İZMİR KÂTİP ÇELEBİ ÜNİVERSİTESİ

Current Journal of Medical Research

CJMR

Araştırma Makalesi / *Research Article* Vol: 4 Issue:3 Year: 2024 e-ISSN: 2791-7061

DOI: 10.52818/cjmr.1483418

Examination of Pelvis Diameters and Pelvis Types On 3D Computed Tomography Images

Pelvis Types in Women in Different Age Groups

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Article Info

Article History

Received: 13/05/2024
Accepted: 03/10/2024
Published: 31/12/2024

Keywords:
Pelvis types,
Gynecoid,
Platypelloid,
Android,
Anthropoid

ABSTRACT

Objective: There are four main types of female pelvis: android, anthropoid, gynecoid, and platypelloid. The anatomical structure of certain pelvic types can make vaginal childbirth more difficult. Pelvic shape may also change slightly with age. Our study aimed to examine the distribution of pelvic types in women from two different age groups: young and old.
Materials and Methods: We analyzed 3D images of 100 women—50 women aged 18-25 and 50 women aged 60-70—created using the RadiAnt DICOM Viewer program. Pelvic diameters were measured, and pelvic types were classified.
Results: Our analysis showed a clear predominance of platypelloid and gynecoid pelvic types compared to the anthropoid and android types. In the 18-25 age group, the gynecoid type was the most common, accounting for 48%, while the android type was the least common at just 2%. In the 60-70 age group, the platypelloid type was most prevalent, at 70%, while the anthropoid type was not observed ($p < 0.005$).
Conclusion: The platypelloid type was the most common pelvic type in our study, followed by the gynecoid type. Notably, the gynecoid type was less common in women aged 60-70, suggesting that age may have a significant impact on changes in pelvic anatomy.

Üç Boyutlu Bilgisayarlı Tomografi Görüntüleri Üzerinde Pelvis Çaplarının ve Pelvis Tiplerinin İncelenmesi

Farklı Yaş Gruplarındaki Kadınlarda Pelvis Tipleri

Makale Bilgisi

Makale Geçmişi
Geliş Tarihi: 13/05/2024
Kabul Tarihi: 03/10/2024
Yayın Tarihi: 31/12/2024

Anahtar Kelimeler:
Pelvis tipleri,
Gynecoid,
Platypelloid,
Android,
Anthropoid

ÖZET

Amaç: Kadın pelvis'inin android, anthropoid, gynecoid ve platypelloid olmak üzere temelde dört farklı tipi vardır. Bu pelvis tiplerinden bazılarının anatomik yapısı normal vajinal doğumun gerçekleşmesini zorlaştırır. Pelvisin şekilsel özellikleri yaş ile beraber bir miktar değişiklik gösterebilir. Çalışmamızda genç ve yaşlı olmak üzere iki farklı yaş grubundaki kadınlarda pelvis tiplerinin incelenmesi amaçlanmıştır.
Gereç ve Yöntemler: 18-25 yaş aralığındaki 50 kadın ve 60-70 yaş aralığındaki 50 kadın olmak üzere toplamda 100 kadının görüntülemeleri RadiAnt DICOM Viewer programı aracılığıyla 3 boyutlu hale getirilerek pelvis çapları ölçüldü ve pelvis tipleri belirlendi.
Bulgular: Elde edilen pelvis tiplerini karşılaştırdığımızda platypelloid ve gynecoid pelvis tipi sayısı, anthropoid ve android pelvis tipi sayısına net bir üstünlük sağlamıştır. 18-25 yaş aralığında %48 oranla gynecoid tip en çok görülürken android tip %2 oranla en az görülmüştür. 60-70 yaş aralığında %70 oranla platypelloid tip en çok görülürken anthropoid tipe hiç rastlanmamıştır ($p<0.005$).
Sonuç: Çalışmamızda en çok görülen pelvis tipi platypelloid tiptir. Gynecoid tip ikinci sıradadır. Araştırmamızda 60-70 yaş aralığındaki kadınlarda gynecoid pelvis tipi daha az yaygındır, bu da yaşın pelvik anatomideki değişiklikler üzerinde belirleyici bir etkiye sahip olabileceğini düşündürebilir.

