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Use of Lateral Teleradiography in Sex Estimation for Forensic Purposes: a Systematic Review

Upotreba bočne teleradiografije za procjenu spola u forenzičke svrhe: sustavni pregled

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Abstract
Methods that use lateral teleradiography for sex estimation need to be discussed considering their feasibility and applicability in forensic cases. **Purpose:** The aim of this study was to conduct a systematic review about the use of lateral teleradiography for sex estimation in adults. **Methods:** A search was conducted on Embase, PubMed/MEDLINE, Scopus, Lilacs, Scielo, and Web of Science databases. The search results were exported to Rayyan (https://www.rayyan.ai/). Subsequently, two independent reviewers applied eligibility criteria to select studies related to the topic, resulting in nine studies. Regarding the risk of bias, the checklist recommended by The Joanna Briggs Institute was applied. The risk of bias in all selected studies was considered low. **Results:** However, a meta–analysis could not be performed, as there was no standardization in the way the data were presented. Regarding the included studies, it was noted that the samples came from six countries and that the studies presented methodological discrepancies regarding the measurements used in the analyses. As a result, the accuracy rates varied from 56.3% to 99.0%. **Conclusion:** It is concluded that lateral cephalometric radiography can support sex estimation in adults, especially in settings with limited resources. However, due to variations in measurement methods and landmarks across studies, future research should adopt standardized and more rigorous methodologies to strengthen its scientific validity.

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Introduction

The biological profile in Forensic Anthropology can be carried out through the application of methods that estimate sex, age, stature, and ancestrality in order to reduce the number of potential victims and contribute to the human identification process (1,2). The first step in this process is the determination of the species, followed by the subsequent estimates (2,3). However, in this context, estimating sex after species determination becomes crucial, as the result can be decisive for other estimation methodologies that will be employed (1,2).

Concerning sex estimation in humans, the methods used for this purpose are based on dimorphic characteristics between the sexes, which are presented through morphological, biochemical, and metric differences in the skeleton (3-7). There are both qualitative and quantitative methodologies that consider different anatomical regions; however, bones

Uvod

Biološki profil u forenzičkoj antropologiji može se dobiti primjenom metoda kojima se procjenjuju spol, dob, visina i podrijetlo kako bi se smanjio broj potencijalnih žrtava i pridonijelo procesu identifikacije ljudi (1, 2). Prvi korak u tom procesu jest određivanje vrste, nakon čega slijede naknadne procjene (2, 3). No u ovom kontekstu procjena spola poslije određivanja vrste postaje ključna zato što rezultat može biti odlučujući za druge metodologije i procjene koje će se koristiti (1, 2).

Kad je riječ o procjeni spola ljudi, metode koje se upotrebljavaju temelje se na dimorfnim karakteristikama između spolova koje se prikazuju na temelju morfoloških, biokemijskih i metričkih razlika u kosturu (3 – 7). Postoje i kvalitativne i kvantitativne metodologije kojima se uzimaju u obzir različita anatomska područja; međutim, često se koriste kosti poput zdjelice, lubanje, pa čak i duge kosti zbog ista-

such as the pelvis, skull, and even long bones, due to their pronounced sexual dimorphism patterns, are frequently used (3,4). Regarding the skull, quantitative approaches consist in measurements of cranial landmarks, as well as the development of statistical models (8,9). On the other hand, qualitative methods rely on observation and comparisons of the skull and teeth morphology (5, 10, 11).

The use of skull radiographs to assess and compare the measurements formed by cranial landmarks between male and female individuals has been applied, for example, teleradiography that showed significant results when analyzed for sexual dimorphism (5, 12-14).

Nevertheless, it is known that imaging techniques such as computed tomography and magnetic resonance imaging are considered advanced and can provide extensive anatomical detail. However, considering that lateral cephalometric radiography is still widely used in educational and clinical settings, particularly in countries and regions where access to more sophisticated techniques and methodologies is hindered by socioeconomic factors, it stands out as a low-cost alternative and a potential solution (15, 16).

Thus, the use of lateral teleradiography in forensic contexts becomes relevant due to its accessibility and frequent use in dental clinics (15). It is well known that, in cases where an individual's identity is being investigated, it is common for forensic professionals, such as experts, to request dental examinations and records from dentists (17-19). Among the dental records provided, lateral teleradiographs are frequently included, especially in the field of orthodontics (20, 21). Therefore, considering the importance of sex estimation in forensic cases, as well as the common use of radiographic exams, it is essential to evaluate the methods using lateral teleradiography, along with the approaches conducted through this exam to estimate sex. Therefore, this study aimed to conduct a systematic review of the use and approaches carried out through lateral teleradiographs for sex estimation in adults.

Materials and methods

This systematic review was registered in the International Prospective Register of Systematic Reviews (PROSPERO) under the number CRD42023461303. Searches were conducted using keywords in the Descriptors in Health Sciences (DeCS), Medical Subject Headings (MeSH), and Embase Subject Headings (Emtree), with the results including "Forensic Dentistry", "Sex Determination by Skeleton", "Sex Determination", "Cephalometry", and "Radiography".

These keywords were combined using Boolean operators, thus forming the search equations for the databases Embase, PubMed/MEDLINE, Scopus, Lilacs, Scielo, and Web of Science described in Table 1. The search results were entered into the Rayyan app (https://www.rayyan.ai/) to perform a screening of the studies and remove duplicates. The search for studies was conducted on January 8th, 2025, in English, Spanish, and Portuguese, with no restriction on the year of publication.

The PICO strategy was followed: P – Population, I – Intervention, C – Comparison, and O – Outcome. Thus, the

knutih obrazaca spolnog dimorfizma (3, 4). Što se tiče lubanje, kvantitativni pristupi sastoje se od mjerenja kranijalnih orijentira, i na izradi statističkih modela (8, 9). Istodobno, kvalitativne metode oslanjaju se na promatranje i usporedbe morfologije lubanje i zuba (5, 10, 11).

Pri korištenju rendgenskih snimki lubanje za procjenu i usporedbu mjerenja dobivenih kranijalnim orijentirima između muških i ženskih osoba primijenjena je, primjerice, teleradiografija koja je pokazala značajne rezultate u analizi spolnog dimorfizma (5, 12 – 14).

Ipak, poznato je da se tehnike snimanja, poput računalne tomografije i magnetske rezonancije, smatraju naprednima i mogu pružiti opsežne anatomske detalje. No s obzirom na to da se lateralna cefalometrijska radiografija još uvijek često koristi u obrazovnim i kliničkim okruženjima, posebno u zemljama i regijama u kojima je pristup sofisticiranijim tehnikama i metodologijama otežan zbog socioekonomskih čimbenika, ističe se kao jeftinija alternativa i potencijalno rješenje (15, 16).

