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Prevalence and distribution of developmental dental anomalies on panoramic radiographs of adults from Ica and Huamanga, Peru, 2021–2023: a retrospective cross-sectional study

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ABSTRACT

Background: Developmental dental anomalies may affect diagnosis, occlusion, esthetics, treatment planning, and long-term oral health. Their prevalence varies among populations, but evidence in Peruvian adults remains limited. **Objective:** This study aimed to determine the prevalence and distribution of developmental dental anomalies observed on panoramic radiographs of adults from Ica and Huamanga, Peru, between 2021 and 2023. **Methods:** A retrospective cross-sectional study was conducted using 646 panoramic radiographs of adults aged 20 to 50 years. Dental anomalies were classified according to alterations in tooth shape, size, and number through radiographic observation. Data were analyzed using absolute and relative frequencies. **Results:** Developmental dental anomalies were identified in 38.5% of radiographs. Shape anomalies were the most frequent category (16.6%), followed by size anomalies (15.6%) and number anomalies (6.3%). No developmental dental anomalies were observed in 61.5% of radiographs. **Conclusions:** Developmental dental anomalies were frequent among adults from Ica and Huamanga, with shape anomalies being the most common finding. These results support the usefulness of panoramic radiographs for identifying dental anomalies and improving clinical decision-making in adult dental care.

Keywords: Tooth Abnormalities; Panoramic Radiography; Prevalence; Adult; Peru.

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Introduction

Developmental dental anomalies are congenital or developmental deviations that occur during odontogenesis and may affect tooth number, size, shape, structure, or position. These anomalies include agenesis, supernumerary teeth, microdontia, macrodontia, fusion, gemination, enamel pearls, dens invaginatus, and taurodontism, among others. Their clinical importance lies in their potential impact on esthetics, occlusion, masticatory function, periodontal health, endodontic complexity, orthodontic planning, prosthetic rehabilitation, and long-term oral prognosis [1–6]. Tooth development is a coordinated biological process regulated by epithelial–mesenchymal interactions and molecular signaling pathways; therefore, genetic variants involving genes such as MSX1, WNT10A, FGF10, and FGF13 have been associated with disturbances in tooth number, morphology, and size [7–10]. Because many developmental anomalies are asymptomatic or detected incidentally, panoramic radiography remains a useful diagnostic tool for identifying alterations across both jaws in a single image [11–14].

Previous studies have shown that the prevalence and distribution of developmental dental anomalies vary widely across populations, age groups, clinical settings, and diagnostic methods. Radiographic studies have reported anomalies involving tooth morphology, number, and size in different populations, including findings related to supernumerary teeth, agenesis, impacted teeth, enamel pearls, taurodontism, fusion, gemination, and tooth-size discrepancies [15–27]. International evidence has also shown associations between specific anomalies, such as maxillary canine impaction and other dental alterations, as well as increased frequency of dental changes in systemic conditions such as osteogenesis imperfecta and Down syndrome [28–30]. In Peru, available evidence remains fragmented and has mainly focused on specific anomalies or pediatric populations, including third molar agenesis, supernumerary teeth, dentoalveolar alterations, and anomalies of size and shape in children and adolescents [31–35]. Consequently, there is still limited evidence regarding the overall prevalence and distribution of developmental dental anomalies in Peruvian adults, particularly in regions outside Lima and in geographically distinct populations such as Ica and Huamanga.

From a clinical, methodological, and public health perspective, evaluating developmental dental anomalies in adults through panoramic radiographs is relevant because these findings may directly influence diagnosis and treatment planning. Alterations in tooth number may affect occlusion and space management; anomalies of size may compromise esthetics and restorative planning; and anomalies of shape may increase the complexity of endodontic, periodontal, orthodontic, and surgical procedures [36–41]. In addition, descriptive, cross-sectional, and retrospective designs are appropriate for estimating prevalence when existing radiographic records are available, allowing the characterization of oral conditions in specific populations and time periods [42–45]. The use of standardized observation instruments and calibrated radiographic evaluation strengthens the reliability of epidemiological information and allows comparison with previous studies in different clinical and geographic contexts [46–48].

The objective of this study was to determine the prevalence and distribution of developmental dental anomalies identified on panoramic radiographs of adults from the provinces of Ica and Huamanga, Peru, between 2021 and 2023. Specifically, this study evaluated anomalies according to tooth number, size, and shape, as well as their distribution by sex, age group, and anatomical quadrant. This research is justified by its contribution to the clinical, epidemiological, and methodological understanding of developmental dental anomalies in Peruvian adult populations, with direct implications for radiographic diagnosis, treatment planning, and evidence-based dental practice.

