are calculated from independent annual administrative totals (CFM examination counts and Ministry of Justice prosecution counts) and do not represent case-linked proportions.

both examinations and summing them would risk double-counting. A comparison of pre- and post-2013 *Adalet İstatistikleri* examination category lists confirmed that "genital examination" and "anal examination" were reported as continuously defined categories throughout the study period. The 2013 reporting reorganization regrouped sex-offense-related categories under a new heading and cross-referenced them to their corresponding TPC articles, without altering the definition of these two examination types.

All figures are presented descriptively. For each year, we report the total number of case files concluded under Articles 102–104, the number resulting in a public prosecution, and the corresponding counts of forensic genital and anal examinations. To assess the relationship between prosecuted cases and forensic examinations, we calculated the ratio of forensic examinations to public prosecutions for each year.

Relevant literature was identified through targeted searches of the Scite database, using terms related to each specific topic addressed in the Discussion (e.g., examiner training and forensic evidence quality, sexual assault nurse examiner (SANE) / sexual assault response team (SART) / sexual assault referral centre (SARC) models, and national judicial and forensic medicine practice). No systematic search protocol, database combination, or formal inclusion/exclusion screening was applied, consistent with the narrative, rather than systematic, nature

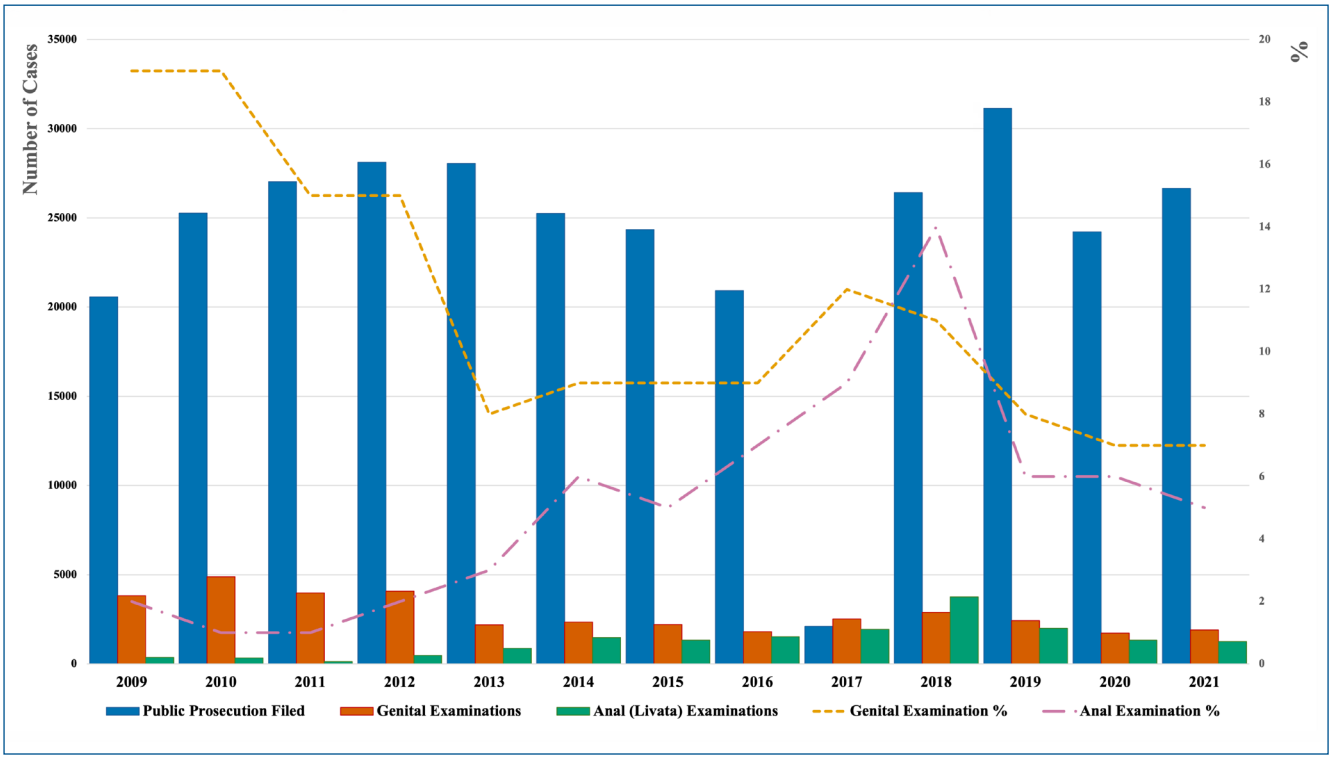

FIGURE 1. Trends in public prosecutions filed and forensic examination rates under TPC Articles 102–104, 2009–2021.

of this review component. No date restriction was applied; recency was prioritized where multiple relevant sources were available. Sources in Turkish and English were both eligible for inclusion, reflecting the study's dual national and international scope.

