

Diagnostic Imaging Utilization Following Teleconsultation Versus In-Person Care: A Real-World Comparative Study

Andrea E Montero

andrea.montero@upch.pe

Centro Nacional de Telemedicina-EsSalud <https://orcid.org/0000-0003-2944-7204>

Marco A. Mascaro

Centro Nacional de Telemedicina- EsSalud

Research Article

Keywords: telemedicine, diagnostic imaging, computed tomography, radiography, health services research

Posted Date: October 18th, 2026

DOI: <https://doi.org/10.21203/rs.3.rs-11350800/v1>

License: © ⓘ This work is licensed under a Creative Commons Attribution 4.0 International License.

[Read Full License](#)

Additional Declarations: The authors declare potential competing interests as follows: The authors are employees of the Centro Nacional de Telemedicina (CENATE), EsSalud, the institution from which the study data were obtained. The authors declare no other competing financial interests or personal relationships that could have influenced the work reported in this manuscript.

Abstract

Objective: To compare the distribution of diagnostic imaging modalities following teleconsultation versus in-person care among consultations that resulted in completed imaging.

Methods: This retrospective cross-sectional study analyzed diagnostic imaging examinations from Peru's Social Health Insurance system (EsSalud) during one month, comparing in-person consultations with CENATE-EsSalud teleconsultations. The primary outcome was CT versus conventional radiography. Modified Poisson regression with patient-clustered robust standard errors estimated adjusted risk ratios controlling for age, sex, specialty, anatomical region, geography, and referral status. A specialty-restricted sensitivity analysis was performed. Pathological versus normal imaging findings were evaluated as a secondary outcome.

Results: Among 26,469 completed examinations, 25,885 followed in-person consultation and 584 followed teleconsultation. Radiography represented 77.3% of in-person and 91.6% of teleconsultation-associated imaging, whereas CT represented 18.4% and 8.0%, respectively. Teleconsultation remained associated with lower CT use relative to radiography after adjustment (aRR, 0.42; 95% CI, 0.33-0.53; $p < 0.001$), with similar findings in the specialty-restricted analysis (aRR, 0.35; 95% CI, 0.28-0.45). Pathological findings were similar between pathways (38.7% vs 39.2%; adjusted OR, 0.99; 95% CI, 0.81-1.21).

Discussion: Among imaging-producing consultations, teleconsultation was associated with a more radiography-dominant profile and lower adjusted CT use, while pathological-result proportions were similar. These findings describe imaging composition rather than the probability of receiving imaging.

Introduction

Telemedicine has become an established component of outpatient care, offering potential advantages in access, convenience, and healthcare resource use (1–4). However, remote consultation can limit direct physical examination and may therefore influence downstream diagnostic decision-making, including the use of imaging (5–7).

Diagnostic imaging is particularly relevant because modality selection depends on the clinical question, examination findings, specialty, and case complexity. Conventional radiography and computed tomography (CT) also differ substantially in diagnostic capability and radiation burden (8). Whether consultation modality influences the relative use of these modalities is therefore relevant to clinicians, radiology services, and health systems.

Available evidence suggests that teleconsultation is associated with different downstream imaging utilization. In a national US study, Chung et al. found that imaging utilization within 7 days was 29.7% lower after telemedicine than after matched in-person visits (9). That study primarily evaluated whether imaging occurred, however, rather than the composition of imaging once a patient entered an imaging

pathway. Specialty-specific evidence also suggests that the relationship may vary by clinical context; in pulmonary care, telemedicine was associated with increased CT ordering but decreased chest radiography (10).

Evidence on the composition of completed imaging after teleconsultation remains limited, particularly in large real-world health systems outside high-income settings. The present study therefore compared diagnostic imaging associated with teleconsultation and in-person encounters within a large integrated healthcare system in Peru. The primary objective was to determine whether consultation pathway was associated with CT versus conventional radiography after adjustment for demographic characteristics, specialty, anatomical region, geographic location, and referral status. Secondary objectives were to describe subgroup imaging patterns and compare pathological imaging findings between pathways.