Zato korištenje lateralne teleradiografije u forenzičkim kontekstima postaje relevantno zbog dostupnosti i česte upotrebe u stomatološkim klinikama (15). Dobro je poznato da je u slučajevima kada se istražuje identitet pojedinca uobičajeno da forenzički stručnjaci, poput vještaka, zatraže stomatološke preglede i zapise stomatologa (17 – 19). Među dostavljenim stomatološkim zapisima česte su lateralne teleradiografske snimke, posebno u području ortodoncije (20, 21). Zato, s obzirom na važnost procjene spola u forenzičkim slučajevima i na uobičajenu upotrebu radiografskih pregleda, bitno je procijeniti metode za primjenu teleradiografija zajedno s pristupima provedenim u ovom pregledu za procjenu spola. Stoga je svrha ove studije bila obaviti sustavni pregled upotrebe i pristupa provedenih na temelju lateralnih teleradiografskih snimki za procjenu spola kod odraslih.

Materijali i metode

Ovaj sustavni pregled upisan je u Međunarodni prospektivni registar sustavnih pregleda (PROSPERO) pod brojem CRD42023461303. Pretrage su obavljene s pomoću ključnih riječi u deskriptorima u zdravstvenim znanostima (DeCS), medicinskim predmetnim naslovima (MeSH) i embaseovim predmetnim naslovima (Emtree), a rezultati uključuju sljedeće sintagme: *forenzička stomatologija*, *određivanje spola na temelju skeleta*, *određivanje spola* te *cefalometrija* i *radiografija*.

Te ključne riječi kombinirane su s pomoću Booleovih operatora, čime su stvorene jednadžbe pretraživanja za baze podataka Embase, PubMed/MEDLINE, Scopus, Lilacs, Scielo i Web of Science opisane u tablici 1. Rezultati pretraživanja uneseni su u aplikaciju Rayyan (https://www.rayyan.ai/) kako bi se obavio pregled studija i uklonili duplikati. Pretraživanje studija obavljeno je 8. siječnja 2025. na engleskome, španjolskome i portugalskome jeziku, bez ograničenja godine objave.

Slijedila se strategija PICO: P – populacija, I – intervencija, C – usporedba i O – ishod. Zato su za ovaj sustavni pre-

Table 1 Quantity of studies found according to the database, search language, and search equations used.

Database	Search language	Search equations	Quantity of studies found
Embase	Portuguese	(('odontologia legal' OR 'odontologia forense') AND 'estimativa de sexo' OR 'determinação de sexo' OR 'predição de sexo' OR 'estimativa de gênero') AND cefalografia OR cefalometria OR 'telerradiografia lateral'	3
	English	(('forensic odontology'/exp OR 'forensic odontology' OR 'forensic dentistry') AND 'sex estimation' OR 'sex determination' OR 'sex prediction' OR 'gender estimation') AND cephalograph OR cephalography OR 'lateral teleradiograph' OR 'lateral teleradiography'	63
	Spanish	(('odontología forense' OR 'odontología legal') AND 'estimación del sexo' OR 'determinación del sexo' OR 'predicción del sexo' OR 'estimación de género') AND cefalografia OR cefalometrie OR 'telerradiografía lateral'	0
LILACS	Portuguese	(„Odontologia legal") OR („Odontologia forense") AND („Estimativa de sexo") OR („Determinação de sexo") OR („Predição de sexo") OR („Estimativa de gênero") AND (Cefalografia) OR (Cefalometria) OR („Telerradiografia lateral")	0
	English	(„Forensic odontology") OR („Forensic dentistry") AND („Sex estimation") OR („Sex determination") OR („Sex prediction") OR („Gender estimation") AND (Cephalograph) OR (Cephalography) OR („Lateral teleradiograph") OR („Lateral teleradiography")	1
	Spanish	(„Odontología forense") OR („Odontología legal") AND („Estimación del sexo") OR („Determinación del sexo") OR („Predicción del sexo") OR („Estimación de género") AND (Cefalografia) OR (Cefalometrie) OR („Telerradiografía lateral")	0
PubMed/MEDLINE	Portuguese	(((((((„Odontologia legal") OR („odontologia forense")) AND („Estimativa de sexo")) OR („determinação de sexo")) OR („Predição de sexo")) OR („estimativa de gênero")) AND (Cefalografia)) OR (Cefalometria)) OR („Telerradiografia lateral")	55
	English	(((((((„Forensic odontology") OR („Forensic dentistry")) AND („Sex estimation")) OR („Sex determination")) OR („Sex prediction")) OR („Gender estimation")) AND (Cephalograph)) OR (Cephalography)) OR („Lateral teleradiograph")) OR („Lateral teleradiography")	143
	Spanish	(((((((„Odontología forense") OR („Odontología legal")) AND („Estimación del sexo")) OR („Determinación del sexo")) OR („Predicción del sexo")) OR („Estimación de género")) AND (Cefalografia)) OR (Cefalometrie)) OR („Telerradiografía lateral")	6
SciELO	Portuguese	(„Odontologia legal") OR („Odontologia forense") AND („Estimativa de sexo") OR („Determinação de sexo") OR („Predição de sexo") OR („Estimativa de gênero") AND (Cefalografia) OR (Cefalometria) OR (Telerradiografia lateral)	0
	English	(„Forensic Dentistry") OR („Forensic Odontology") AND („Sex estimation") OR („Sex determination") OR („Sex prediction") OR („Gender estimation") AND (Cephalograph) OR (Cephalography) OR (Lateral teleradiograph) OR (Lateral teleradiography)	1
	Spanish	(„Odontología forense") OR („Odontología legal") AND („Estimación del sexo") OR („Determinación del sexo") OR („Predicción del sexo") OR („Estimación de género") AND (Cefalografia) OR (Cefalometrie) OR (Telerradiografía lateral)	0
Scopus	Portuguese	(ALL („Odontologia legal") OR ALL („Odontologia forense") AND ALL (estimativa AND de AND sexo) OR ALL („Determinação de sexo") OR ALL („Predição de sexo") OR ALL („Estimativa de gênero") AND ALL (cefalografia) OR ALL (cefalometria) OR ALL („Telerradiografia lateral"))	0
	English	(ALL („Forensic odontology") OR ALL („Forensic dentistry") AND ALL („Sex estimation") OR ALL („Sex determination") OR ALL („Sex prediction") OR ALL („Gender estimation") AND ALL (cephalograph) OR ALL (cephalography) OR ALL („Lateral teleradiograph") OR ALL („Lateral teleradiography"))	6
	Spanish	(ALL („Odontología forense") OR ALL („Odontología legal") AND ALL („Estimación del sexo") OR ALL („Determinación del sexo") OR ALL („Predicción del sexo") OR ALL („Estimación de género") AND ALL (cefalografia) OR ALL (cefalometrie) OR ALL („Telerradiografía lateral"))	0
Web of Science	Portuguese	(((((((ALL=(„Odontologia legal")) OR ALL=(„Odontologia forense")) AND ALL=(„Estimativa de sexo")) OR ALL=(„Determinação de sexo")) OR ALL=(„Predição de sexo")) OR ALL=(„Estimativa de gênero")) AND ALL=(Cefalografia)) OR ALL=(Cefalometria)) OR ALL=(„Telerradiografia lateral")	1
	English	(((((((ALL=(„Forensic Dentistry")) OR ALL=(„Forensic Odontology")) AND ALL=(„Sex estimation")) OR ALL=(„Sex prediction")) OR ALL=(„Gender estimation")) AND ALL=(Cephalograph)) OR ALL=(Cephalography)) OR ALL=(„Lateral teleradiograph")) OR ALL=(„Lateral teleradiography")	245
	Spanish	(((((((ALL=(„Odontología forense")) OR ALL=(„Odontología legal")) AND ALL=(„Estimación del sexo")) OR ALL=(„Determinación del sexo")) OR ALL=(„Predicción del sexo")) OR ALL=(„Estimación de género")) AND ALL=(cefalografia)) OR ALL=(cefalometrie)) OR ALL=(„Telerradiografía lateral")	0

studies selected for this systematic review were those that described participants (P), who had their biological sex known to the researchers through documentary records (I), whose cephalometric points were assessed through lateral teleradiography (C), aiming to estimate the participants' sex (O). Based on the PICO strategy, the following question was formulated: What is the accuracy of methods using lateral teleradiographs to estimate sex in forensic contexts?