To cite this article:
Kucuk, S., et al. (2024). Examination of Pelvis Diameters and Pelvis Types On 3D Computed Tomography Images. CJMR, 4(3), 12-22. https://doi.org/10.52818/cjmr.1483418

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"This study was presented as an oral presentation at the 4th National Medical Student Congress of Izmir Katip Celebi University Faculty of Medicine.

Introduction

The pelvis is formed by the union of the right and left hip bones with the sacrum and coccyx at the back. The area above the linea arcuata is known as the pelvis major, while the area below it is referred to as the pelvis minor. The entrance to the pelvis minor, called the apertura pelvis superior (pelvic inlet), has different shapes depending on the type of pelvis.

The most commonly used classification for pelvic types is the one proposed by Caldwell and Moloy, which takes into account the dimensions and appearance of the apertura pelvis superior. According to Caldwell and Moloy's classification, there are four distinct types of pelvis: gynecoid, android, anthropoid, and platypelloid.

In the gynecoid type, the maximal transverse diameter of the apertura pelvis superior is wider, giving the pelvic inlet an oval shape. It is generally considered the most common pelvis type in women. Additionally, the distance between the spinae ischiadica is wider, which facilitates the passage of the baby through the birth canal. The android type resembles the male pelvis; thus, the apertura pelvis superior is triangular, and the pelvis minor is typically funnel-shaped. The anthropoid type is characterized by a long conjugata vera, with a decreased and narrowed maximal transverse diameter. The pelvis is usually deeper in this type. The platypelloid type features a shorter sagittal diameter and a longer maximal transverse diameter, with a shallower depth of the pelvis minor.

The purpose of our study; The aim of our study was to compare the distribution of pelvic types (gynecoid, android, anthropoid, and platypelloid) in women from two different age groups in our society: young adults (just before the pelvis is fully developed) and older adults.

Materials and Methods

In this study, pelvic types were examined in women from two different age groups: 60-70 years old and 18-25 years old. The study was approved by the Ethics Committee of Izmir Katip Celebi University Faculty of Medicine, under the decision number 21.09.2023/0373, issued by the Non-Invasive Clinical Research Ethics Committee.

The CT images of a total of 100 women were examined, including 50 women aged 18-25 years and 50 women aged 60-70 years, who had undergone CT scans of the lower abdomen between 01.01.2020 and 31.12.2023 at Izmir Katip Çelebi University Atatürk Training and Research Hospital. Women with images showing traffic accidents, pelvic fractures, previous surgeries that could disrupt pelvic structure, or congenital pelvic anomalies were excluded from the study. All images were obtained using a 128-detector CT scanner (GE Revolution) with a routine protocol for the lower abdomen. The acquisition parameters were 120 kV, with an axial slice thickness of 2.5 mm. Additionally, sagittal and coronal reconstructions with a slice thickness of 3 mm were available. All data were transferred to the RadiAnt DICOM Viewer program (Medixant, Poland) and converted into 3D. Diameters of the apertura pelvis superior were measured from the obtained images. These included the median

diameter (conjugata anatomica), transverse diameter, conjugata vera (the narrowest distance between the promontory and the symphysis pubis in the midline), both oblique diameters (right and left), and the posterior sagittal diameter (the distance between the promontory and the transverse diameter) (Figure 1). A total of 600 measurements were made in the study. Pelvic types were determined by calculating the Brim index from the obtained data (2). The Brim index is calculated by multiplying the ratio of the shortest distance in the sagittal plane to the widest distance in the transverse plane of the pelvic inlet by 100. Based on reference values for the Brim index, all pelvises were classified into the following types: Gynecoid type (85-100%), anthropoid type (>100%), and platypelloid type (<85%). The Android type is considered a modified anthropoid type and requires a clear distinction from the anthropoid type. The Brim index alone is insufficient to distinguish between these two types. Therefore, a special formula suggested by Nikola et al. was used to determine the Android type. This formula uses the following calculation: (posterior sagittal diameter/conjugata vera) x 100 was used (2). According to this formula, if the result is between 24% and 40%, the pelvis type is classified as Android.

