



ARTIFICIAL INTELLIGENCE IN DIAGNOSIS OF DEVELOPMENTAL DYSPLASIA OF THE HIP (DDH): A REVIEW OF CURRENT CAPABILITIES AND POTENTIAL IMPACT

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1. INTRODUCTION

DDH is a congenital condition where the hip joint fails to form properly, leading to instability and potential dislocation (1). It affects about **4.9 per 1000 live births**, with *early diagnosis improving prognosis and reducing the need for costly surgical interventions* (2, 3).

Current diagnostic methods, such as **X-rays** and **ultrasonography**, require significant expertise, limiting their effectiveness (4). Recent advancements in **artificial intelligence (AI)** offer promising solutions by enhancing image-based diagnostics, particularly in areas with limited orthopedic resources (5).

2. OBJECTIVES

Provide a comprehensive overview of advancements in AI for diagnosing DDH.

Compare accuracy and sensitivity levels across different AI models.

3. METHODOLOGY

A comprehensive search of 5 databases yielded 10 studies on 28 AI models, trained overall on a total of 41,865 images.

4. RESULTS

Table 1 – Study Characteristics

Study, Year	Country	Centers	Input	Output	Algorithm used	No. of images	Training size	Validation size	Testing Size	Ground Truth	FR(%)
J Chen et al. 2024	China	1 center	Pelvic X-ray, Age, Gender	Dx of DDH	CNN: YOLOv5	7750	6220	765	765	NR	61.74%
H Den et al. 2023	Japan	NR	AP view hip radiography	Dx of DDH	CNN: YOLOv5, SSD (VGG16 backbone)	305	686	47	47	Yes	78.69%
Y Chen et al. 2023	Taiwan	1 center	2D US	Dx of DDH	(CNN): UNet++	2406	1754	NR	434	NR	64.77%
W Xu et al. 2022	China	3 centers	AP pelvic radiographs	Classify DDH	Mask-RCNN, Hnet, ResNet50	1265	1012	253	NR	Yes	55.97%
M Fraiwan et al. 2022	Jordan	2 centers	AP Pelvic X-ray	Dx of DDH	CNN	354	NR	NR	NR	Yes	NR
H Park et al. 2020	Korea	3 centers	AP view hip radiography	Dx of DDH	CNN	5589	18552	NR	513	Yes	NR
S-C Zhang et al. 2020	China	1 center	AP pelvic radiographs	Dx of DDH	DL: ResNet-101, RPN, ROI pooling	10219	8000	1081	1138	NR	76.42%
A Sezer et al. 2019	France	NR	2D US	Dx of DDH	CNN	675	472	NR	203	NR	NR
D Zonoobi et al. 2018	Canada	4 centers	3D + 2D US	Dx of DDH	ML: Logistic Regression	1728	NR	NR	NR	NR	NR
Q Li et al. 2019	China	1 center	AP pelvic radiographs	Sharps angle	Mask R-CNN (ResNet101 + FPN backbone)	11574	9248	2225	101	NR	NR

Table 2 – Model Performance

Study, Year	Model architecture	Pretrained	No. of images	Sensitivity (%)	Specificity (%)	Precision (%)	F1-score (%)	Accuracy (%)
J Chen et al. 2024	CNN: YOLOv5	NR	7750	86.73%	87.23%	86.54%	86.57%	86.70%
H Den et al. 2023	CNN: YOLOv5, SSD (VGG16 backbone)	Yes	305	94.00%	96.00%	85.00%	NR	96.00%
Y Chen et al. 2023	(CNN): UNet++	No	2406	88.20%	80.30%	85.40%	NR	84.80%
W Xu et al. 2022	Mask-RCNN, Hnet, ResNet50	NR	1265	91.73%	66.61%	91.51%	91.51%	92.22%
M Fraiwan et al. 2022	CNN	Yes	354	100.00%	94.30%	90.60%	95.00%	NR
H Park et al. 2020	CNN	No	5589	94.00%	98.90%	90.40%	NR	NR
S-C Zhang et al. 2020	DL: ResNet-101, RPN, ROI pooling	Yes	10219	95.50%	99.50%	NR	NR	99.00%
A Sezer et al. 2019	CNN	Yes	675	96.17%	98.02%	NR	NR	97.70%
D Zonoobi et al. 2018	ML: Logistic Regression	NR	1728	92.53%	97.51%	97.29%	94.53%	94.58%
Q Li et al. 2019	Mask R-CNN (ResNet101 + FPN backbone)	No	11574	72.75%	80.00%	56.10%	NR	76.75%