Methods

Study Design and Setting

This retrospective cross-sectional study analyzed diagnostic imaging examinations performed nationwide within the Peruvian Social Health Insurance system (EsSalud). The associated consultations were divided into two groups: the first comprised in-person consultations, and the second comprised completed consultations conducted through the National Telemedicine Center (Centro Nacional de Telemedicina [CENATE]-EsSalud). CENATE is a national telehealth referral center located in Lima, Peru, where imaging study results are recorded in a centralized radiology information system. All eligible examinations with a finalized result during a one-month index period were included. Consultation dates and imaging request dates were not analyzed.

Participants and Variables

Eligible examinations were linked to either in-person consultation or teleconsultation; other service categories were excluded. Accordingly, the cohort represents consultations that resulted in completed diagnostic imaging rather than all consultations, and the probability of receiving imaging could not be estimated. The exposure was consultation pathway. The primary outcome was imaging modality among examinations classified as conventional radiography or CT. Mammography was described but excluded from the primary model because of its distinct referral pathway. The secondary outcome was a pathological versus normal imaging finding. Covariates were age, sex, requesting specialty, anatomical region, geographic location (Lima vs outside Lima), and referral status (locally enrolled vs referred).

Imaging Classification and Bias Control

Imaging modality was derived from the structured study-type field. Anatomical region was derived from procedure descriptions using a predefined classification. Because specialty composition differed substantially between consultation pathways, specialty was included in the primary multivariable model and a prespecified sensitivity analysis restricted the CT-versus-radiography comparison to specialties

with at least 15 teleconsultation-associated imaging examinations and adequate representation in both pathways. Repeated examinations from the same patient were addressed using patient-clustered robust standard errors.

Statistical Analysis

Continuous variables were compared using Student t tests and categorical variables using chi-square tests. The primary analysis included 25,350 CT or radiography examinations and used modified Poisson regression with a log link and patient-clustered robust standard errors to estimate an adjusted risk ratio (aRR) for CT versus radiography. The model adjusted for age, sex, specialty, anatomical region, geographic location, and referral status. A logistic model with the same covariates was used as a sensitivity check, although the aRR was considered the primary estimate because CT was not rare. The secondary pathological-finding outcome was analyzed using multivariable logistic regression adjusted for age, sex, specialty, imaging modality, anatomical region, geographic location, and referral status. Exploratory interaction terms assessed effect modification by age group (< 40, 40–64, >=65 years) and sex. Two-sided $p < 0.05$ was considered statistically significant. Analyses were performed in Python 3 using pandas and statsmodels.

Results

Study Cohort

A total of 26,469 completed diagnostic imaging examinations were linked to eligible consultations: 25,885 (97.8%) followed in-person consultation and 584 (2.2%) followed teleconsultation. These examinations represented approximately 21,342 unique patients. Teleconsultation-associated patients were older in the crude analysis (57.4 +/- 17.8 vs 52.4 +/- 20.9 years; $p<0.001$), while the proportion of women was similar (66.3% vs 64.3%; $p=0.36$). After adjustment for specialty and sex among specialties adequately represented in both groups, the age difference was no longer evident (adjusted mean difference, -0.26 years; 95% CI, -1.82 to 1.29; $p=0.74$), indicating substantial case-mix influence.

Table 1. Cohort and care-pathway characteristics

Characteristic	In-person	Teleconsultation	p value / interpretation
Imaging studies, n	25,885	584	-
Age, mean +/- SD, y	52.4 +/- 20.9	57.4 +/- 17.8	<0.001 (crude)
Female sex, %	64.3	66.3	0.36
Locally enrolled patient, %	83.9	96.1	<0.001
Referred patient, %	15.1	3.8	<0.001
Outside Lima, %	54.8	47.3	<0.001

Note: The cohort includes only consultations associated with completed diagnostic imaging. The crude age difference was no longer evident after specialty and sex adjustment.

