

## Supplementary

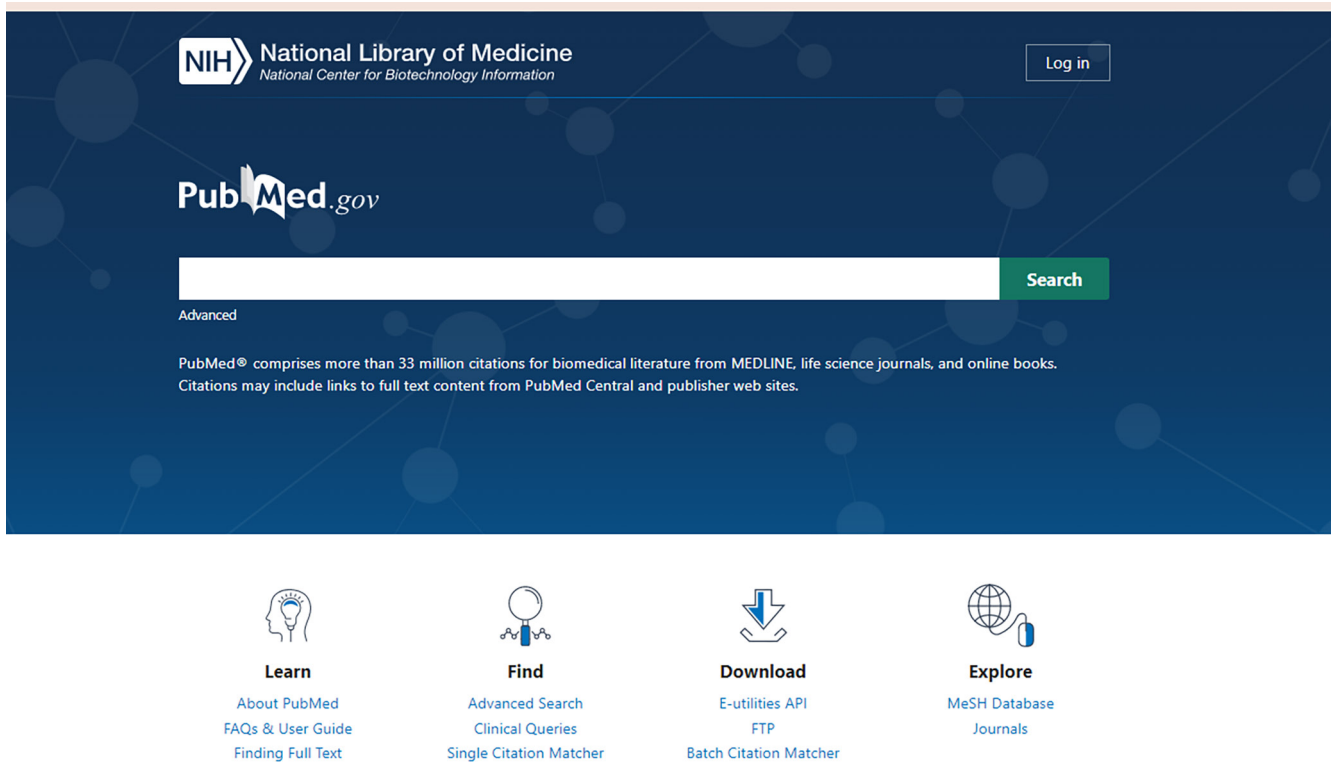
Step 1: Log in to the official website of PubMed.

Step 2: Use "deep learning" + "spine" as keywords to search in the title or abstract of the literature.

Step 3: Select the search time as January 1, 2015 to March 20, 2021.

Step 4: Literature selection and download.