Materials and methods

Study Design

An observational, retrospective, cross-sectional study was conducted following the recommendations of the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) statement [49–52]. The study aimed to determine the prevalence and distribution of developmental dental anomalies identified on panoramic radiographs of adults from the provinces of Ica and Huamanga, Peru, between 2021 and 2023.

Population and Sample

The study population consisted of 2,000 panoramic radiographs obtained from two branches of the same diagnostic imaging center located in Ica and Huamanga, Peru. The radiographs corresponded to patients aged between 20 and 50 years who attended the centers between 2021 and 2023.

The inclusion criteria were: (1) panoramic radiographs of adults aged 20–50 years; (2) radiographs obtained during the study period; (3) radiographs from both sexes; and (4) images with adequate diagnostic quality for evaluation. Repeated radiographs and images with insufficient quality for analysis were excluded.

The sample size was calculated using the formula for finite populations considering a 95% confidence level, 5% margin of error, and expected proportion of 50%, resulting in a final sample of 323 panoramic radiographs. A non-probabilistic sampling method was employed. The unit of analysis was the panoramic radiograph of each eligible patient [53–55].

Procedures and Radiographic Assessment

Authorization was obtained from the diagnostic imaging centers prior to data collection. Panoramic radiographs were reviewed by a trained examiner following a calibration process supervised by an expert in radiographic diagnosis of developmental dental anomalies.

Radiographic assessment focused on anomalies affecting tooth number, size, and shape. Number anomalies included agenesis and supernumerary teeth; size anomalies included microdontia and macrodontia; and shape anomalies included fusion, gemination, enamel pearls, dens invaginatus, peg-shaped lateral incisors, and taurodontism. Diagnostic criteria were established according to the scientific literature and previously published reports on developmental dental anomalies [1–41]. All observations were recorded in a standardized data collection form. Additional demographic variables, including age and sex, were obtained from the radiographic records.

Measurement Instrument, Validity and Reliability

Data were collected using a structured observation form designed for the identification of developmental dental anomalies on panoramic radiographs. Prior to the main study, a pilot evaluation was performed using a subset of radiographs not included in the final sample. Instrument reliability was assessed using Cronbach's alpha coefficient, yielding a value of 0.889, indicating satisfactory internal consistency.

Statistical Analysis

Data were entered into a Microsoft Excel database and subsequently analyzed using IBM SPSS Statistics version 21. Descriptive statistics were used to summarize the findings. Absolute and relative frequencies were calculated for all categorical variables, including anomaly type, sex, age group, and anatomical location. Results were presented in tables and figures. Statistical significance was established at $p < 0.05$.

Ethical considerations

The study protocol was reviewed and approved by the Ethics Committee of the School of Dentistry of Universidad César Vallejo under Resolution No. 0151-2024/UCV/P. Because the study was based exclusively on retrospective analysis of radiographic records, no direct patient intervention was performed. Patient anonymity and confidentiality were strictly preserved throughout the investigation. The study adhered to the ethical principles established in the Declaration of Helsinki and current regulations governing human research.

Results

A total of 646 panoramic radiographs were evaluated. Developmental dental anomalies were identified in 38.5% of the radiographs. Shape anomalies were the most frequent category (16.6%), followed by size anomalies (15.6%) and number anomalies (6.3%), whereas 61.5% of radiographs showed no developmental dental anomalies (Table 1).

Table 1. Prevalence of developmental dental anomalies identified on panoramic radiographs of adults from Ica and Huamanga, Peru, 2021–2023.

Developmental dental anomalies	n	%
Shape anomalies	107	16.6
Size anomalies	101	15.6
Number anomalies	41	6.3
No anomalies	397	61.5
Total	646	100.0

Size anomalies were identified in both provinces and included microdontia and macrodontia. In Ica, microdontia was most frequently observed in quadrant 2, whereas macrodontia was most frequently observed in quadrants 1 and 4. In Huamanga, microdontia was most frequently observed in quadrant 2, while macrodontia was most frequently observed in quadrant 4 (Table 2).

Table 2. Distribution of developmental dental anomalies of size according to province and dental quadrant in adults from Ica and Huamanga, Peru, 2021–2023.