Imaging Modality and Subgroup Patterns

Imaging modality distribution differed markedly between pathways ($p<0.001$). Radiography accounted for 77.3% of in-person and 91.6% of teleconsultation-associated imaging, whereas CT accounted for 18.4% and 8.0%, respectively; mammography accounted for 4.3% and 0.3% (Figure 1).

The difference in CT utilization was minimal among patients younger than 40 years (11.2% in-person vs 12.8% teleconsultation) and larger among those aged 40-64 years (19.0% vs 8.1%) and ≥ 65 years (22.7% vs 6.1%) (Figure 2). The exploratory age-by-pathway interaction was significant ($p=0.041$). A radiography-dominant teleconsultation pattern was present in both women and men, with no evidence of interaction by sex (p approximately 0.20).

Anatomical distribution also differed between pathways. Teleconsultation-associated imaging was more concentrated in spinal and musculoskeletal examinations, whereas abdominal/pelvic and breast imaging were uncommon (Figure 3). Anatomical region was included in the adjusted primary model.

Specialty and Referral Characteristics

Specialty distribution differed substantially between pathways ($p<0.001$). Teleconsultation-associated imaging was concentrated in Family and Community Medicine, Neurology, Pulmonology, Internal Medicine, and Rheumatology, whereas in-person imaging was dominated by General Medicine, Orthopedics/Traumatology, Internal Medicine, and Neurology (Table 2). Locally enrolled patients represented 96.1% of teleconsultation-associated imaging versus 83.9% of in-person imaging; referred patients represented 3.8% and 15.1%, respectively ($p<0.001$).

Table 2. Leading specialties contributing imaging studies

Specialty	In-person (%)	Teleconsultation (%)
Family and Community Medicine	2.7	36.6
Neurology	6.1	16.3
Pulmonology	2.7	8.4
Internal Medicine	8.0	8.0
Rheumatology	3.1	7.4
General Medicine	38.0	6.3
Orthopedics/Traumatology	12.0	4.5

Adjusted CT Utilization and Sensitivity Analysis

In the primary adjusted model, teleconsultation remained associated with a lower probability of CT relative to conventional radiography (aRR, 0.42; 95% CI, 0.33-0.53; p<0.001), corresponding to an approximately 58% lower adjusted probability of CT. Standardized CT probabilities were approximately 19.2% after in-person consultation and 8.3% after teleconsultation, an adjusted absolute difference of about -10.9 percentage points. The logistic sensitivity model yielded an adjusted OR of 0.12 (95% CI, 0.08-0.19; p<0.001). In the prespecified specialty-restricted analysis (n=19,537), the association remained significant (aRR, 0.35; 95% CI, 0.28-0.45; p<0.001) (Figure 4).

Pathological Imaging Findings

Pathological findings were nearly identical between pathways: 10,007/25,885 (38.7%) after in-person consultation and 229/584 (39.2%) after teleconsultation (p=0.82). After multivariable adjustment, consultation pathway was not associated with a pathological finding (adjusted OR, 0.99; 95% CI, 0.81-1.21; p=0.91). Adjusted predicted probabilities were 38.7% and 38.4%, respectively (Table 3).

Table 3. Pathological imaging findings by consultation pathway

Measure	In-person	Teleconsultation	Effect estimate
Pathological findings, n/N (%)	10,007/25,885 (38.7)	229/584 (39.2)	Crude p=0.82
Adjusted pathological finding probability	38.7%	38.4%	aOR 0.99 (95% CI, 0.81-1.21); p=0.91

Similar pathological-report proportions do not establish equivalent diagnostic accuracy, appropriateness, sensitivity, specificity, or clinical outcomes.

Discussion

In this real-world cohort of consultations that resulted in completed diagnostic imaging, teleconsultation was associated with a substantially different imaging profile from in-person care. Radiography represented 91.6% of teleconsultation-associated imaging compared with 77.3% after in-person consultation, whereas CT represented 8.0% and 18.4%, respectively. The difference persisted after adjustment for demographic characteristics, specialty, anatomical region, geography, and referral status, and remained in the specialty-restricted sensitivity analysis. By contrast, pathological-result proportions were nearly identical between pathways.