Inclusion and exclusion criteria

Inclusion Criteria: Pelvic CT images of women aged 18-25 years and 60-70 years.

Exclusion Criteria: Women who have had a traffic accident, pelvic fractures, surgery that may disrupt the pelvic structure, or congenital pelvic anomalies; women under the age of 18; pelvic CT images of women aged 25-60; and male pelvis CT images.

Data collection tools

This study was conducted using the PROBEL data recording procedures at Izmir Katip Çelebi University Atatürk Training and Research Hospital. Pelvic CT images, retrospectively obtained from the radiology archive between 2020 and 2023, were used in the study.

Statistical analysis

In order to ensure standardization, measurements for each parameter on computed tomography images were repeated three times and the average of all three measurements was used as data. The data obtained was saved in the Microsoft Office Excel program. Data analysis was done with SPSS 25.00 program. The Shapiro-Wilk test was used to check whether the measurement values were homogeneous (normally distributed) across the sample size. Descriptive statistical results such as mean, standard deviation and median of the measured morphometric distances were revealed. Spearman Correlation analysis was used to determine whether there was a correlation between measured distances and pelvis types. Comparisons between groups were made using the independent sample test or Mann Whitney U test, depending on whether the pelvis measurement values showed a normal distribution. Chi-square test, a statistical test, was used to compare the pelvis types of the young and old groups with

each other.

Results

The ages of the women included in the study, the pelvic diameters obtained from measurements on 3D CT images, and the descriptive values of the calculated unit index (mean, median, standard deviation, minimum, and maximum values) are presented in Table 1. When both groups are evaluated together, the most common pelvis type is the platypelloid type, followed by the gynecoid type. The frequency distribution of pelvis types is provided in Table 2. The least common pelvis types are the anthropoid and android types. When evaluating pelvis type frequencies separately in the young and elderly groups, the gynecoid type is the most common in the young group (18–25 years old), with a prevalence of 48%, while the android type is the least common, at 2%. In contrast, in the elderly group (60–70 years old), the platypelloid type is the most common, with a prevalence of 70%, and the anthropoid type is not observed at all. Detailed results are shown in Table 3. According to the Chi-Square test, the differences in pelvis type distribution between the young and elderly groups are statistically significant, $p<0.005$ (Table 4).

Except for the right oblique diameter, the values of other pelvic diameters and brim index values showed a normal distribution. For group comparisons, the Whitney U test was used for the right oblique diameter, while the independent samples test was applied for the other pelvic diameters (Table 5). Significant differences between the young and elderly groups were found in the right and left oblique diameters, posterior sagittal diameter, and transverse diameters ($p< 0.005$). Additionally, the differences in calculated brim index values between the groups were also statistically significant ($p < 0.005$). Further details are provided in Table 5.

Discussion

In our study, we compared the prevalence of pelvic types in young adult and elderly women from the same society to identify generational differences. Studies in the literature have examined the frequency of pelvic types in women from different societies. The results of our study differ from those of Vučinić et al. (2). Their study measured pelvic CT images from 54 individuals of varying ages, while our study analyzed pelvic patterns in two distinct groups of women: young and elderly. Vučinić et al. reported that among the 54 individuals, 28 (52%) had a gynecoid pelvis, 11 (20%) had a platypelloid pelvis, 8 (15%) had an anthropoid pelvis, and 7 (13%) had an android pelvis. The order of frequency was gynecoid > platypelloid > anthropoid > android. In contrast, in our study of 100 women, 58% had a platypelloid pelvis, 38% had a gynecoid pelvis, 2% had an anthropoid pelvis, and 2% had an android pelvis. The frequency order in our study was platypelloid > gynecoid > anthropoid = android. When comparing results, the gynecoid pelvis was the most dominant type in their study, while it was the second most common type in ours. The notable differences in the frequencies of android and anthropoid pelvis types between the studies are significant. One possible explanation for these

differences could be the geographic and societal variations in the populations studied.