With the studies on Rayyan app and duplicates removed, the first selection was made based on the study titles, and the second on the abstracts. Subsequently, the third selection was carried out through a full reading of each study. All selection steps were performed independently by two researchers and, in case of doubt regarding the inclusion of a study, a third evaluator guided the decision–making process. Studies that did not aim to estimate sex through lateral teleradiography were excluded, as well as publications from scientific conferences, literature reviews, book chapters, and case reports.

To assess the quality of the methodology applied by each selected study, the Critical Appraisal Checklist for Analytical Cross Sectional Studies from The Joanna Briggs Institute[21] was used. Regarding the responses on the checklist, there were four possible options: "yes", "no", "unclear", and "not applicable" which were ultimately used to assess whether the risk of bias was low, medium, or high. Each response was assigned a previously standardized score, resulting in a percentage. If the percentage was below 49%, the risk of bias was defined as high; between 50% and 69%, as moderate; and 70% or above, the risk was considered low.

Results

The search on September 4, 2023 in six databases resulted in 524 studies, and 199 duplicate were identified and removed. The quantity of studies that proceeded to the subsequent evaluation stages was 325. Conflicts regarding the inclusion or exclusion of studies among the evaluators were resolved at each stage. In the title selection stage, five studies (1.53%) out of the 325 required discussion among the evaluators, while in the abstract selection stage, eight studies (2.46%) were discussed. Altogether, in the title and abstract selection stages, 318 studies were excluded, resulting in seven studies for full–text reading. Subsequently, in the final stage, four more studies were eliminated based on the eligibility criteria, resulting in three studies being included (Figure 1).

With the three studies included at this stage, manual searches were conducted using their references to verify whether any additional studies could be included. As a result, six studies were identified and added for meeting the eligibility criteria. So a total of nine studies were included for evaluation, considering the theme and the objective proposed in this systematic review.

In the new search conducted on January 8, 2025, 53 studies were found. Eight duplicates were resolved, and after resolving these, the quantity of studies was reduced to 45. In the title selection stage, 44 studies were excluded, leaving only one study. It is important to note that one of the studies excluded in this stage had already been selected in the initial search.

gled odabrane studije u kojima su opisani sudionici (P) čiji je biološki spol bio poznat istraživačima iz dokumentiranih zapisa (I), a čije su cefalometrijske točke procijenjene lateralnom teleradiografijom (C) s ciljem da se procijeni spol sudionika (O). Na temelju strategije PICO formulirano je sljedeće pitanje: Kolika je točnost metoda koje se primjenjuju u lateralnoj teleradiografiji za procjenu spola u forenzičkim kontekstima?

Nakon što su uklonjene studije o aplikaciji Rayyan i duplikati, prvi odabir učinjen je na temelju naslova studija, a drugi na temelju sažetaka. Nakon toga treći je odabir proveden detaljnim čitanjem svake studije. Sve korake odabira neovisno su provela dva istraživača, a u slučaju dvojbe u vezi s uključivanjem studije, treći evaluator vodio je proces donošenja odluka. Isključene su studije kojima svrha nije bila procjena spola lateralnom teleradiografijom i tekstovi sa znanstvenih konferencija, pregledi literature, poglavlja u knjigama i prikazi slučajeva.

Za procjenu kvalitete metodologije primijenjene u svakoj odabranoj studiji korišten je kontrolni popis kritičke procjene za analitičke presječne studije Instituta Joanna Briggs (21). U vezi s odgovorima na kontrolnom popisu postojale su četiri moguće opcije: „da", „ne", „nejasno" i „nije primjenjivo" koje su u konačnici korištene za procjenu je li rizik od pristranosti nizak, srednji ili visok. Svakom odgovoru dodijeljen je standardizirani rezultat, što je rezultiralo postotkom. Ako je postotak bio manji od 49 %, rizik od pristranosti definiran je kao visok, između 50 % i 69 % smatrao se umjerenim, a u slučaju da je bio 70 % ili veći, smatrao se niskim.

Rezultati

Pretraga obavljena 4. rujna 2023. u šest baza podataka rezultirala je s 524 studije, a identificirano je i uklonjeno 199 duplikata. Broj studija koje su uvrštene u sljedeće faze evaluacije bio je 325. Nesuglasice među evaluatorima u vezi s uključivanjem ili isključivanjem studija, rješavane su u svakoj fazi. U fazi odabira naslova za pet je studija (1,53 %) od 325 bila potrebna rasprava među procjenjivačima, a u fazi odabira sažetaka raspravljali su o njih osam (2,46 %). Ukupno je u fazama odabira naslova i sažetaka isključeno 318 studija, što je rezultiralo sa sedam studija za čitanje u punom tekstu. Nakon toga, u završnoj fazi, još su četiri studije eliminirane na temelju kriterija prihvatljivosti, što je rezultiralo uključivanjem njih triju (slika 1.).

Nakon što su tri studije uključene u ovoj fazi, obavljena su ručna pretraživanja s pomoću njihovih referencija da bi se provjerilo mogu li se odabrati dodatne studije. Kao rezultat toga, identificirano je i dodano šest studija zato što su ispunjavale kriterije prihvatljivosti. Dakle, uzimajući u obzir temu i cilj predložen u ovom sustavnom pregledu, ukupno je u evaluaciju bilo uključeno devet studija.