Maxilla	Quadrant	Dental anomaly	Ica				Huamanga			
			Microdontia		Macrodontia		Microdontia		Macrodontia	
			n	%	n	%	n	%	n	%
UPPER	Quadrant 1	No	11	40.70%	10	50.00%	8	42.10%	20	57.10%
		Yes	16	59.30%	10	50.00%	11	57.90%	15	42.90%
	Quadrant 2	No	10	37.00%	12	60.00%	6	31.60%	20	57.10%
		Yes	17	63.00%	8	40.00%	13	68.40%	15	42.90%
LOWER	Quadrant 3	No	26	96.30%	17	85.00%	18	94.70%	29	82.90%
		Yes	1	3.70%	3	15.00%	1	5.30%	6	17.10%
	Quadrant 4	No	27	100.00%	12	60.00%	19	100.00%	21	60.00%
		Yes	0	0.00%	8	40.00%	0	0.00%	14	40.00%
Total			27	100.00%	20	100.00%	19	100.00%	35	100.00%

Table 3. Distribution of developmental dental anomalies of number according to province and dental quadrant in adults from Ica and Huamanga, Peru, 2021–2023.

Maxilla	Quadrant	Dental anomaly	Ica				Huamanga			
			Agenesis		Supernumerary		Agenesis		Supernumerary	
			n	%	n	%	n	%	n	%
UPPER	Quadrant 1	No	2	66.70%	13	68.40%	1	20.00%	11	78.60%
		Yes	1	33.30%	6	31.60%	4	80.00%	3	21.40%
	Quadrant 2	No	2	66.70%	15	78.90%	4	80.00%	10	71.40%
		Yes	1	33.30%	4	21.10%	1	20.00%	4	28.60%
LOWER	Quadrant 3	No	2	66.70%	12	63.20%	2	40.00%	8	57.10%
		Yes	1	33.30%	7	36.80%	3	60.00%	6	42.90%
	Quadrant 4	No	2	66.70%	10	52.60%	2	40.00%	6	42.90%
		Yes	1	33.30%	9	47.40%	3	60.00%	8	57.10%
Total			3	100.00%	19	100.00%	5	100.00%	14	100.00%

Number anomalies included agenesis and supernumerary teeth. In Ica, agenesis showed the same frequency across all quadrants, whereas supernumerary teeth were most frequently observed in quadrant 4. In Huamanga, agenesis was most frequent in quadrant 1, and supernumerary teeth were most frequent in quadrant 4 (Table 3).

Shape anomalies were identified in both provinces. In Ica, dens invaginatus was the most frequent shape anomaly, followed by taurodontism. In Huamanga, dens invaginatus and taurodontism were also the most frequent shape anomalies, while fusion, peg-shaped tooth, and enamel pearls showed lower frequencies (Table 4).

Developmental dental anomalies were observed in both males and females from Ica and Huamanga. In Ica, shape anomalies were more frequent in females in quadrants 1 and 2, while number anomalies were more frequent in males in quadrant 4. In Huamanga, shape anomalies were more frequent in females in quadrant 2, size anomalies in females in quadrant 1, and number anomalies in males in quadrant 4 (Table 5).

Table 4. Distribution of developmental dental anomalies of shape according to province and dental quadrant in adults from Ica and Huamanga, Peru, 2021–2023.

Province	Maxilla	Quadrant		Type of anomaly				
			Dental anomaly	Fusion n (%)	Peg-shaped tooth n (%)	Dens invaginatus n (%)	Enamel pearls n (%)	Taurodontism n (%)
Ica	UPPER	Quadrant 1	No	0 (0.0)	3 (75.0)	13 (43.3)	1 (100.0)	5 (45.5)
			Yes	2 (100.0)	1 (25.0)	17 (56.7)	0 (0.0)	6 (54.5)
		Quadrant 2	No	2 (100.0)	0 (0.0)	14 (46.7)	1 (100.0)	5 (45.5)
			Yes	0 (0.0)	4 (100.0)	16 (53.3)	0 (0.0)	6 (54.5)
	LOWER	Quadrant 3	No	2 (100.0)	4 (100.0)	24 (80.0)	1 (100.0)	9 (81.8)
			Yes	0 (0.0)	0 (0.0)	6 (20.0)	0 (0.0)	2 (18.2)
		Quadrant 4	No	2 (100.0)	4 (100.0)	27 (90.0)	0 (0.0)	8 (72.7)
			Yes	0 (0.0)	0 (0.0)	3 (10.0)	1 (100.0)	3 (27.3)
Province	**Maxilla**	**Total**		2 (100.0)	4 (100.0)	30 (100.0)	1 (100.0)	11 (100.0)
Huamanga	UPPER	Quadrant 1	No	3 (75.0)	3 (75.0)	19 (63.3)	6 (100.0)	7 (46.7)
			Yes	1 (25.0)	1 (25.0)	11 (36.7)	0 (0.0)	8 (53.3)
		Quadrant 2	No	2 (50.0)	0 (0.0)	14 (46.7)	5 (83.3)	7 (46.7)
			Yes	2 (50.0)	4 (100.0)	16 (53.3)	1 (16.7)	8 (53.3)
	LOWER	Quadrant 3	No	4 (100.0)	4 (100.0)	23 (76.7)	4 (66.7)	13 (86.7)
			Yes	0 (0.0)	0 (0.0)	7 (23.3)	2 (33.3)	2 (13.3)
		Quadrant 4	No	3 (75.0)	4 (100.0)	27 (90.0)	2 (33.3)	14 (93.3)
			Yes	1 (25.0)	0 (0.0)	3 (10.0)	4 (66.7)	1 (6.7)
		Total		4 (100.0)	4 (100.0)	30 (100.0)	6 (100.0)	15 (100.0)