These findings complement recent evidence that telemedicine is associated with differences in downstream imaging utilization. Chung et al. reported 29.7% lower 7-day imaging utilization after telemedicine than after matched in-person visits in a national US cohort (9). Their study evaluated whether imaging occurred after the visit, whereas our analysis began after imaging had occurred and evaluated which modality was used. The two studies therefore address different stages of the diagnostic

pathway. Our results should not be interpreted as evidence that teleconsultation reduces overall CT ordering because consultations without imaging were not available in the source dataset.

The association also appears to be context dependent. In pulmonary care, Puthumana et al. reported increased odds of CT ordering but decreased odds of chest radiography after telemedicine visits (10), opposite to the aggregate pattern observed here. This difference reinforces the importance of specialty and case mix. In our cohort, teleconsultation-associated imaging was concentrated in family medicine, neurology, pulmonology, internal medicine, and rheumatology, whereas in-person imaging included more general medicine, orthopedics, and other specialties. Specialty differences also largely explained the crude age difference between pathways. Nevertheless, adjustment for specialty and anatomy and the specialty-restricted analysis did not eliminate the CT-versus-radiography association.

Several mechanisms could contribute. Teleconsultation may be used more often for clinical scenarios in which radiography is an appropriate first examination, while patients with greater diagnostic complexity or an anticipated need for cross-sectional imaging may be preferentially evaluated in person. Alternatively, remote care may favor a more stepwise diagnostic strategy in selected cases. Limitations of the virtual physical examination could also influence modality selection; a recent scoping review found that virtual examination can be informative but its feasibility depends on the clinical problem, technology, and patient factors (5). These mechanisms remain hypotheses because clinical indication, disease severity, prior imaging, and imaging appropriateness were unavailable.

The anatomical and age patterns provide additional context. Teleconsultation-associated imaging was more concentrated in spinal and musculoskeletal regions, and the difference in CT utilization was more pronounced among middle-aged and older patients. The age interaction was exploratory and should be interpreted cautiously. Sex did not significantly modify the association. These subgroup findings may help identify clinical settings in which future prospective work should examine appropriateness and downstream outcomes.

A notable secondary finding was the similarity in pathological-result proportions. Approximately 39% of completed studies were classified as pathological in both pathways, and the adjusted odds were essentially identical. This finding suggests that the more radiography-dominant profile after teleconsultation was not accompanied by an obvious reduction in the proportion of abnormal reports. It does not establish equivalent diagnostic accuracy or appropriateness, because no independent reference standard, missed-diagnosis assessment, clinical outcome, or expert appropriateness adjudication was available.

Our imaging-selected design introduces an additional source of selection. Henson et al. found that imaging ordered during telehealth hepatology encounters was less likely to be completed than imaging ordered during in-person encounters (11). Patients who received an imaging order but did not complete it are absent from our dataset. Consequently, our findings characterize completed imaging rather than all imaging decisions initiated during consultation.

This study has limitations. First, the dataset did not include consultations without imaging and therefore cannot estimate the overall probability of imaging or CT ordering. Second, residual confounding is possible because detailed clinical indication, symptoms, disease severity, comorbidities, and prior imaging were unavailable. Third, the teleconsultation group was substantially smaller, producing sparse cells in some specialty strata. Fourth, the pathological-result classification cannot assess diagnostic accuracy or appropriateness. Finally, the study reflects a single national healthcare system and a defined index period. Strengths include a large real-world imaging cohort, multiple specialties and anatomical regions, patient-level clustering, multivariable adjustment, and a sensitivity analysis designed to address specialty imbalance.