Tijekom nove pretrage obavljene 8. siječnja 2025. pronađene su 53 studije. Osam je duplikata riješeno, a nakon toga je broj studija smanjen na 45. U fazi odabira naslova isključene su 44 studije i ostala je samo jedna. Važno je napomenuti da je jedna od studija isključenih u toj fazi već bila odabrana u početnoj pretrazi ovog pregleda, što je rezultiralo samo jed-

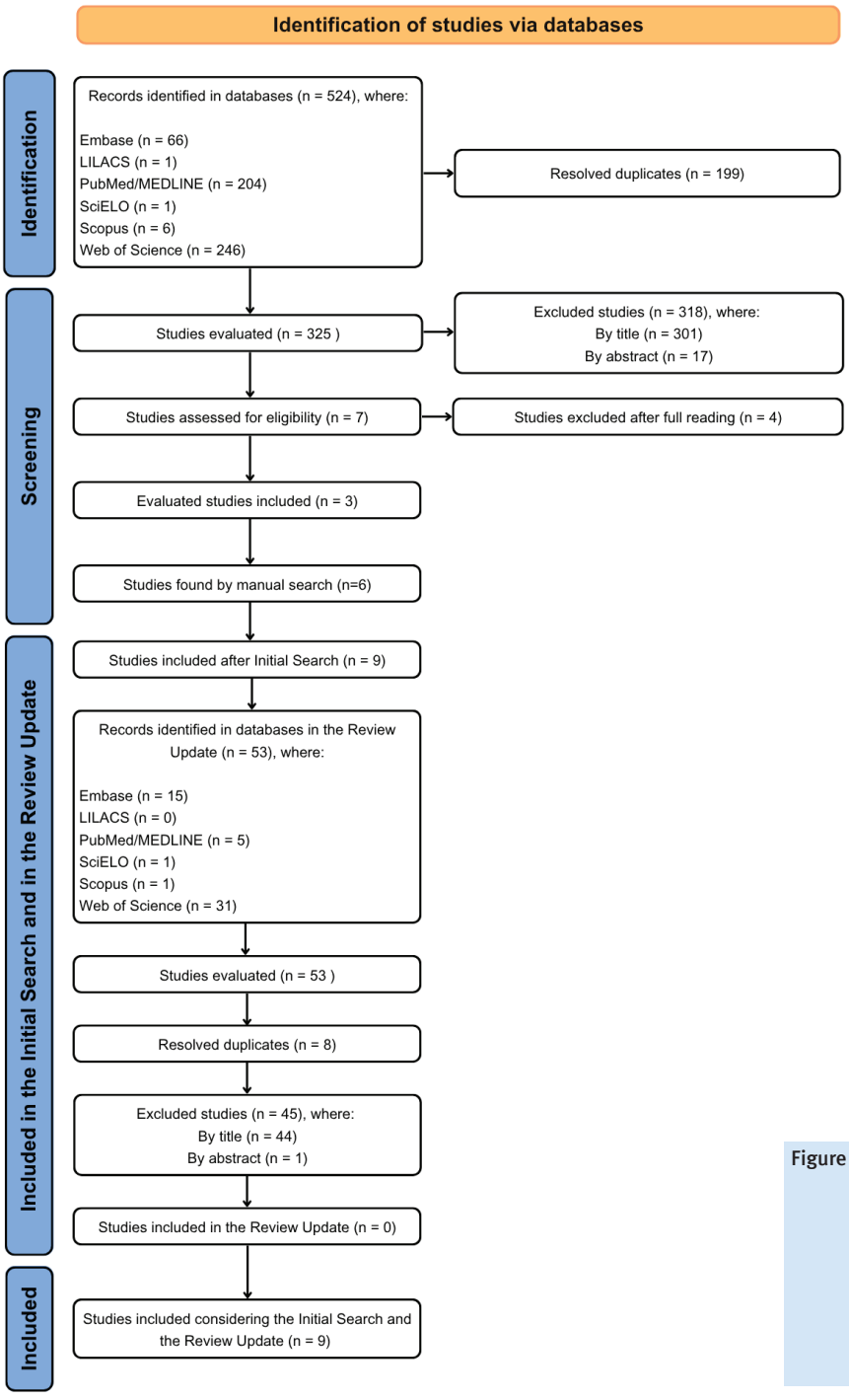

Figure 1 Flowchart adapted according to the recommendations of the Preferred Reporting Items for Systematic Reviews and Meta–Analyses (PRISMA)[21], 2020 version.

tial search of this review, which resulted in only one study for the abstract selection stage. This study was also excluded as it did not meet the eligibility criteria. Thus, no new studies were added in the update of this review.

Among the included studies, only two did not perform their analyses considering only lateral teleradiography as the sample type. In the study by Naikmasur *et al.* (2010), (22), the postero-anterior radiograph was also included in the sample, while Upadhyay *et al.* (2012), (23) used mandibles from skeletal remains in addition to lateral teleradiography (Table 2).

nom studijom za fazu odabira sažetaka. Ta je studija također isključena jer nije ispunjavala kriterije prihvatljivosti. Zato u ažuriranju ovog pregleda nisu dodane nove studije.

Među uključenim studijama, uzimajući u obzir samo lateralnu teleradiografiju kao vrstu uzorka, samo u dvjema nije provedena analiza. U studiji Naikmasura i suradnika (2010.) (22), postero-anteriorni radiogram također je uključen u uzorak, a Upadhyay i suradnici (2012.) (23) koristili su se, uz lateralnu teleradiografiju, i mandibulama sa skeletnih ostataka (tablica 2.).

Table 2 Description of each included study, study identification, study title, journal name, sample type, quantity of samples by sex, and nationality (country of origin of the sample).

Study identification	Study title	Journal name	Sample type	Quantity of samples by sex	Nationality (country of origin of the sample)
Domingues *et al.* (2023)[3]	Sex estimation through lateral cephalometric analysis in a Brazilian sample using a binary logistic regression model	Forensic Imaging	Lateral teleradiography	127 male and 125 female	Brazilian
Missier *et al.* (2019)[13]	Facial indices in lateral cephalogram for sex prediction in Chennai population – A semi–novel study	Journal of Forensic Dental Sciences	Lateral teleradiography	150 male and 150 female	Indian (Dravidians)
Bibby (1979)[14]	A cephalometric study of sexual dimorphism	American Journal of Orthodontics	Lateral teleradiography	144 male and 124 female	Scottish
Naikmasur *et al.* (2010)[22]	Determination of sex in South Indians and immigrant Tibetans from cephalometric analysis and discriminant functions	Forensic Science International	Lateral teleradiography and Posteroanterior teleradiography	55 male and 50 female*	Indian and Tibetan
Upadhyay *et al.* (2012)[23]	Analysis of gonial angle in relation to age, gender, and dentition status by radiological and anthropometric methods	Journal of Forensic Dental Sciences	Lateral teleradiography and jaws	53 male and 50 female**	Indian
Belaldavar *et al.* (2019)[24]	Sex estimation in Indians by digital analysis of the gonial angle on lateral cephalographs	The Journal of Odonto–Stomatoloty	Lateral teleradiography	149 male and 155 female	Indian
Patil *et al.* (2005)[25]	Determination of sex by discriminant function analysis and stature by regression analysis: a lateral cephalometric study	Forensic Science International	Lateral teleradiography	75 male and 75 female	Indian
Veyre–Goulet *et al.* (2008)[26]	Recent Human Sexual Dimorphism Study Using Cephalometric Plots on Lateral Teleradiography and Discriminant Function Analysis	Journal of Forensic Sciences	Lateral teleradiography	59 male and 55 female	French
Qaq *et al.* (2019)[27]	Sex estimation using lateral cephalograms: A statistical analysis	Forensic Science International: Reports	Lateral teleradiography	68 male and 67 female	Canadian and American

*Lateral teleradiography and Posteroanterior teleradiography (does not distinguish quantity among imaging exams)
** Sample of adults

The quantity of samples used in the studies varied from 105 to 320 radiographic exams, while the population origin was diverse, with samples from Asia, America, and Europe. However, the majority of the populations were from Asia, specifically from India. Regarding the distribution of the sample between female and male participants, the studies showed a balanced sample distribution, with the largest but not statistically significant difference found in Bibby (1979), (14), who included 144 males and 124 females (Table 2). Concerning the age of participants in the studies, it ranged from 17 to 72 years; however, the age range was not specified in Bibby (1979), (14). It is worth noting that although Upadhyay et *al.* (2012), (23) used an age range of 0 to 72 years, the authors carried out the analyses and presented the results according to specific age ranges for adult participants, so this study was included in this systematic review.