In their study of 400 Nigerian women, Bukar M and colleagues reported that 361 women (90.3%) had a gynecoid pelvis, 36 women (9%) had an android pelvis, and 3 women (0.8%) had an anthropoid pelvis (3). They did not observe any instances of the platypelloid pelvis type. While the most common pelvis types in our study were platypelloid and gynecoid, Bukar et al. identified gynecoid and android as the most prevalent types. This discrepancy is likely attributable to genetic differences and variations in the geographical conditions of populations living in vastly different regions.

Ciftcioglu et al., in their study of pelvic radiographs from 284 women aged 15–49 (mean age = 30.32), found that the gynecoid pelvis was the most common type, with a prevalence of 64.1% (4). The gynecoid type was followed by the platypelloid type (16.5%), the anthropoid type (11.3%), and the android type (8.1%). In our study, the platypelloid pelvis was the most common type, followed by the gynecoid type. Comparing the results of Ciftcioglu's study with ours, although the rankings differ, both studies identified the platypelloid and gynecoid types as the two most common, while the anthropoid and android types were the least common. The higher average age in our study, along with the exclusion of middle-aged women (25–60 years old), may explain the differences between the results, even though both studies were conducted in the same country.

The table comparing the results of some studies in the literature with our study is provided below (Table 6) (1, 4–6). According to the sources in the table, the gynecoid pelvis is consistently the most common type, although the percentages vary. In the 1938 study by Caldwell and Moloy on white and black women, the platypelloid pelvis was the least common type, which contrasts significantly with the findings of our study. Details are shown in Figure 2. In our study, unlike the values reported in classical textbooks, the platypelloid pelvis was the most common type, while the gynecoid type, typically identified as the most frequent in classical references, ranked second. Comparing the results of three studies—Vural et al. in Istanbul, Ciftcioglu et al. in the Black Sea region, and our study in Izmir (4, 7)—the order of pelvis type prevalence is as follows: Vural et al. reported gynecoid, platypelloid, android, and anthropoid; Ciftcioglu et al. found gynecoid, platypelloid, anthropoid, and android; and in our study, platypelloid, gynecoid, anthropoid, and android were observed. In conclusion, when evaluating results from three different regions, the most common pelvis types among Turkish women are gynecoid and platypelloid. Differences in the results across regions may be partially explained by variations in the number of births among the women included in the studies.

Kolesova et al. published a study investigating how pelvic anatomy changes with gender and age (8). In their study, pelvic measurements of 211 women and 181 men were obtained using computed tomography pelvimetry. They observed that age-related changes in pelvic

dimensions are more pronounced in the apertura pelvis superior and apertura pelvis inferior (pelvic inlet and outlet). They reported that the transverse and sagittal diameters of female pelvises are larger than those of males; however, the age-related changes are similar for both sexes. With age, the transverse diameter of the apertura pelvis superior increases while the sagittal diameter decreases. Conversely, in the apertura pelvis inferior, the transverse diameter decreases, and the sagittal diameter increases. Kolesova et al. did not address the frequency of pelvic types in their study, making it impossible to compare their findings with ours in terms of pelvic typing (8). However, their age-related results may provide insights that help interpret the differences in pelvic types between the young and elderly women in our study.