Conclusions

Among consultations that resulted in completed diagnostic imaging, teleconsultation was associated with a more radiography-dominant profile and a lower adjusted probability of CT relative to conventional radiography. This association persisted after adjustment and specialty-restricted sensitivity analysis, while pathological-result proportions remained similar. Studies incorporating all consultations, detailed clinical indications, imaging appropriateness, and downstream outcomes are needed to determine whether these differences reflect patient selection, clinical complexity, or changes in diagnostic decision-making associated with virtual care.

Declarations

Ethics approval: This study was approved by the COMITÉ DE ÉTICA DEL HOSPITAL NACIONAL EDGARDO REBAGLIATI MARTINS. Consent to participate: The requirement for informed consent was waived by the because of the retrospective nature of the study and the use of data containing no personally identifying information.

Declaration of generative AI and AI-assisted technologies in the writing process

During the preparation of this work the authors used OpenAI ChatGPT in order to assist with language editing, organization, and clarity. After using this tool/service, the authors reviewed and edited the content as needed and takes full responsibility for the content of the publication.

References

1. Dorsey ER, Topol EJ. State of Telehealth. *N Engl J Med*. 2016;375(2):154-161. doi:10.1056/NEJMr1601705.
2. Monaghesh E, Hajizadeh A. The role of telehealth during COVID-19 outbreak: a systematic review based on current evidence. *BMC Public Health*. 2020;20:1193. doi:10.1186/s12889-020-09301-4.

3. Snoswell CL, Taylor ML, Comans TA, Smith AC, Gray LC, Caffery LJ. Determining if telehealth can reduce health system costs: scoping review. *J Med Internet Res*. 2020;22(10):e17298. doi:10.2196/17298.
4. Kruse CS, Krowski N, Rodriguez B, Tran L, Vela J, Brooks M. Telehealth and patient satisfaction: a systematic review and narrative analysis. *BMJ Open*. 2017;7(8):e016242. doi:10.1136/bmjopen-2017-016242.
5. Tong SYK, Jackson TM, Lau AYS. Virtual physical examination in teleconsultation: a scoping review. *Int J Med Inform*. 2024;191:105561. doi:10.1016/j.ijmedinf.2024.105561.
6. Greenhalgh T, Shaw S, Wherton J, et al. Real-world implementation of video outpatient consultations at macro, meso, and micro levels: mixed-method study. *J Med Internet Res*. 2018;20(4):e150. doi:10.2196/jmir.9897.
7. Deldar K, Bahaadinbeigy K, Tara SM. Teleconsultation and clinical decision making: a systematic review. *Acta Inform Med*. 2016;24(4):286-292. doi:10.5455/aim.2016.24.286-292.
8. Brenner DJ, Hall EJ. Computed tomography-an increasing source of radiation exposure. *N Engl J Med*. 2007;357(22):2277-2284. doi:10.1056/NEJMr072149.
9. Chung Y, Nicola LP, Nicola GN, Rula EY. Imaging utilization differences after telemedicine versus in-person visits. *J Am Coll Radiol*. 2025;22(9):998-1007. doi:10.1016/j.jacr.2025.05.018.
10. Puthumana RM, Grosogoeat CA, Davis JK, et al. Telemedicine and resource utilization in pulmonary clinic. *BMC Pulm Med*. 2024;24:267. doi:10.1186/s12890-024-03066-x.
11. Henson JB, Patel YA, Wall AH, Muir AJ. Decreased completion of ordered laboratories and imaging in telehealth compared with in-person hepatology encounters. *J Clin Gastroenterol*. 2025;59(4):354-360. doi:10.1097/MCG.0000000000002023.