Regarding the methodologies employed by the studies to estimate sex from lateral teleradiography, it was observed that, despite common cranial landmarks in the analyses, different sets of variables were selected from distinct perspectives (Table 3 and Table 4). For example, the study by Missier

Količina uzoraka korištenih u studijama varirala je od 105 do 320 radiografskih pregleda, a podrijetlo populacije bilo je različito, s uzorcima iz Azije, Amerike i Europe. No većina populacija bila je iz Azije, točnije iz Indije. Kad je riječ o raspodjeli uzorka između ženskih i muških sudionika, autori studija istaknuli su uravnoteženu raspodjelu, s najvećom, ali ne i statistički značajnom razlikom pronađenom u studiji Bibbyja (1979.) (14) koja je uključivala 144 muškarca i 124 žene (tablica 2.). U vezi s dobi sudionika u studijama, kretala se od 17 do 72 godine, no raspon dobi nije bio naveden u studiji Bibbyja (1979.) (14). Vrijedi napomenuti da, iako su se Upadhy i suradnici (2012.) (23) koristili dobnim rasponom od 0 do 72 godine, autori su obavili analize i predstavili rezultate prema specifičnim dobnim rasponima za odrasle sudionike, pa je ta studija uključena u ovaj sustavni pregled.

Kad je riječ o metodologijama korištenima u studijama za procjenu spola iz lateralne teleradiografije, uočeno je da su, unatoč zajedničkim kranijalnim orijentirima u analizama, odabrani različiti skupovi varijabli iz različitih perspektiva (tablice 3. i 4.). Primjerice, Missier i suradnici (2019.) (13) razmatrali su 99 varijabli, a drugi, poput Upadhyaya i surad-

Table 3 Anatomical landmarks, planes, angles, and provided descriptions and ranked by their importance in terms of reliability for sex estimation, according to the studies included in this systematic review.

Landmarks/planes/angle	Abbreviation	Description
Mandibular Ramus lenght	MLR	Distance between the condylion and gonion points.
Condylion-Gnathion	Co-Gn	Linear measurement between Condylion (Co) and Gnathion (Gn).
Basion-nasion	Ba-N	The linear measurement between basion (Ba) and nasion (N).
Anterior Nasal Spine	ANS	Tip of bone anterior nasal spine in the median plane.
Glabella	G	The most forward point on the midsagittal plane located between the superciliary arches.
Gonio	Go	Linear measurement between Condylion (Co) and Gnathion (Gn).
Sella	S	Mid-point of sella-turcica.
Nasion	N	The most anterior midline point at the frontonasal suture, where the frontal bone meets the nasal bones.
Basion Condylion	Ba Co	The lowest point at the anterior margin of the foramen magnum in the median plane. Superior most point on the head of the condyle.
Bizygomatic width	Zn – Zn	Distance from the right to left zygomatics.
Mandibular symphysis height	Id – Me	Distance between infradentale (Id) to menton (Me).
Bicondylar width	Co – Co	Distance from the right to the left condylion superioris.
Bigonial width	Go – Go	Distance from the right to the left gonion.
Articulare	Ar	Point of intersection of the images of the posterior border of condylar process of the mandible and the inferior border of the basilar part of occipital bone.
Opisthocranion	Op	Most prominent point of the occipital bone in the midline.
Mastoidale	Ma	Lowest point of the mastoid process.
Menton	Me	The most inferior (caudal) and midline point on the mandibular symphysis.
Orbitale	Or	Lowest point on the bony orbit.
Porion	Po	Uppermost point of the external auditory meatus.
Mandibular plane	Me – Go	A tangent line to the average infero-posterior surface of the mandibular ramus that passes through the articulare.
Sella-Nasion plane	SN plane	Line connecting sella with nasion.
Infradentale	In	The highest and anterior most point on the alveolar process, in the median plane, between the mandibular central incisors.
Frankfurt Horizontal plane	FH plane	Line connecting the porion (top of the earpost of the cephalostat) with the orbitale (lowest point of bony orbit).
Ma–FH	Ma – FH	Perpendicular distance from the mastoid to the FH plane.
Ma–B1B2	MaHt	Mastoid height from the cranial base.
B1–B2	MaWd	Mastoid width at the cranial base level.
GMSN	GMSN angle	The angle between the glabella-to-metopion line and the sella-to-nasion line.
GMBaN	GMBaN angle	The angle between the glabella-to-metopion line and the basion-to-nasion line.
GPI	GPI angle	Glabella projection index.
GMFH	GMFH angle	The angle between the glabella-to-metopion line and the porion-to-orbitale line.

et al. (2019), (13) considered 99 variables, while others, such as Upadhyay *et al*. (2012), (23) and Belaldavar *et al*. (2019), (24), focused on only one specific point, the gonial angle.

Regarding the risk of bias of the selected studies, it was noted that the level fell within values that correspond to a low risk of bias. Among the nine studies, three reported a 75% rate of 'yes' responses, while one study showed an even higher percentage, reaching 87%. Thus, five studies achieved 100% considering the quantity of "yes" responses, classifying them as low risk of bias, as described in Table 5.

nika (2012.) (23) i Belaldavara i suradnika (2019.) (24), usredotočili su se samo na jednu specifičnu točku – na kut gonija.

U vezi s rizicima za pristranost u odabranim studijama, uočeno je da je razina pala unutar vrijednosti koje odgovaraju niskom riziku. Među devet studija, u trima su autori izvijestili o stopi odgovora „da" od 75 %, a u jednoj je taj postotak bio i veći – 87 %. Dakle, u pet studija postiglo se 100 % ako se uzme u obzir količinu odgovora s „da" i klasificira ih se kao studije s niskim rizikom od pristranosti, kao što je opisano u tablici 5.

Table 4 Study identification, cephalometric points/variables assessed, anatomical regions, type of statistical analysis used, and results.