In a study conducted at Monmouth University in New Jersey, Delprete H examined the pelvises of 182 women with an average age of 56.57 years, all of whom had completed bone development after the age of 24, using three different skeletal collections (Hamann-Todd, Terry, Coimbra) (9). Among the 182 pelvises, 108 (59.3%) were android, 23 (12.6%) were anthropoid, 26 (14.3%) were gynecoid, and 25 (13.7%) were platypelloid. Unlike our study, the android pelvis was the most common type in their results, with the frequency order being android > anthropoid > gynecoid > platypelloid. In contrast, in our study, the most common type among women aged 18–25 was the gynecoid pelvis (48%), followed by the platypelloid type (46%). In the 60–70 age group, the platypelloid type was the most common (70%). The low prevalence of the anthropoid (2%) and android (2%) pelvis types in our study differentiates our findings from those of Delprete's study.

The study by Koļesova, O et al. was conducted on 172 women aged 18–69, divided into three groups: 18–25 years, 26–49 years, and 50–69 years (10). Contrary to expectations that pelvic sizes would be larger in younger women, the study found the opposite—narrow pelvises were more frequently observed in the younger age group. In the 26–49 age group, the prevalence of the gynecoid pelvis, which facilitates childbirth, was found to be 36%. The authors suggested that more detailed research is needed on pelvic type distribution and parameters in the 18–25 age group, given the growth trend where pelvic parameters change with age, with pelvic inlet dimensions increasing until age 25. In our study, the most common pelvis types in the 18–25 age group were gynecoid (48%) and platypelloid (46%).

In their study on 60 women in Nepal, Manandhar et al. found the prevalence of the gynecoid pelvis type to be 10% in the 25–45 age group and 36.66% in the 45–65 age group (11). In contrast, in our study, the gynecoid pelvis type was found in 48% of the 18–25 age group and 28% of the 60–70 age group.

Conclusion

Although it is generally believed in the literature that the gynecoid pelvis is the most common type in women and the platypelloid type is the least common, various studies reveal significant differences in the frequency of pelvis types across societies. The least common anthropoid and android pelvis types in one society may be the most common in another. Therefore, this topic needs to be examined and reinterpreted specifically for populations living in different geographical regions.

Limitations

The unknown number of births among individuals included in our retrospective study is a limitation.

Acknowledgement: There is no conflict of interest in the study. This study has not been funded.

Funding: This study has not been funded.

Ethics Approval: The study was approved by the Ethics Committee of Izmir Katip Celebi University Faculty of Medicine, under the decision number 21.09.2023/0373, issued by the Non-Invasive Clinical Research Ethics Committee.

Author contributions

For the preparation of the article all authors have taken equal responsibility. All authors discussed the results and contributed to the final manuscript

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Table 1. Descriptive parameters

		Age	Diameters (cm)						Brim Index
			Sagittal	Conjugata	Right_Oblik	Left Oblik	Transvers	Posterior Sagittal	
N	Valid	100	100	100	100	100	100	100	100
	Missing	0	0	0	0	0	0	0	0
Mean		42.37	12.73	10.64	11.56	11.64	12.97	5.26	82.45
Median		42.00	12.73	10.67	11.57	11.60	12.95	5.22	83.83
Std. Deviation		22.82	1.19	1.22	0.85	0.76	0.95	0.78	10.75
Minimum		18.00	9.57	8.02	8.65	10.15	10.68	3.42	59.06
Maximum		69.00	16.25	14.14	13.62	13.60	15.26	7.37	111.43

Table 2. Pelvis types

	Pelvis types	Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Platypelloid pelvis	58	58	58	58
	Gynecoid pelvis	38	38	38	96
	Anthropoid pelvis	2	2	2	98
	Android pelvis	2	2	2	100
	Total	100	100	100	