Discussion

The present study evaluated the prevalence and distribution of developmental dental anomalies identified on panoramic radiographs of adults from Ica and Huamanga, Peru, between 2021 and 2023. Overall, developmental dental anomalies were observed in 38.5% of the evaluated radiographs, with anomalies of shape representing the most frequent category, followed by anomalies of size and number. These findings are consistent with previous investigations reporting that morphological anomalies are among the most common developmental dental alterations identified in radiographic examinations. Studies conducted in Greece, Brazil, and Colombia have similarly described a predominance of anomalies affecting dental morphology, including dens invaginatus, peg-shaped teeth, fusion, and taurodontism, although the reported frequencies vary according to population characteristics and diagnostic criteria used [13,10,3,38].

Regarding anomalies of size, microdontia and macrodontia were identified in both provinces, with a greater concentration in the maxillary quadrants. These findings are partially consistent with the study conducted by Palacios and Cárdenas [55], who reported that anomalies of size and shape were frequent findings in a Peruvian population. Developmental alterations in tooth size have been associated with disturbances occurring during odontogenesis and may coexist with other dental anomalies, suggesting common developmental pathways involved in craniofacial growth and tooth formation [21,39,54]. From a clinical perspective, these conditions may influence esthetic outcomes, restorative treatment planning, and orthodontic management.

Table 5. Distribution of developmental dental anomalies according to sex, province, and dental quadrant in adults from Ica and Huamanga, Peru, 2021–2023.

Province	Sex	Maxilla	Quadrant	Dental anomaly	Shape n (%)	Size n (%)	Number n (%)
Ica	Male	UPPER	Quadrant 1	No	13 (52.0)	11 (45.8)	11 (78.6)
				Yes	12 (48.0)	13 (54.2)	3 (21.4)
			Quadrant 2	No	13 (52.0)	11 (45.8)	10 (71.4)
				Yes	12 (48.0)	13 (54.2)	4 (28.6)
		LOWER	Quadrant 3	No	18 (72.0)	23 (95.8)	8 (57.1)
				Yes	7 (28.0)	1 (4.2)	6 (42.9)
			Quadrant 4	No	22 (88.0)	19 (79.2)	6 (42.9)
				Yes	3 (12.0)	5 (20.8)	8 (57.1)
			Total		25 (100.0)	24 (100.0)	14 (100.0)
	Female	UPPER	Quadrant 1	No	9 (39.1)	10 (43.5)	4 (50.0)
				Yes	14 (60.9)	13 (56.5)	4 (50.0)
			Quadrant 2	No	9 (39.1)	11 (47.8)	7 (87.5)
				Yes	14 (60.9)	12 (52.2)	1 (12.5)
		LOWER	Quadrant 3	No	22 (95.7)	20 (87.0)	6 (75.0)
				Yes	1 (4.3)	3 (13.0)	2 (25.0)
			Quadrant 4	No	19 (82.6)	20 (87.0)	6 (75.0)
				Yes	4 (17.4)	3 (13.0)	2 (25.0)
			Total		23 (100.0)	23 (100.0)	8 (100.0)
Province	**Sex**	**Maxilla**	**Quadrant**	**Dental anomaly**	**Shape n (%)**	**Size n (%)**	**Number n (%)**
Huamanga	Male	UPPER	Quadrant 1	No	19 (73.1)	21 (63.6)	10 (76.9)
				Yes	7 (26.9)	12 (36.4)	3 (23.1)
			Quadrant 2	No	13 (50.0)	18 (54.5)	9 (69.2)
				Yes	13 (50.0)	15 (45.5)	4 (30.8)
		LOWER	Quadrant 3	No	20 (76.9)	28 (84.8)	7 (53.8)
				Yes	6 (23.1)	5 (15.2)	6 (46.2)
			Quadrant 4	No	23 (88.5)	23 (69.7)	5 (38.5)
				Yes	3 (11.5)	10 (30.3)	8 (61.5)
			Total		26 (100.0)	33 (100.0)	13 (100.0)
	Female	UPPER	Quadrant 1	No	19 (57.6)	7 (33.3)	1 (33.3)
				Yes	14 (42.4)	14 (66.7)	2 (66.7)
			Quadrant 2	No	15 (45.5)	8 (38.1)	5 (83.3)
				Yes	18 (54.5)	13 (61.9)	1 (16.7)
		LOWER	Quadrant 3	No	28 (84.8)	19 (90.5)	3 (50.0)
				Yes	5 (15.2)	2 (9.5)	3 (50.0)
			Quadrant 4	No	27 (81.8)	17 (81.0)	3 (50.0)
				Yes	6 (18.2)	4 (19.0)	3 (50.0)
			Total		33 (100.0)	21 (100.0)	6 (100.0)