RESULTS

Data were obtained from the Ministry of Justice's Justice Statistics archive, covering the period from 2009 to 2025. No figures were available before 2009. Articles 102, 103, and 104 of the TPC were reported as distinct categories in every year except 2022. In 2022, only the combined total for Articles 102–105 was published, and 2022 was therefore excluded from the combined series. The combined 102–105 totals for 2021, 2022, and 2023 were 127,297; 118,959; and 118,900, respectively. These totals were 6.5% lower in 2022 than in 2021 and were nearly identical in 2022 and 2023. However, this comparison does not establish that the distribution of cases across the four articles remained stable; therefore, the combined 102–1105 total was not used to derive article-specific values for 2022. The surrounding years, 2021 and 2023, were retained in the main series.

The total number of case files concluded under Articles 102–104 rose from 46,495 in 2009 to a peak of 105,667 in 2019. It then declined, with year-to-year fluctuation, to 76,694 in 2025. The number of files resulting in a public prosecution followed a similar pattern, from 20,566 in 2009 to a peak of 31,143 in 2019, declining to 20,864 in 2025 (Table 1).

According to the figures reported in the Justice Statistics yearbooks, the CFM conducted between 1,730 and 4,877 genital examinations per year, from 2009 to 2021. There was no sustained upward or downward trend. Anal (livata) examination counts followed a different pattern. They rose from 360 in 2009 to a peak of 3,763 in 2018, then declined to 1,256 in 2021 (Table 1). Figures for both examination types were not published after 2021.

The ratios represent two independently reported annual administrative series and do not reflect case-level linkage between individual prosecutions and examinations. Accordingly, they should not be interpreted as the percentage of prosecuted victims examined by the CFM.

The ratio of genital examinations to public prosecutions fell from 18.6% in 2009 to 7.1% in 2021. The ratio of anal (livata) examinations rose from 1.8% in 2009 to a peak of 14.2% in 2018, before declining to 4.7% in 2021, as presented in Table 1 and Figure 1. Figure 1 illustrates these trends over the study period. The gap between public prosecutions filed and forensic examinations conducted persisted throughout most of the study period.

DISCUSSION

The number of case files concluded under TPC Articles 102–104 followed a fluctuating course between 2009 and 2025. It rose overall from 46,495 to 76,694 (Table 1). These articles apply to sexual assault, child sexual abuse, and sexual intercourse with a minor, respectively. Prosecution ordinarily requires a complaint. In aggravated forms of these offenses, however, a public prosecution proceeds independently of complaint. These aggravated cases are also more likely to require a genital or anal examination and the collection of biological evidence. In 2009, the number of genital examinations conducted by the CFM corresponded to 18.6% of the public prosecutions filed that year. By 2021, the last year with available forensic examination data, this ratio had fallen to 7.1%. This decline may indicate that the examination of these cases shifted, at least in part, from forensic medicine units to hospital-based units. In hospitals, this examination may be performed by a forensic medicine specialist, where one is available, or by a physician from another specialty, most commonly obstetrics and gynecology or general surgery.

This distinction matters because examiner training may affect evidence quality. A systematic review comparing forensic nurse examiners with non-specialist physicians found that examiner training was associated with more complete forensic evidence collection (11). Corum and Carroll (12) reported that forensic laboratory analysts observed higher-quality specimens from trained examiners than from untrained providers. Trained examiners were also associated with a greater likelihood that cases proceeded through prosecution (13). These findings apply to genital examination generally. They do not depend on the examiner's underlying specialty. A physician who is skilled in female pelvic anatomy is not, by that skill alone, skilled in forensic sample collection, sequencing, or chain-of-custody documentation. The two competencies are related but distinct. Non-standardized examination and documentation have also been noted to complicate subsequent forensic psychiatric evaluation in Turkish sexual assault cases (14).

An alternative, non-training-related explanation should also be considered. Law No. 6545 (2014) added a lower-severity "sarkıntılık" subtype to TPC Article 102/1. This subtype does not typically involve genital or anal examination. Its addition may have broadened the pool of public prosecutions filed under Article 102, diluting the examination ratio independently of any change in referral or examiner behavior. The available yearbook data do not permit disaggregation of this subtype from the broader Article 102 total, so this explanation cannot be quantified, but it cannot be excluded either.

