



# The Growing Problem of Radiologist Shortage: Taiwan's Perspective

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Taiwan is confronting a shortage of radiologists, a challenge that is echoed globally. This shortfall is attributed to the rising demand for medical imaging services, technological advancements, the aging population, and limited radiology residency positions.

As healthcare access widens and preventive care gains traction, the demand for medical imaging procedures has increased. Clinical diagnosis has shifted from symptom-based diagnosis to relying on imaging, owing to evolving patient expectations and medical disputes. Despite stable emergency room visits, computed tomography (CT) scans increased from 11.10% in 2009 to 17.70% in 2013, indicating physicians' inclination to prevent misdiagnosis through CT utilization [1].

The increased use of preventive imaging has amplified this burden. In addition to national screening programs for mammography (started in 2004) to detect breast cancer, and low-dose CT scans (started in 2022) to detect lung cancer, there has been an increase in self-paid health examinations through imaging studies. Although screening can identify early-stage cancers, false-positive results can

lead to anxiety. Patients could potentially be included in the cohort for "long-term tracking," requiring regular medical imaging assessments.

Based on a comprehensive big data analysis that surveyed CT and magnetic resonance imaging (MRI) usage data collected from the National Health Insurance Research Database in Taiwan from 2000 to 2017, the annual growth rates of both imaging modalities remained positive [2]. The most substantial growth rates for CT (9%–12%) and magnetic resonance (24%) usage were observed between 2001 and 2004, followed by a general upward trend with a growth rate of 2%–4% [2]. Recent statistics have revealed a notable increase in the number of CT examinations from 2.21 million in 2018 to 2.59 million in 2022. Likewise, the number of MRI examinations increased from 840000 in 2018 to 980000 in 2022.

With advancements in medical imaging technology, there has been a substantial increase in the number and complexity of imaging studies. Although Taiwan's utilization of imaging remains lower than that of other developed countries [3,4], the number of CT and MRI scanners has been steadily increasing. Moreover, the complexity of imaging studies has also increased. In 2015, only 50.40% of CT scanners in Taiwan were 64-slice models or greater; this percentage increased to 61.5% by 2017 [2]. Similarly, the prevalence of modern 3T MRI systems is increasing, accounting for 14.29% of all systems in 2015 and increased to 15.93% in 2017 [2]. This trend necessitates a greater number of radiologists, and subspecialty-trained radiologists, to interpret and analyze the results.

Taiwan is currently experiencing demographic aging. In 1999, the population over 65 years of age constituted only 10.5% of the total population; however, by 2025, Taiwan is projected to transform into a super-aged society, with one

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in five individuals aged  $\geq 65$  years. Taiwan is witnessing a surge in medical demands for age-related ailments and conditions. CT and MRI utilization rates were significantly higher in the older adult population, accounting for 54% of all scans conducted in 2017 [2].

The number of board-certified radiologists in Taiwan has increased from 885 in 2011 to 1354 in 2022. However, the number of radiology residency positions in Taiwan has remained unchanged for the past decade, remaining at approximately 50 since 2013. An overarching disparity exists between the escalating demand for physicians and the actual numbers in Taiwan. The country's medical schools admit a maximum of 1300 students per year, a quota set by the government that has remained unchanged for the past 24 years. The number of physicians remains closely linked to national healthcare expenditure, which is constrained by the adoption of a single-payer system by the National Health Insurance (NHI). In terms of gross domestic product share, Taiwan's healthcare expenditure remains modest at 6.1%, which is relatively low compared with other developed countries. The increase in imaging examinations without a corresponding increase in manpower worsened burnout symptoms among radiologists. In a retrospective analysis of diagnostic medical images encompassing X-rays, CT scans, and MRIs conducted between 2005 and 2020 at a single medical center, a significant increase in the number of overall imaging examinations over the years was observed [5]. However, the average time spent on interpreting a single image decreased from 16.0 s in 2005 to 2.9 s in 2020.

Artificial intelligence (AI) has emerged as a potent tool to address the shortage of radiologists. AI can handle tasks that radiologists find tiresome or time-consuming, effectively managing monotonous and repetitive duties that often lead to burnout, inefficiency, and reduced accuracy. In Taiwan, several AI products have entered the market for diagnostic purposes. Nonetheless, most AI-assisted medical benefits have yet to match doctors' expertise and technical advantages. The potential of AI lies in enhancing the workflow of radiologists through informatics-based interventions and streamlining processes, such as report creation.

To reduce redundant examinations and minimize unnecessary public exposure to radiation, the NHI established a cloud-based medical image information-sharing platform in 2018. Efforts have been made to encourage the swift uploading of images and reports onto this platform following CT and MRI scans. With access to

a cloud query system, physicians can view examination images and reports, accelerate processes, and avoid repeat examinations. In 2019, new reimbursement regulations were introduced to restrict clinicians from ordering advanced medical imaging in quick succession across different institutions.

In the long run, a potential solution to this issue involves increasing the number of radiology residency positions and implementing incentives to motivate medical graduates to choose radiology. Furthermore, radiological societies should develop and solidify subspecialty training programs to cultivate experts in specific areas of radiology, thereby enhancing the overall quality of care.

Finally, increasing public awareness of the significance of radiology in healthcare and educating the public about the appropriate principles and utilization of medical imaging can aid in the prudent allocation of medical imaging resources.

#### Conflicts of Interest

The authors have no potential conflicts of interest to disclose.

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