Figures

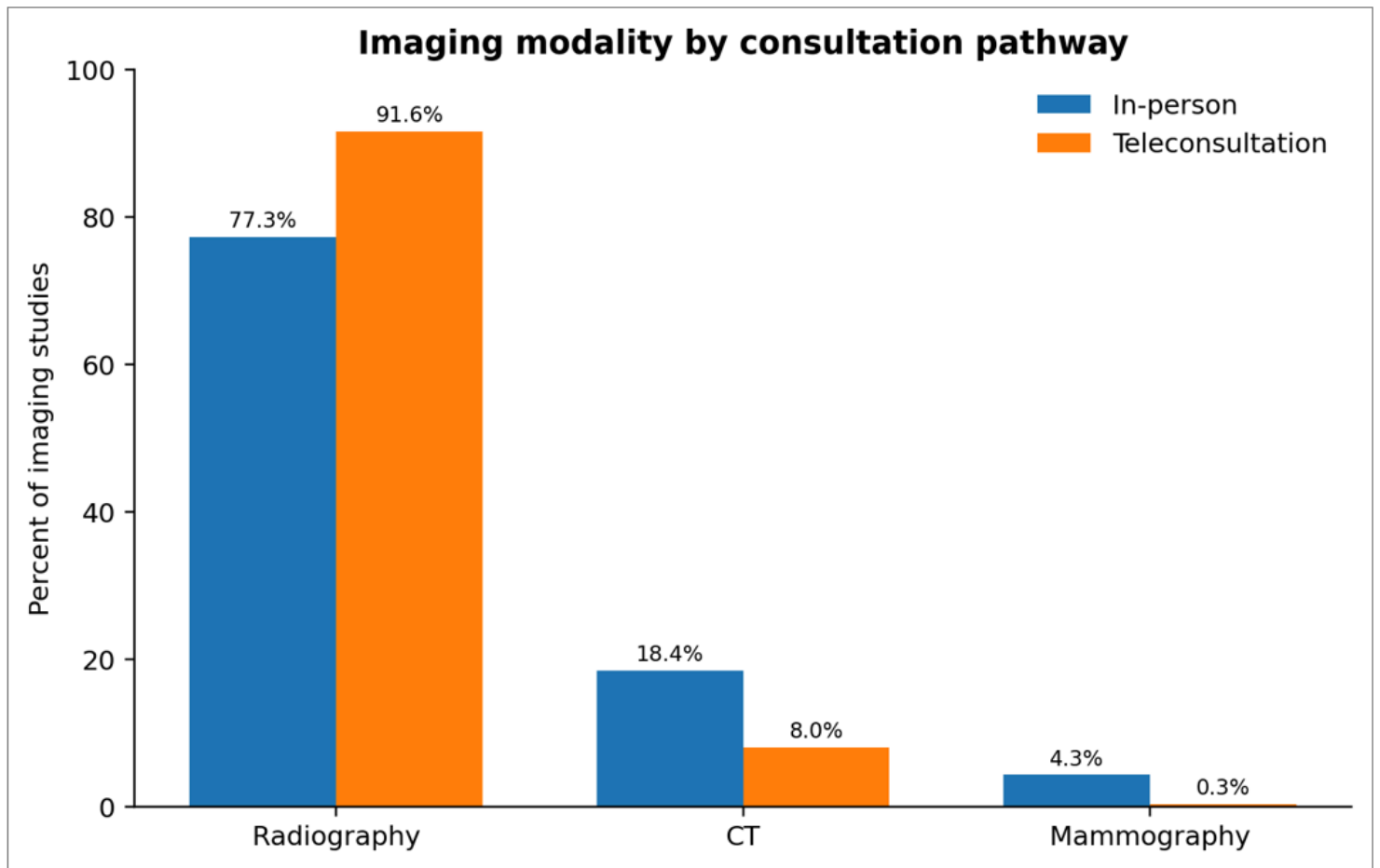


Figure 1

Distribution of imaging modalities by consultation pathway

Teleconsultation-associated imaging was more radiography-dominant and less CT-intensive than imaging following in-person consultation (overall modality distribution $p < 0.001$).