Victim consent is also a relevant factor. A victim may decline a genital or anal examination even where one is clinically indicated, independent of examiner availability, specialty, or training. This factor may account for part of the observed decline but does not alter the interpretation regarding examiner training, since declined consent is unrelated to which specialty is available to conduct the examination.

National specialty training does not close this gap. The core curriculum for obstetrics and gynecology (TUKMOS) defines competencies for genital trauma and for pediatric-adolescent sexual abuse. It defines no competency for forensic sample collection, sample sequencing, or chain-of-custody procedures in adult sexual assault cases (15). A specialist trained under this curriculum is trained to diagnose and treat genital injury. Training in the forensic documentation of that injury is not part of the program. This reflects an absence of a standardized curriculum requirement, not a judgment about individual physicians' skills; some physicians may acquire relevant competence informally, through rotations, institutional protocols, or accumulated clinical experience, but this is not systematically ensured or verified. The core curriculum for general surgery shows the same pattern. It contains no reference to the management of sexual assault cases (16). Two specialties commonly tasked with this examination in practice are, by their own national training standards, not specifically prepared for it.

The core curriculum for emergency medicine differs from the other two specialties. It includes a competency labeled "evaluation of sexual abuse cases" ("cinsel istismar olgusunun değerlendirilmesi"), along with "appropriate sample collection" under a forensic matters heading. However, three qualifications apply. First, "cinsel istismar" (sexual abuse) is the terminology conventionally used for child victims in Turkish medical and legal usage, distinct from "cinsel saldırı" (sexual assault, TPC Article 102, adult victims); the competency's applicability to adult forensic examination is therefore unclear. Second, both competencies are defined at the lowest proficiency level (Level 1: knowledge of the procedure and ability to explain it, not independent performance), in contrast to competencies such as forensic record-keeping, which are defined at the highest level (Level 4: independent performance in any case). Third, the curriculum does not include chain-of-custody documentation or sample sequencing as separate, higher-level competencies. Emergency medicine training therefore acknowledges this domain in principle, but does not develop it to a level of independent clinical competency (17).

This gap in proficiency level is itself a significant finding. A physician who may be called upon to conduct a

forensic genital examination and collect legally admissible evidence is, by the curriculum's own standard, only required to reach the level of being able to explain the procedure, not to perform it independently. This mismatch between clinical responsibility in practice and the formal competency level required by training reflects the same underlying problem identified throughout this study: the absence of a forensic examination competency proportionate to the responsibility physicians actually carry.

Neither obstetrics and gynecology nor general surgery includes this training, and emergency medicine addresses it only at the lowest proficiency level. Forensic medicine specialists receive such training, but their numbers remain limited relative to national need (18). The forensic medicine core curriculum defines "sexual abuse and sexual assault cases" as a clinical competency at the highest proficiency level (independent case management), and defines sample collection, physical examination, and documentation/chain-of-custody as interventional competencies at the highest level (independent performance in any case), in clear contrast to the fragmented, low-level competencies found in the other specialties reviewed (8). One alternative exists elsewhere. Several health systems train and certify non-physician specialists specifically for this task: forensic nurses and forensic midwives. A physician typically remains involved in a supervisory role. Hands-on examination and sample collection, however, are performed by personnel trained and credentialed specifically for this purpose.

At the undergraduate level, the National Core Curriculum for Pre-Graduation Medical Education (UÇEP-2020) includes several relevant but fragmented competencies: "forensic case examination," "evidence recognition, preservation, and transfer," and "vaginal and cervical sample collection," each defined at an intermediate proficiency level (Level 2–3 of 4, corresponding to guided or routine-case performance, not independent management of complex cases). "Sexual assault" also appears as a listed topic within the curriculum's Behavioral, Social, and Human Sciences component, without a corresponding clinical or procedural competency level. No single, named competency for sexual assault forensic examination exists at the undergraduate level. These fragments provide a general foundation, but not a specific, assessable competency for this task, and they precede specialty training in any case.