Study identification	Cephalometric points/variables assessed	Anatomical regions	Type of statistical analysis	Results
Domingues *et al.* (2023)[3]	8 cephalometric points: G (gabella); Or (orbitale); S (sella); Ba (basion); Po (porion); N (nasion); ANS (anterior nasal spine); PNS (posterior nasal spine)	Cranial base and maxilla	Binary logistic regression	In the test sample, the model showed an accuracy of 84.38% in sex estimation and 82.14% in the training sample
Missier *et al.* (2019)[13]	99 cephalometric variables	Cranial base, maxilla, mandible, and teeth	Discriminant function	The Ramus length (Ramus ln), Condylion to Gnathion (Co–Gn), and ramus height showed greater consistency regarding sex (78%). The lower anterior facial height (LAFH) showed only 52%
Bibby (1979)[14]	Angular and linear variables of the human skull	Base of the skull, maxilla, mandible, and teeth	ANOVA*	S–Ar–Go was the only angular variable that showed sexual dimorphism, with a higher value for females compared to males. The male skulls were 8.5% larger than the female skulls in the sample
Naikmasur *et al.* (2010)[22]	Plane, linear measurements, and cephalometric points: Ba–ANS (facial depth); N–ANS (upper facial height); Ba–N (cranial base length); N–Me (anterior facial height); ANS–Me (lower facial height); Id–Me (symphysis height); Ar–Go (mandibular ramus height); Me–Go (mandibular body length)	Cranial base, maxilla, mandible, and teeth	Discriminant function	The parameters were higher in males compared to females
Upadhyay *et al.* (2012)[23]	Gonial angle	Mandible	ANOVA and *t*-test	There was no relationship between the gonial angle and sex
Belaldavar *et al.* (2019)[24]	Gonial angle	Mandible	Logistic Regression	The average angle was 122.7° for females and 121.1° for males. Logistic regression had an accuracy rate of 56.3% in sex estimation. The accuracy for females was 61.9%, and for males, it was 50.3%
Patil *et al.* (2005)[25]	10 cephalometric variables: G–Op (maximum cranial length); Ba–ANS (basion to the anterior nasal spine); N–ANS (upper facial height); Ba–N (cranial base length); N–M (total facial height); FsHt: (V1–V2, frontal sinus height); Ma–SN (perpendicular distance from the mastoid to the SN plane); Ma–FH (perpendicular distance from the mastoid to the FH plane); MaHt (Ma–B1B2, mastoid height from the cranial base); MaWd (B1–B2, mastoid width at the cranial base level)	Base of the skull, maxilla, mandible, and teeth	Discriminant function	99% reliability in sex estimation
Veyre–Goulet *et al.* (2008)[26]	19 cephalometric points (8 angles, 9 linear measurements, and one proportional measurement)	Cranial base and maxilla	Linear Discriminant Analysis and Quadratic Discriminant Analysis	The average values for males in angular measurements were lower compared to females, except for the angles GMSN (angle between the glabella to metopion line and the sella to nasion line), GMFH (angle between the glabella to metopion line and the porion to orbitale line) and GMBaN (angle between the glabella to metopion line and the basion to nasion line). In the linear measurements and the proportional variable GPI (glabella projection index), the average values for males were higher compared to females
Qaq *et al.* (2019)[27]	22 measurements (linear, angular, area) considering 9 cephalometric points: G (glabella); V (vertex); Op (opisthocranion); Ba (basion) N (nasion); S (sella); ANS (anterior nasal spine); Po (porion); Or (orbitale)	Cranial base, maxilla, and nasal region	Binary logistic regression	An overall accuracy of 82.4% in sex estimation. Three angular measurements (DN–S–V, DN–S–G, DG–N–S) and one ratio for two area measurements (G–V–Op–Ba–G/N–S–Ba–ANS–N) were the best parameters

*The study used descriptive statistics

Table 5 Assessment of risk of bias according to the checklist proposed by The Joanna Briggs Institute[13].

Study identification	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Percentage of "Yes" (%)	Risk of bias
Domingues *et al.* (2023)[3]	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	100%	low
Missier *et al.* (2019)[13]	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	100%	low
Bibby (1979)[14]	Yes	Unclear	Yes	Yes	Unclear	Unclear	Yes	Yes	75%	low
Naikmasur *et al.* (2010)[22]	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	100%	low
Upadhyay *et al.* (2012)[23]	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	100%	low
Belaldavar *et al.* (2019)[24]	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	100%	low
Patil *et al.* (2005)[25]	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	100%	low
Veyre–Goulet *et al.* (2008)[26]	Yes	Yes	Yes	Yes	Unclear	Unclear	Yes	Yes	75%	low
Qaq *et al.* (2019)[27]	Yes	Yes	Yes	Yes	Unclear	Unclear	Yes	Yes	75%	low

Q1 - Were the criteria for inclusion in the sample clearly defined?; Q2 - Were the study subjects and the setting described in detail?; Q3 - Was the exposure measured in a valid and reliable way?; Q4 - Were objective, standard criteria used for measurement of the condition?; Q5 - Were confounding factors identified?; Q6 - Were strategies to deal with confounding factors stated?; Q7 - Were the outcomes measured in a valid and reliable way?; Q8 - Was appropriate statistical analysis used?

Discussion

The oldest study available and selected in the present research used lateral teleradiography to investigate the anatomical differences of the skulls of male and female to propose assessing sexual dimorphism using lateral teleradiographs, focusing on cephalometric points and measurements between anatomical regions where these points can be located[14]. This study by Bibby (1979), (14) found that both male and female skulls appeared to have a similar pattern, however, angular measurements such as S–Ar–Go (sella–articulare–gonion) showed sexual dimorphism, with the variable having a higher value in females compared to males. Furthermore, Bibby (1979), (14) found that male skulls were 8.5% larger than female skulls. Thus, this systematic review aimed to evaluate all available studies that used lateral teleradiography for sex estimation in adults, as well as the respective approaches and reliability for forensic contexts.

The studies included in this systematic review presented both similar and highly divergent results. It is evident that the studies not only showed variation in methodology but also in the selection of variables chosen by the authors based on lateral teleradiography. Furthermore, other objectives beyond sex estimation can be observed. For instance, Upadhyay *et al.* (2012), (23) evaluated only the gonial angle, with the aim of studying the relationship between this angle and dental loss, as well as the influence of sex and age on this anatomical point. Belaldavar *et al.* (2019), (24) also evaluated the gonial angle, but their focus was solely on its relationship with sex.

On the other hand, studies such as Missier *et al.* (2019), (13) used 99 variables from lateral teleradiographs. However, the average quantity of variables used across all studies in this review was 21 parameters. Regarding methodology, all studies employed statistical techniques to classify the variables (Table 4).

Furthermore, some variables selected by the studies through lateral teleradiography showed a significant relationship to sex. In the study by Missier *et al.* (2019), (13), from the 99 variables used, 24 were subjected to statistical anal-

Rasprava

Autori najstarije dostupne studije odabrane u ovom istraživanju koristili su se lateralnom teleradiografijom za istraživanje anatomskih razlika lubanja muškaraca i žena kako bi predložili procjenu spolnog dimorfizma s pomoću lateralne teleradiografije, fokusirajući se na cefalometrijske točke i mjerenja između anatomskih regija gdje se te točke mogu nalaziti (14). Ta studija Bibbyja (1979.) (14) otkrila je da i muške i ženske lubanje imaju sličan uzorak, no kutna mjerenja poput S–Ar–Go (sella–articulare–gonion) pokazala su spolni dimorfizam s varijablom koja ima veću vrijednost kod žena u usporedbi s muškarcima. Nadalje, Bibby (1979.) (14) je otkrio da su muške lubanje 8,5 % veće od ženskih. Zato je ovaj sustavni pregled imao za cilj procijeniti sve dostupne studije koje su se koristile lateralnom teleradiografijom za procjenu spola odraslih te odgovarajuće pristupe i pouzdanost za forenzičke kontekste.