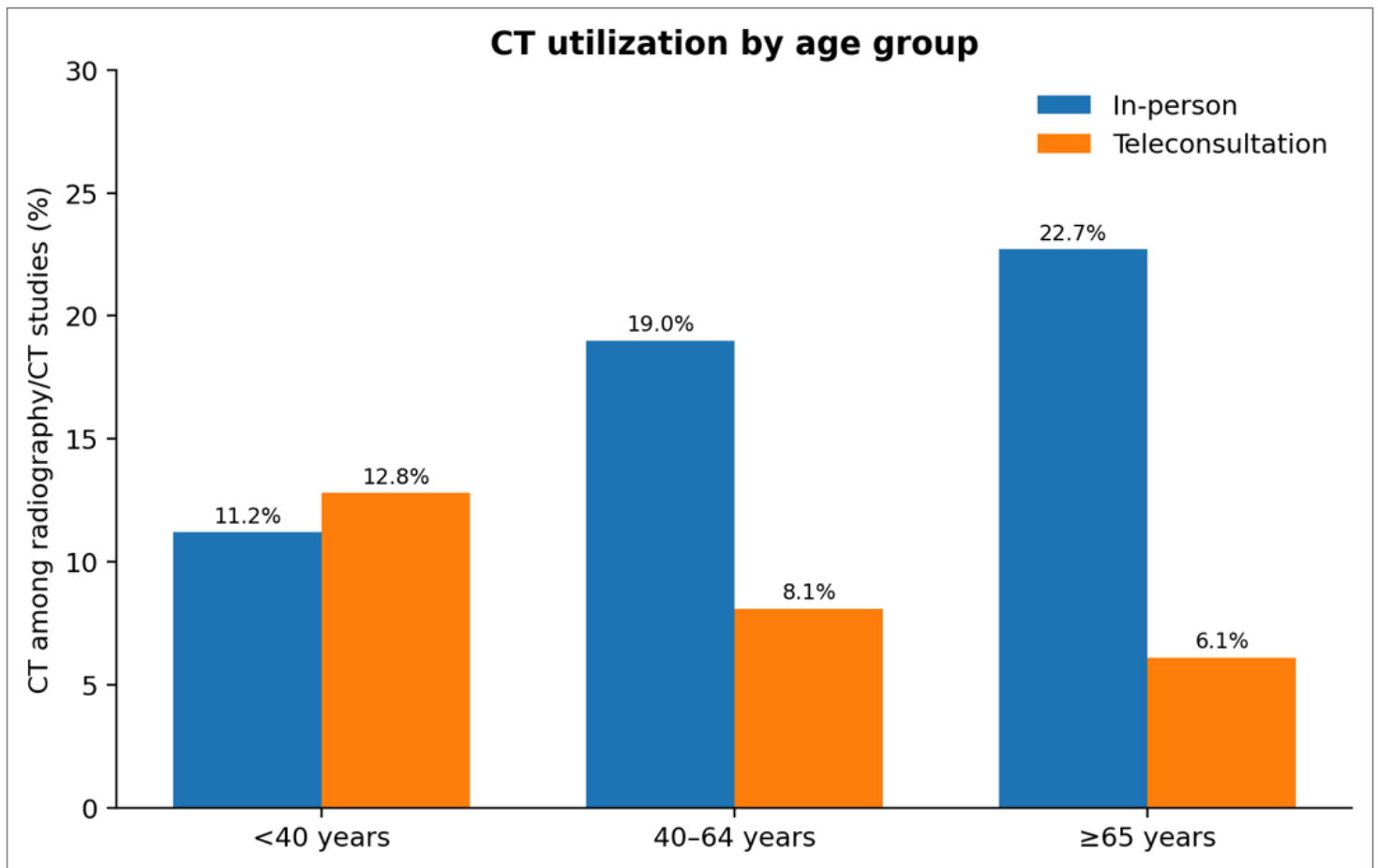


Figure 2

CT utilization by age group and consultation pathway

The difference in CT utilization was minimal in patients younger than 40 years and more pronounced in older age groups. Exploratory adjusted interaction $p=0.041$.