The Sexual Assault Nurse Examiner (SANE) model, developed in the United States, trains registered nurses specifically in forensic examination and evidence collection for sexual assault cases (19). These SANEs typically work within a Sexual Assault Response Team (SART), a coordinated group that includes law enforcement, prosecutors, and victim advocates alongside the examiner (20). In the United Kingdom, Sexual Assault Referral Centres (SARCs) provide a parallel structure: a single site where forensic examination, medical care, and psychosocial support are delivered together, often by forensic physicians working alongside trained nurses (21). A systematic review found that trained non-physician examiners performed comparably to physicians in forensic evidence collection, with some evidence of shorter waiting times for examination (11). These models developed within legal systems that permit non-physician forensic examiners to perform this role. In Türkiye, CMK Article 76 restricts this examination to a physician. Adoption of a nurse- or midwife-led examiner model would therefore require legislative amendment; under the current legal framework, it is not achievable through training or institutional reorganization alone.

Türkiye already has a precedent for this kind of structure. The national action plan against violence against women (2016–2020) called for centers that combine statement-taking, forensic examination, and psychological support under one roof for victims of sexual violence (22). Child Monitoring Centers (ÇİM) and Violence Prevention and Monitoring Centers (ŞÖNİM) already operate on this model, for child abuse and domestic violence, respectively. The same logic applies to adult sexual assault. What is needed is not a collection of scattered examiners, each acting alone. It is a small number of standing centers, staffed continuously, where trained personnel remain in place regardless of individual turnover. This requires formal regulation. That regulation should define the qualifications of the examining personnel, the sequence of evidence collection, and the chain-of-custody procedure, as a binding national standard.

The curriculum review points to a clear training gap. Obstetrics and gynecology and general surgery do not include forensic examination and sample collection in their core curricula. Emergency medicine addresses related competencies only at the lowest proficiency level. Undergraduate training offers only fragmented, intermediate-level competencies. Forensic medicine defines this domain at the highest proficiency level, but its workforce remains too small to cover national need. The statistical trend reported above shows a possible implication of this gap: as public prosecutions filed under TPC Articles 102–104 increasingly outpaced examinations conducted within the forensic medicine system, a growing share of cases may have been examined by physicians without this specific training.

Limitations

This study has several limitations. Prosecution and examination counts were obtained from independent aggregate administrative datasets and could not be linked at the individual case level. Judicial data were not available

before 2009; the study period could not be extended to 2000, as originally intended. Forensic examination data were available only for 2009–2021; publication of these figures stopped thereafter, limiting the ratio analysis to this earlier period. For 2022, TPC Articles 102, 103, and 104 were not reported separately; only a combined total for Articles 102–105 was published. Article-specific values for 2022 could not be verified or estimated from this combined total and were therefore treated as missing. The examination and public prosecution counts used in the ratio calculation are drawn from the same calendar year, but the two events do not necessarily occur within the same year for a given case. This may introduce a structural mismatch, which cannot be quantified with the available case-level data. This study is descriptive. No inferential or significance testing was performed, and no causal claim is made regarding the observed patterns.
The judicial statistics used in this study report case files at the level of the TPC article (102–104), not at the level of the specific subsection. A more restrictive denominator limited to subsections explicitly involving penetration (e.g., TPC 102/2) could not be constructed with the available data. The "public prosecution filed" category was retained as the closest available proxy, since these cases have passed an evidentiary threshold and are more likely to involve a genital or anal examination than cases resulting in a decision of no grounds for prosecution.

The interpretation that examinations may have shifted toward hospital-based, non-forensic-medicine settings is inferential. It is drawn from the aggregate relationship between prosecution and examination counts over time, not from case-level data identifying examination location or examiner specialty. This interpretation should be read as a plausible explanation for the observed pattern, not as a confirmed finding.

Whether a single victim could be represented more than once within the same examination category (for example, through a repeat examination for the same case) cannot be verified with the aggregate data available and is not excluded.

Finally, the curriculum review reflects the formal content of national training programs. It does not directly measure individual physicians' actual clinical competence, examination quality, or chain-of-custody compliance in practice.

CONCLUSION

This study described the relationship between prosecuted sexual offense cases and forensic examination in Türkiye, and situated this pattern within the training available to the physicians who perform these examinations. The findings address both aims. The ratio of CFM-recorded genital and anal examinations to annual public prosecutions filed under TPC Articles 102–104 declined over the study period, based on independently reported annual administrative series. Whether this decline reflects an actual shift of examinations toward hospital-based, non-forensic-medicine settings is a plausible but unconfirmed interpretation, since the two datasets could not be linked at the individual case level. The core curricula of the specialties that may be responsible for these examinations in practice show an absence of explicit, standardized forensic sample collection competencies; this does not establish that practicing specialists in these fields are individually untrained, but it does indicate that such training is not systematically required or verified. Anatomical competence is not, by itself, forensic competence. Closing this gap is a matter of training and structure, not of restricting who may perform the examination.