Table 3. Pelvis types seen in young and old groups

Pelvis_Type * Grup Crosstabulation					
			Group		Total
			18-25	60-70	
Pelvis_Types	Platypelloid pelvis	Count	23_a	35_b	58
		% within Grup	46.00%	70.00%	58.00%
	Gynecoid pelvis	Count	24_a	14_b	38
		% within Grup	48.00%	28.00%	38.00%
	Anthropoid pelvis	Count	2_a	0_a	2
		% within Grup	4.00%	0.00%	2.00%
	Android pelvis	Count	1_a	1_a	2
		% within Grup	2.00%	2.00%	2.00%
Total		Count	50	50	100
		% within Grup	100.00%	100.00%	100.00%

Table 4. Chi-Square Tests results

	Value	df	Asymptotic Significance (2-sided)	Monte Carlo Sig. (2-sided)			Monte Carlo Sig. (1-sided)		
				Sig.	99% Confidence Interval		Sig.	99% Confidence Interval	
					Lower Bound	Upper Bound		Lower Bound	Upper Bound
Pearson Chi-Square	7.114[a]	3	0.068	.038[b]	0.033	0.043			
Likelihood Ratio	7.936	3	0.047	.055[b]	0.049	0.06			
Fisher's Exact Test	6.936			.034[b]	0.029	0.038			
Linear-by-Linear Association	4.737[c]	1	0.03	.042[b]	0.037	0.047	.020[b]	0.016	0.023
N of Valid Cases	100								

Table 5. Group statistics

		Group	N	Mean	Std. Deviation	Std. Error Mean	Sig.(2-tailed)
Brim_Index		18-25	50	86.34	9.84	1.39	<0,001*
		60-70	50	78.57	10.29	1.45	
Diameters (cm)	Sagittal	18-25	50	12.91	1.22	0.17	0,133
		60-70	50	12.55	1.14	0.16	
	Conjugata	18-25	50	10.88	1.09	0.15	0,053
		60-70	50	10.41	1.32	0.19	
	Left_Oblik	18-25	50	11.36	0.70	0.10	<0,001*
		60-70	50	11.93	0.72	0.10	
	Transvers	18-25	50	12.66	0.97	0.14	0,001*
		60-70	50	13.28	0.83	0.12	
	Posterior Sagittal	18-25	50	5.54	0.76	0.11	<0,001*
		60-70	50	4.98	0.71	0.10	
	Right_Oblik	18-25	50	11,36	0.70	0.10	<0,05 **
		60-70	50	11.75	0.94	0.13	