U studijama uključenima u ovaj sustavni pregled dobiveni su i slični i vrlo različiti rezultati. Očito je da u studijama nisu pokazane samo varijacije u metodologiji, nego i u odabiru varijabli koje su autori odabrali na temelju lateralne teleradiografije. Nadalje, mogu se uočiti i drugi ciljevi osim procjene spola. Primjerice, Upadhyay i suradnici (2012.) (23) procijenili su samo gonijalni kut sa svrhom proučavanja odnosa između toga kuta i gubitka zuba te utjecaja spola i dobi na tu anatomsku točku. Belaldavar i suradnici (2019.) (24) također su procijenili gonijalni kut, ali njihov je fokus bio isključivo na njegovu odnosu sa spolom.

S druge strane, u studijama poput Missierove i suradnika (2019.) (13) korišteno je 99 varijabli iz lateralnih teleradiografija. Međutim, prosječna količina varijabli korištenih u svim studijama u ovom pregledu bila je 21 parametar. Kad je riječ o metodologijama, u svim su studijama korištene statističke tehnike za klasifikaciju varijabli (tablica 4.).

Nadalje, neke varijable odabrane u studijama na temelju lateralne teleradiografije pokazale su značajnu povezanost sa spolom. U studiji Missiera i suradnika (2019.) (13), od 99 korištenih varijabli, 24 su podvrgnute statističkoj analizi jer su pokazale značajne vrijednosti. Missier i suradnici (2019.)

ysis as they showed significant values. Missier *et al*. (2019), (13) found that the mandibular ramus length, specifically from the condyle to the gnathion (Co–Gn), as well as the ramus height, showed a consistency of 78% with respect to sex, while the lower anterior facial height had only 52%.

Domingues *et al*. (2023) (3) used two angular measurements (G–N–S and Po–Or–G) and one area measurement (S–N–Or–Po) to construct a binary logistic regression model. The model showed an accuracy of 82.14% in sex estimation in the training sample and 84.38% in the test sample (3). In contrast, Bibby (1979), (14), as previously described, found that the only angular variable that demonstrated sexual dimorphism was the S–Ar–Go. Meanwhile, Qaq *et al*. (2019), (25) highlighted three angular measurements (N–S–V, N–S–G, and G–N–S), in addition to a ratio with two area measurements (G–V–Op–Ba–G/N–S–Ba–ANS–N) as the best measures. Overall, Qaq *et al*. (2019), (25) demonstrated an overall accuracy of 82.4% in sex estimation.

In turn, Veyre-Goulet *et al*. (2008), (26) stated that the angular measurement values for males were smaller compared to females, with the exception of the GMSN angle (angle between the glabella-to-metopion line and the sella-to-nasion line), GMFH (angle between the glabella-to-metopion line and the porion-to-orbitale line), and GMBaN (angle between the glabella-to-metopion line and the basion-to-nasion line). However, both the linear measurements and the glabella projection index (GPI) showed higher average values in males (25). On the other hand, Naikmasur *et al*. (2010), (22) explained that the parameters selected from the lateral teleradiography were higher in males compared to females.

Moreover, there were studies that used only one parameter, such as Belaldavar *et al*. (2019), (24), who analyzed only the gonial angle and obtained average values of 122.7° and 121.1° for females and males, respectively. Additionally, in the study by Belaldavar *et al*. (2019), (24), the logistic regression model had an accuracy rate of 56.3% in sex estimation, with 61.9% accuracy for females and 50.3% for males. However, this result was divergent when compared to the study by Upadhyay *et al*. (2012), (23), who also used only the gonial angle and stated that no relationship was found between this measure and sex.

With the study by Patil *et al*. (2005), (27),it was possible to observe that the reliability of the discriminant function was 99%. However, some variables stood out, such as Ba–N, MaHt, N–M, MaWd, Ba–ANS, Ma–FH, and G–Op. In contrast, the variables FsHt, Ma–SN, and N–ANS) were less reliable (26). Thus, it is possible to observe divergent results between the studies selected in this work, which can be justified by the choice of different measurements and landmarks (14, 22-27). However, the qualitative analysis demonstrated that the risk of bias in the studies was low, which is a positive factor regarding the way the authors conducted their research (Table 5). However, the anatomical regions were different, which prevents a quantitative comparison in this regard as presented in Table 3 and Table 4. Nevertheless, some points in the lateral teleradiographs stood out, such as the mandibular ramus length, condylion-gnathion,

(13) otkrili su da dužina mandibularnog ramusa, posebno od kondila do gnationa (Co–Gn) i visina ramusa, pokazuju konzistentnost od 78 % u odnosu na spol, a visina donjega prednjeg dijela lica imala je samo 52 %.

Domingues i suradnici (2023.) (3) koristili su se dvama kutnim mjerenjima (G–N–S i Po–Or–G) i jednim mjerenjem površine (S–N–Or–Po) za konstrukciju binarnoga logističkoga regresijskoga modela. Model je pokazao točnost od 82,14 % u procjeni spola u uzorku za vježbu i 84,38 % u testnom uzorku (3). Suprotno tomu, Bibby (1979.) (14), kao što je već opisano, otkrio je da je jedina kutna varijabla koja je pokazala spolni dimorfizam bila S–Ar–Go. U međuvremenu su Qaq i suradnici (2019.) (25) obavili tri kutna mjerenja (N–S–V, N–S–G i G–N–S), uz omjer s dvama površinskim mjerenjima (G–V–Op–Ba–G/N–S–Ba–ANS–N) kao najboljim mjerama. Sveukupno, Qaq i suradnici (2019.) (25) pokazali su u procjeni spola ukupnu točnost od 82,4 %.

Istodobno, Veyre-Goulet i suradnici (2008.) (26) naveli su da su vrijednosti kutnih mjerenja za muškarce bile manje u usporedbi sa ženama, osim kutova GMSN (kut između linije glabela-metopion i linije sella-nasion), GMFH (kut između linije glabela-metopion i linije poriona-orbitale) i GMBaN (kut između linije glabela-metopion i linije basion-nasion). Međutim, i linearna mjerenja i indeks projekcije glabele (GPI) pokazali su više prosječne vrijednosti kod muškaraca (25). Naikmasur i suradnici (2010.) (22) objasnili su da su parametri odabrani iz lateralne teleradiografije bili viši kod muškaraca u usporedbi sa ženama.