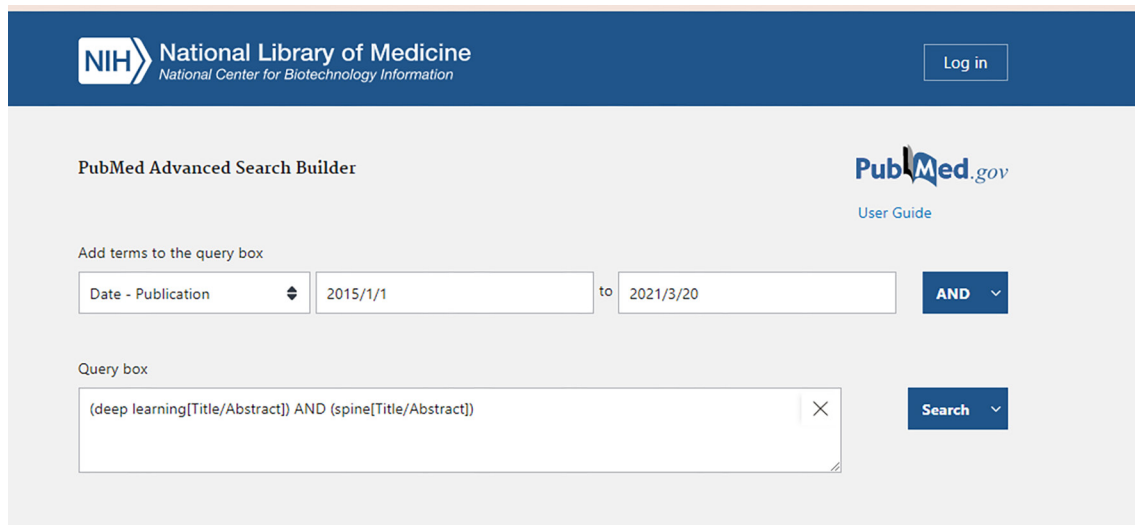
Step 1: Log in to the official website of PubMed. (<https://pubmed.ncbi.nlm.nih.gov/>)



The screenshot shows the PubMed.gov homepage. At the top left is the NIH logo and the text "National Library of Medicine National Center for Biotechnology Information". To the right is a "Log in" button. Below this is the "PubMed.gov" logo and a search bar with a "Search" button. Under the search bar, it says "Advanced" and "PubMed® comprises more than 33 million citations for biomedical literature from MEDLINE, life science journals, and online books. Citations may include links to full text content from PubMed Central and publisher web sites." At the bottom, there are four main sections: "Learn" (About PubMed, FAQs & User Guide, Finding Full Text), "Find" (Advanced Search, Clinical Queries, Single Citation Matcher), "Download" (E-utilities API, FTP, Batch Citation Matcher), and "Explore" (MeSH Database, Journals).

Step 2: Use “deep learning” + “spine” as keywords to search in the title or abstract of the literature.

Step 3: Select the search time as January 1, 2015 to March 20, 2021.




The screenshot shows the PubMed Advanced Search Builder interface. At the top left is the NIH logo and the text "National Library of Medicine National Center for Biotechnology Information". To the right is a "Log in" button. Below this is the "PubMed Advanced Search Builder" title and the "PubMed.gov" logo with a "User Guide" link. The main area has a section "Add terms to the query box" with a dropdown menu set to "Date - Publication", a text box containing "2015/1/1", a "to" label, another text box containing "2021/3/20", and a blue "AND" button with a dropdown arrow. Below this is a "Query box" containing the text "(deep learning[Title/Abstract]) AND (spine[Title/Abstract])" and a blue "Search" button with a dropdown arrow.

## Step 4: Literature selection and download.

**Deep learning of lumbar spine X-ray for osteopenia and osteoporosis screening: A multicenter retrospective cohort study.**

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## Deep learning of lumbar spine X-ray for osteopenia and osteoporosis screening: A multicenter retrospective cohort study



Bin Zhang<sup>a,b,1</sup>, Keyan Yu<sup>c,1</sup>, Zhenyuan Ning<sup>d,1</sup>, Ke Wang<sup>d,1</sup>, Yuhao Dong<sup>e</sup>, Xian Liu<sup>f</sup>, Shuxue Liu<sup>g</sup>, Jian Wang<sup>c</sup>, Cuiling Zhu<sup>c</sup>, Qinqin Yu<sup>c</sup>, Yuwen Duan<sup>c</sup>, Siying Lv<sup>c</sup>, Xintao Zhang<sup>c</sup>, Yanjun Chen<sup>c</sup>, Xiaojia Wang<sup>h</sup>, Jie Shen<sup>i</sup>, Jia Peng<sup>j</sup>, Qiuying Chen<sup>a,b</sup>, Yu Zhang<sup>d,\*</sup>, Xiaodong Zhang<sup>c,\*\*</sup>, Shuixing Zhang<sup>a,\*\*\*</sup>