* p<0.05 Independent sample test results
**p<0.05 Mann-Whitney U test result

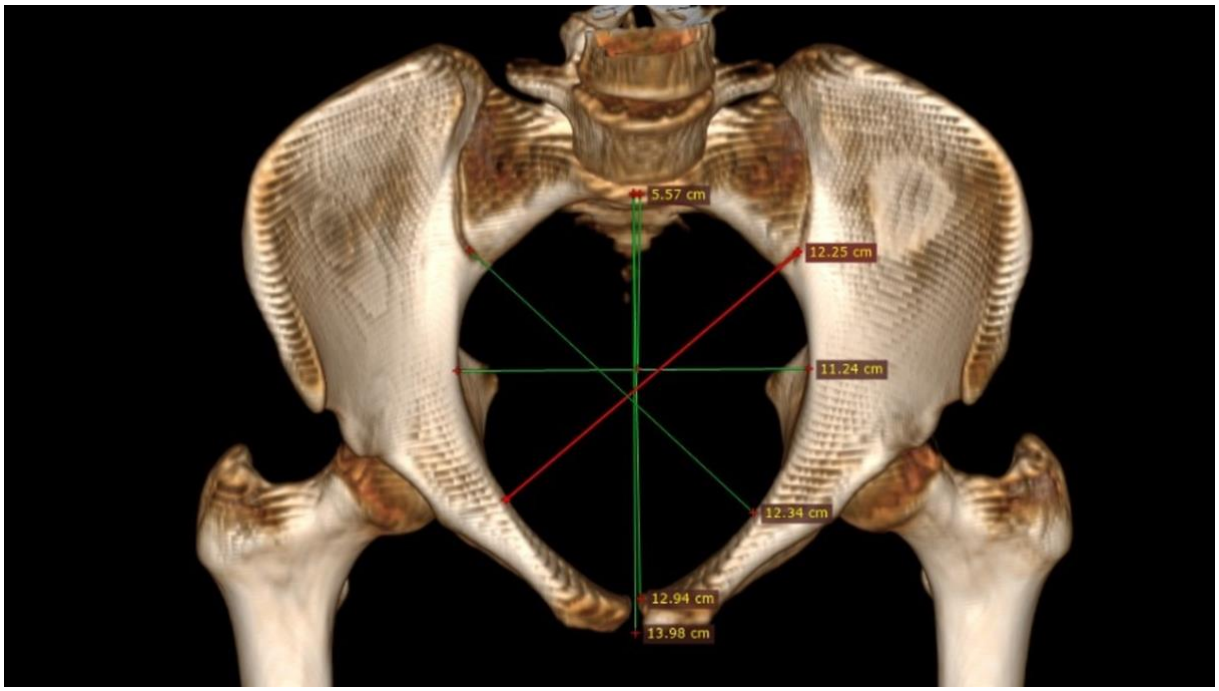

Figure 1. Measured distance and diameters.

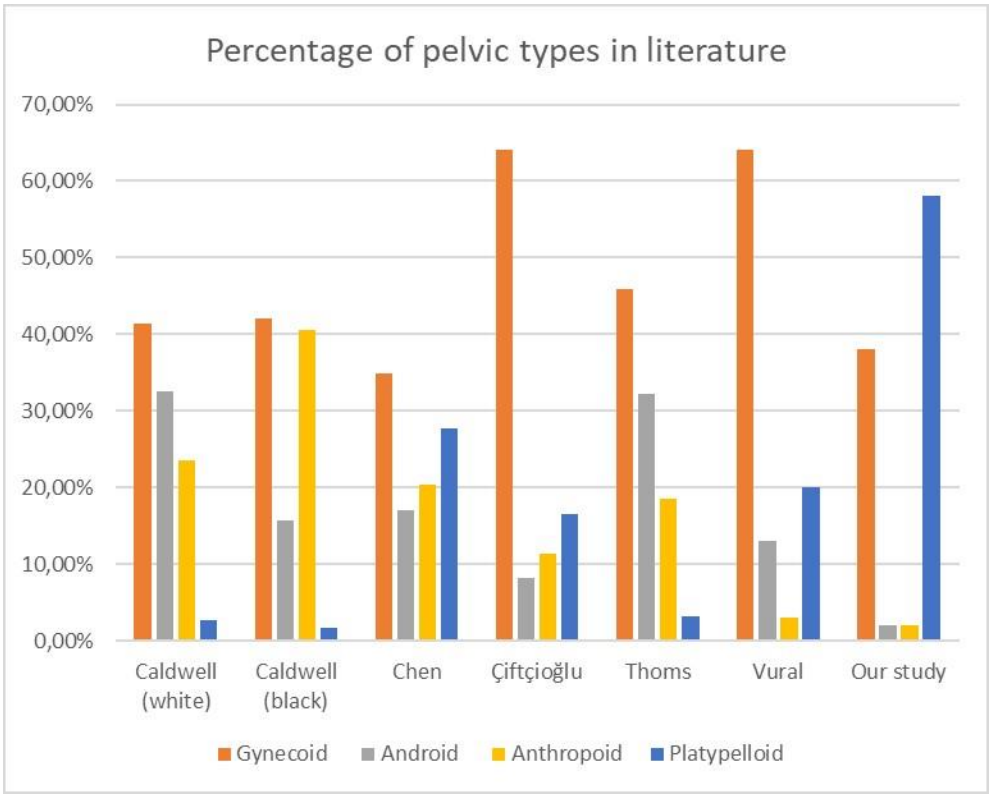

Figure 2. Percentage of the pelvis in literature.