NR = Not Reported; FR = Female Ratio; Dx = Diagnosis; DDH = Developmental Dysplasia of Hip; AP = Anteroposterior; US = Ultrasound

CNN = Convolutional Neural Network; SSD = Single Shot Multibox Detector; VGG16 = Visual Geometry Group 16; UNet++ = U-Net Plus Plus; Mask-RCNN = Mask Region-based Convolutional Neural Network; Hnet = High-Resolution Network; ResNet = Residual Network; DL = Deep Learning; RPN = Region Proposal Network; ROI = Region of Interest; ML = Machine Learning; FPN = Feature Pyramid Network

5. ILLUSTRATIONS

Fig. 1 – H. Den 2023 YOLOv5 Model- Image Output

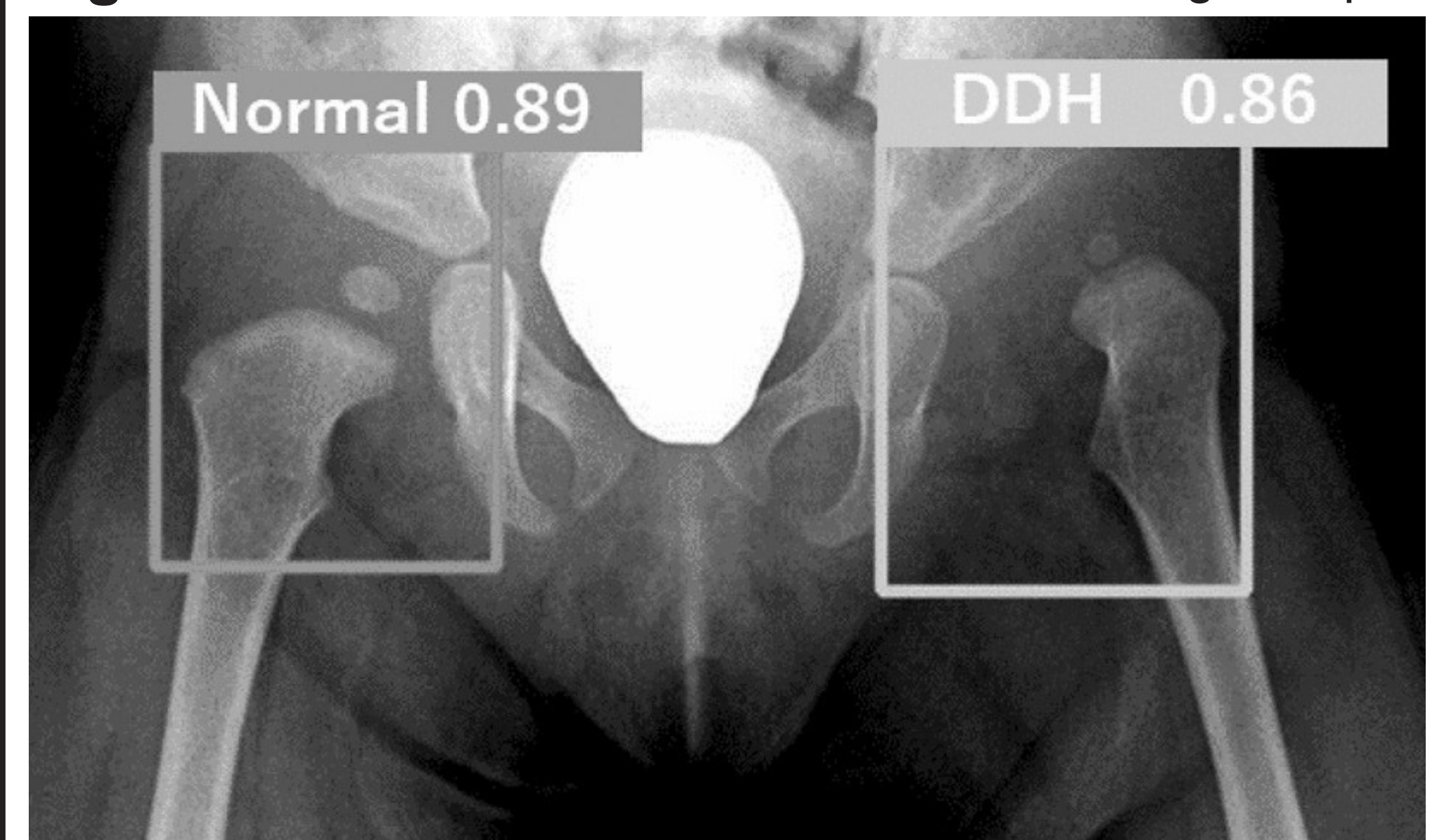
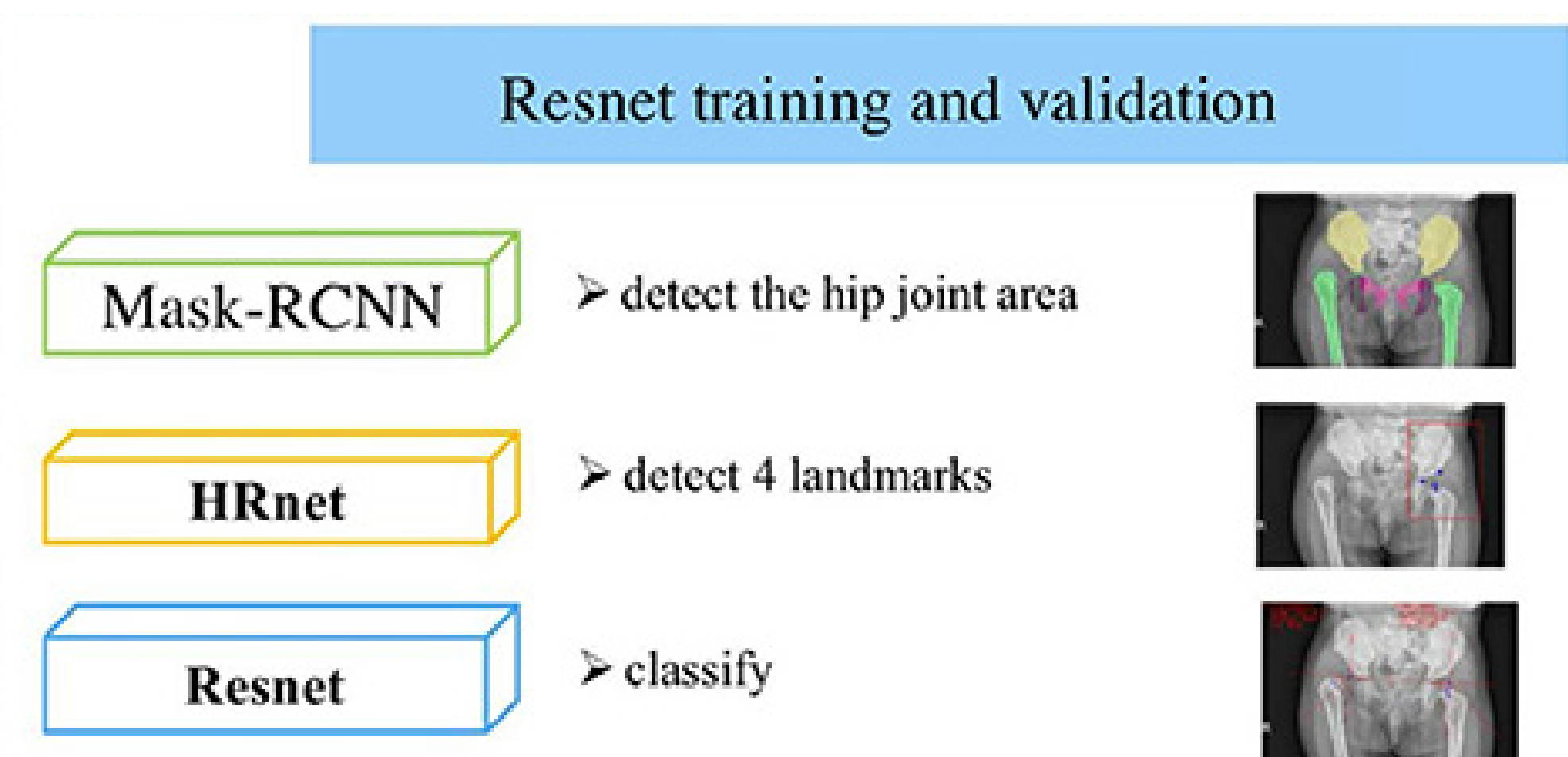


Fig. 2 – W. Xu 2022- 3-Stage Model Pipeline



6. CONCLUSION

AI models demonstrated performance **comparable to trained orthopedic surgeons** in diagnosing DDH, but many lacked external validation.

7. FUTURE DIRECTIONS

Future research should prioritize *clinical integration* and address *algorithmic bias* to enhance the utility and validity of AI models.

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