Štoviše, u nekim studijama autori su se koristili samo jednim parametrom, poput Belaldavara i suradnika (2019.) (24) koji su analizirali samo kut gonija i dobili prosječne vrijednosti od 122,7° i 121,1° za žene, odnosno muškarce. Osim toga, u studiji Belaldavara i suradnika (2019.) (24) logistički regresijski model imao je stopu točnosti od 56,3 % u procjeni spola, s točnošću od 61,9 % za žene i 50,3 % za muškarce. No taj je rezultat bio drukčiji u usporedbi sa studijom Upadhyaya i suradnika (2012.) (23) koji su također odabrali samo gonijalni kut i naveli da nisu pronašli vezu između te mjere i spola.

Patila i suradnici (2005.) u svojoj su studiji pokazali da je pouzdanost diskriminantne funkcije bila 99 %. No neke su se varijable istaknule, poput Ba–N, MaHt, N–M, MaWd, Ba–ANS, Ma–FH i G–Op. Suprotno tomu, varijable FsHt, Ma–SN i N–ANS bile su manje pouzdane (26). Stoga je moguće uočiti divergentne rezultate između studija odabranih u ovom radu, što se može opravdati izborom različitih mjerenja i orijentira (14, 22 – 27). No kvalitativna analiza pokazala je da je rizik od pristranosti u studijama bio nizak, što je pozitivan čimbenik kad je riječ o načinu na koji su autori proveli svoja istraživanja (tablica 5.). Međutim, anatomske regije bile su različite, što sprječava kvantitativnu usporedbu kao što je prikazano u tablicama 3. i 4. Ipak, neke točke na lateralnim teleradiografijama istaknule su se, poput dužine mandibularne grane, kondilion-gnation, bazion-nasion, sella, gonion i glabella, koje su bile prisutne u nekoliko skupova varijabli sa značajnim vrijednostima, potencijalno usmjeravajući buduća istraživanja. Najpouzdanije varijable i njihove kombinacije prikazane su u tablici 3. – poredane su od najvažnijih do najmanje važnih.

basion-nasion, sella, gonion and glabella, which were present in several sets of variables with significant values, potentially guiding future research. The most reliable variables and their combinations are presented in Table 3, ordered from the most to the least important.

It is important to highlight that, in this systematic review, in order to include the largest possible number of scientific articles, we chose not to restrict the study search to a specific time frame. Thus, older studies were also considered, as they provided important methodological foundations that supported subsequent research.

Therefore, the validation, as well as the standardization of the choice of cephalometric variables, is necessary, considering that methods in the forensic field require a well-defined probability regarding the margin of error[25]. In this regard, it is essential that studies on the use of lateral teleradiography continue to bring improvements and contributions to forensic practice. Given that, in the forensic context, specifically in the construction of the biological profile, sex estimation is fundamental.

Conclusion

It is concluded that lateral cephalometric radiography is an imaging method that can be used as a complementary tool in sex estimation of adult victims, especially in regions with limited resources or restricted access to more sophisticated imaging techniques. However, the included studies employed different approaches regarding the measurements and anatomical landmarks used. Therefore, it is essential that future primary studies adopt standardized methodologies and greater methodological rigor in order to provide stronger scientific support for sex estimation methods based on lateral cephalometric radiography.

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Author's contribution: I.S.M. - wrote the original draft; **I.S.M.** and **A.E.M.P.C.** - conducted the literature search, selected the eligible articles, extracted the data, and obtained and interpreted the results; **P.H.V.P.** and **R.H.A.S.** conceived and designed the study, supervised its development, and critically revised the manuscript. All authors read and approved the final version of the manuscript.

Važno je istaknuti da smo u ovom sustavnom pregledu, kako bismo uključili što veći broj znanstvenih članaka, odlučili ne ograničiti pretraživanje studija na određeni vremenski okvir. Zato su uzete u obzir i starije studije jer su pružile važne metodološke temelje koji su podržali naknadna istraživanja.

Stoga je validacija, kao i standardizacija izbora cefalometrijskih varijabli, prijeko potrebna, s obzirom na to da metode u forenzičkom području zahtijevaju dobro definiranu vjerojatnost kad je riječ o margini pogreške (25). U tom smislu bitno je da autori studija o korištenju lateralne teleradiografije nastave s poboljšanjima i doprinosima forenzičkoj praksi, zato što je u forenzičkom kontekstu procjena spola temeljna, posebno pri konstrukciji biološkog profila.

Zaključak

Lateralna cefalometrijska radiografija metoda snimanja može se koristiti kao komplementarni alat u procjeni spola odraslih žrtava, posebno u regijama s ograničenim resursima ili ograničenim pristupom sofisticiranijim tehnikama snimanja. Međutim, autori uključenih studija koristili su se različitim pristupima u mjerenju i upotrebljavali su različite anatomske orijentire. Zato je bitno da se u budućim primarnim studijama prihvate standardizirane metodologije i poveća metodološka strogost kako bi se omogućila jača znanstvena potpora metodama procjene spola na temelju lateralne cefalometrijske radiografije.

Sukob interesa: Autori nisu bili u sukobu interesa.

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Doprinos autora: I. S. M. – napisao je originalni nacrt rada; **I. S. M.** i **A. E. M. P. C.** – proveli su pretraživanje literature, odabrali odgovarajuće članke, izdvojili podatke te dobili i interpretirali rezultate; **P. H. V. P.** i **R. H. A. S.** osmislili su i dizajnirali studiju, nadzirali njezin razvoj i kritički revidirali rukopis. Svi autori pročitali su i odobrili konačnu verziju rukopisa.

Sažetak
Metode koje se koriste za bočnu teleradiografiju pri procjeni spola trebaju biti razmotrene s obzirom na njihovu izvedivost i primjenjivost u forenzičkim slučajevima. **Svrha:** Cilj ove studije bio je provesti sustavni pregled o uporabi bočne teleradiografije u procjeni spola odraslih osoba. **Metode:** Istraživanje je provedeno na temelju podataka iz baza Embase, PubMed/MEDLINE, Scopus, Lilacs, Scielo i Web of Science. Rezultati pretraživanja uneseni su u aplikaciju Rayyan (https://www.rayyan.ai/). Nakon toga dva su neovisna recenzenta primijenila kriterije podobnosti za odabir studija povezanih s ovom temom, što je rezultiralo s devet studija. Kad je riječ o riziku od pristranosti, primijenjen je kontrolni popis koji preporučuje The Joanna Briggs Institute. Rizik od pristranosti u svim odabranim studijama smatran je niskim. **Rezultati:** Ističemo da metaanaliza nije moguća zbog nedostatka standardizacije u načinu prezentacije podataka. Kad je riječ o uključenim studijama, zabilježeno je da su uzorci bili iz šest zemalja te da su autori pokazali metodološke diskrepancije u vezi s korištenim mjerama u analizama. Kao rezultat toga, stopa točnosti kretala se od 56,3 % do 99,0 %. **Zaključak:** Zaključuje se da bočna cefalometrijska radiografija može podržati procjenu spola kod odraslih, posebno u okruženjima s ograničenim resursima. No zbog varijacija među studijama u metodama mjerenja i oznakama, u budućim istraživanjima trebale bi se prihvatiti standardizirane i rigoroznije metodologije radi jačanja njihove znanstvene valjanosti.

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