Number anomalies represented the least frequent category in the present study. Agenesis and supernumerary teeth showed different distribution patterns according to province and dental quadrant. The predominance of agenesis in the maxillary region agrees with findings reported by Miranda-Medina [17], who identified a higher frequency of third molar agenesis in the maxilla. Likewise, the occurrence of supernumerary teeth is consistent with reports from Peruvian and international radiographic studies that have highlighted substantial variability in their anatomical distribution [12,18,40,42]. These anomalies are clinically relevant because they may alter eruption patterns, occlusion, and space availability within the dental arches.

Among shape anomalies, dens invaginatus and taurodontism were the most frequently identified findings in both provinces. Similar observations have been reported in studies evaluating developmental dental anomalies through panoramic radiographs [10,25,36,37,38]. The identification of these conditions is particularly important because they may complicate endodontic, restorative, periodontal, and orthodontic treatment. Therefore, panoramic radiography remains a valuable diagnostic resource for the early recognition of developmental anomalies and for improving treatment planning in routine dental practice [3,10,13].

This study presents several strengths. First, it included radiographs from two geographically distinct Peruvian provinces, providing epidemiological information from populations that have been underrepresented in the literature. Second, the use of panoramic radiographs allowed standardized evaluation of multiple developmental anomalies within a relatively large sample of adult patients. Nevertheless, some limitations should be acknowledged. The retrospective design restricted the availability of clinical information and prevented evaluation of potential etiological factors associated with the anomalies. In addition, the use of non-probabilistic sampling may limit the external generalizability of the findings beyond the study population. Furthermore, panoramic radiographs may present lower diagnostic accuracy than three-dimensional imaging techniques for certain dental anomalies.

Future studies should incorporate multicenter designs involving broader geographic regions of Peru and should evaluate potential genetic, environmental, and demographic factors associated with developmental dental anomalies. The use of cone-beam computed tomography and standardized diagnostic criteria may also improve the characterization of these conditions and facilitate comparisons across populations. Additional research is needed to establish national epidemiological estimates and to determine the clinical impact of developmental dental anomalies on oral health outcomes.

Conclusions

Developmental dental anomalies were identified in 38.5% of panoramic radiographs from adults in Ica and Huamanga, Peru, between 2021 and 2023. Shape anomalies were the most frequent category, followed by size anomalies and number anomalies. Dens invaginatus and taurodontism were the most common shape anomalies, while microdontia, macrodontia, agenesis, and supernumerary teeth showed variable distribution according to province, quadrant, and sex. These findings support the relevance of panoramic radiographic assessment for identifying developmental dental anomalies in adult dental care

Author Contributions Statement (CrediT)

EEM: Conceptualization, Methodology, Writing – Original Draft, Supervision, Formal analysis, Data curation, Validation, Visualization, Resources, Project administration, Funding acquisition, Writing – Review & Editing.

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Conflict of Interest

The authors declare that they have no competing financial, professional, institutional, or personal interests that could have influenced the design, conduct, analysis, interpretation, or reporting of this study.

Data Availability

The data supporting the findings of this study are not publicly available because they contain clinical records subject to institutional confidentiality requirements. However, anonymized data may be obtained from the corresponding author upon reasonable request and with permission from the participating institution.

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