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Informed Consent: Not applicable.

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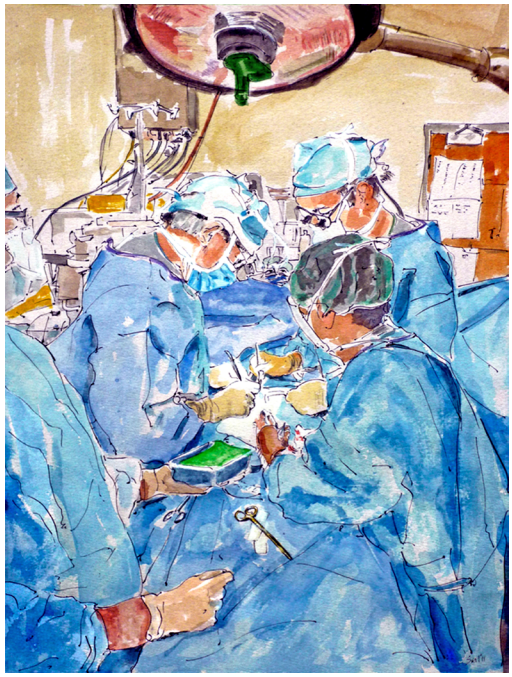
Dr. Andrew Seal

Dr. Andrew Seal, a proud husband, father, and grandfather, is Associate Professor Emeritus in the Department of Surgery at the University of British Columbia. He graduated from Guy's Hospital Medical School in London, England, in 1969 and came to Canada in 1975 to join the UBC General Surgery Residency Program, becoming a Fellow of the Royal College of Physicians and Surgeons of Canada in 1979. Dr. Seal joined the UBC Department of Surgery in 1981 and became a staff member at the UBC Health Sciences Centre Hospital, where he practiced until 2003, when he moved to St. Paul's Hospital and remained there until his retirement in 2010. In 1994, Dr. Seal was appointed the first Associate Dean of Student Affairs in the Faculty of Medicine. During his tenure, he initiated the annual medical student Spring Gala concerts and organized the first student, faculty, and alumni art exhibitions. On completion of his term in 1999, he became a visiting scholar at St. Catharine's College, Cambridge, where he studied the linkages between the history of medicine and the history of art. Outside medicine, Dr. Seal is an artist himself, having attended art school in England, and from 1982 to 1987, the Emily Carr College of Art and Design in Vancouver, as a part-time student. Among Dr. Seal's academic awards and distinctions, he received a Killam Teaching Prize in 2000, the Faculty of Medicine's Career Award for Excellence in Clinical Teaching in 2008, and the William Webber Award from the UBC Medical Undergraduate Society in 2010. Since his retirement, Dr. Seal enjoys providing surgical assistance to his colleagues at St. Paul's Hospital, occasional undergraduate and postgraduate teaching, and painting in his art studio at home, but most importantly spending time with his three beautiful grandchildren.



COVER "Self-portrait from my last operation before retiring as a general surgeon", 2011. Watercolor and ink on paper by Dr. Andrew Seal.

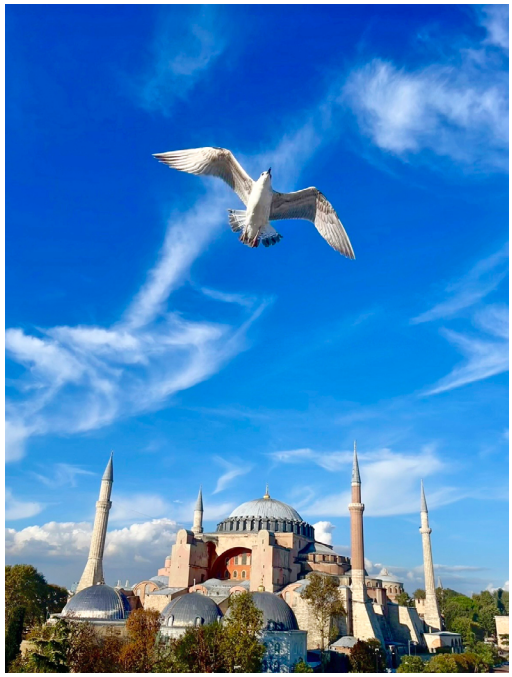


PHOTO. Hagia Sophia, Istanbul, 2023. Photograph by Dr. Andrew Seal.