<sup>a</sup> Department of Radiology, The First Affiliated Hospital of Jinan University, Guangzhou, Guangdong, PR China

<sup>b</sup> Jinan University, Guangzhou, Guangdong, PR China

<sup>c</sup> Department of Medical Imaging, The Third Affiliated Hospital of Southern Medical University (Academy of Orthopedics Guangdong Province), Guangzhou, PR China

<sup>d</sup> School of Biomedical Engineering, Southern Medical University, Guangzhou, Guangdong, PR China

<sup>e</sup> Department of Catheterization Lab, Guangdong Cardiovascular Institute, Guangdong Provincial Key Laboratory of South China Structural Heart Disease, Guangdong Provincial People's Hospital, Guangdong Academy of Medical Sciences, Guangzhou, PR China

<sup>f</sup> Department of Radiology, Guangdong Provincial Hospital of Chinese Medicine, Guangzhou, Guangdong, PR China

<sup>g</sup> The Affiliated Zhongshan Hospital of Traditional Chinese Medicine University of Guangzhou, Guangdong, PR China

<sup>h</sup> Bone mineral density test room, Health Management Centre, The Third Affiliated Hospital of Southern Medical University (Academy of Orthopedics Guangdong Province), Guangzhou, PR China

<sup>i</sup> Department of endocrinology, The Third Affiliated Hospital of Southern Medical University (Academy of Orthopedics Guangdong Province), Guangzhou, PR China

<sup>j</sup> Department of computed tomography, The Affiliated Zhongshan City Hospital of Sun Yat-sen University, PR China

### ARTICLE INFO

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### ABSTRACT

Osteoporosis is a prevalent but underdiagnosed condition. As compared to dual-energy X-ray absorptiometry (DXA) measures, we aimed to develop a deep convolutional neural network (DCNN) model to classify osteopenia and osteoporosis with the use of lumbar spine X-ray images. Herein, we developed the DCNN models based on the training dataset, which comprising 1616 lumbar spine X-ray images from 808 postmenopausal women (aged 50 to 92 years). DXA-derived bone mineral density (BMD) measures were used as the reference standard. We categorized patients into three groups according to DXA BMD T-score: normal ( $T \geq -1.0$ ), osteopenia ( $-2.5 < T < -1.0$ ), and osteoporosis ( $T \leq -2.5$ ). T-scores were calculated by using the BMD dataset of young Chinese female aged 20–40 years as a reference. A 3-class DCNN model was trained to classify normal BMD, osteoporosis, and osteopenia. Model performance was tested in a validation dataset (204 images from 102 patients) and two test datasets (396 images from 198 patients and 348 images from 147 patients respectively). Model performance was assessed by the receiver operating characteristic (ROC) curve analysis. The results showed that in the test dataset 1, the model diagnosing osteoporosis achieved an AUC of 0.767 (95% confidence interval [CI]: 0.701–0.824) with sensitivity of 73.7% (95% CI: 62.3–83.1), the model diagnosing osteopenia achieved an AUC of 0.787 (95% CI: 0.723–0.842) with sensitivity of 81.8% (95% CI: 67.3–91.8); In the test dataset 2, the model diagnosing osteoporosis yielded an AUC of 0.726 (95% CI: 0.646–0.796) with sensitivity of 68.4% (95% CI: 54.8–80.1), the model diagnosing osteopenia yielded an AUC of 0.810 (95% CI, 0.737–0.870) with sensitivity of 85.3% (95% CI, 68.9–95.0). Accordingly, a deep learning diagnostic network may have the potential in screening osteoporosis and osteopenia based on lumbar spine radiographs. However, further studies are necessary to verify and improve the diagnostic performance of DCNN models.