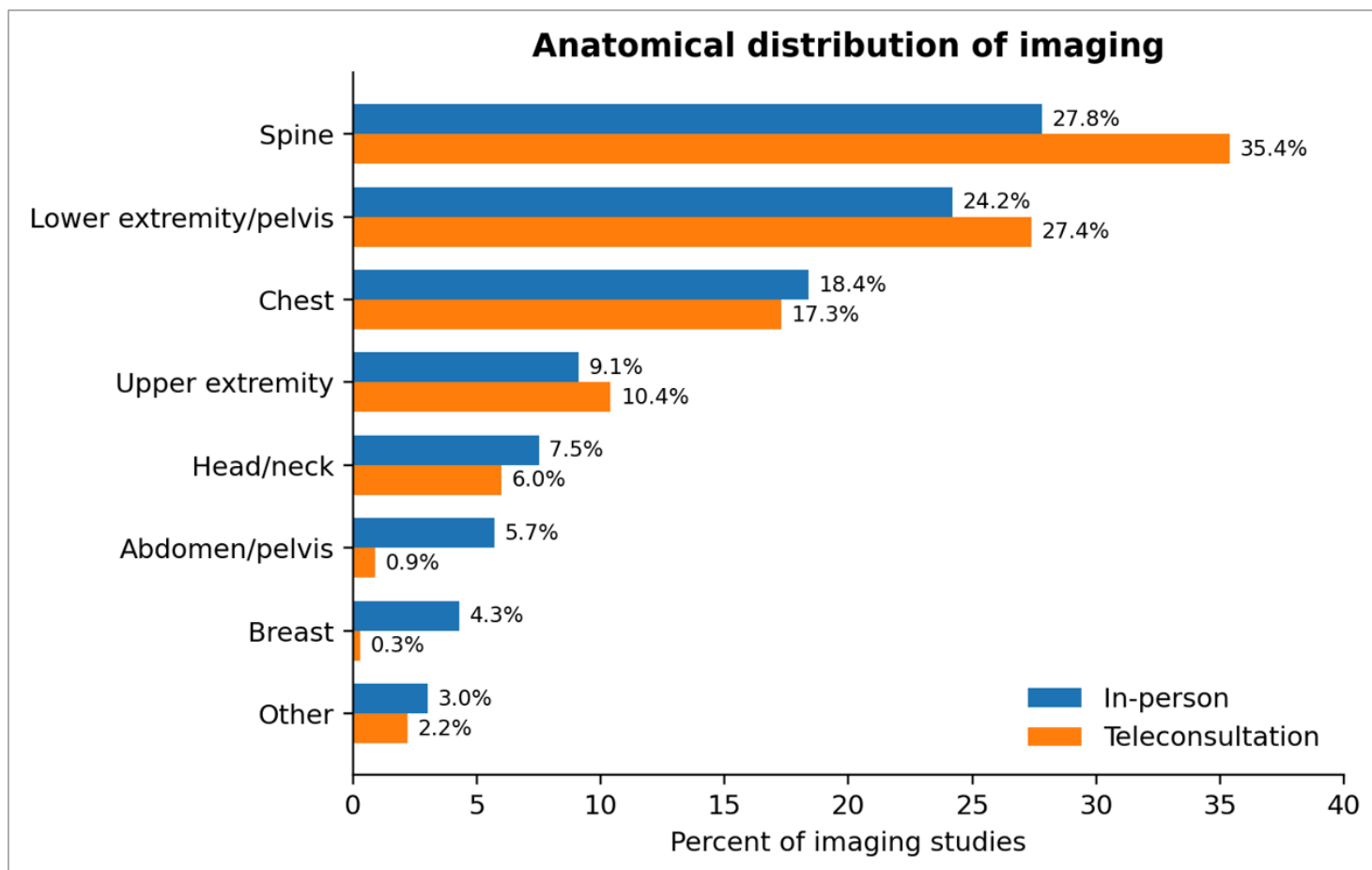


Figure 3

Anatomical distribution of imaging by consultation pathway

Teleconsultation-associated imaging was more concentrated in spinal and musculoskeletal examinations.

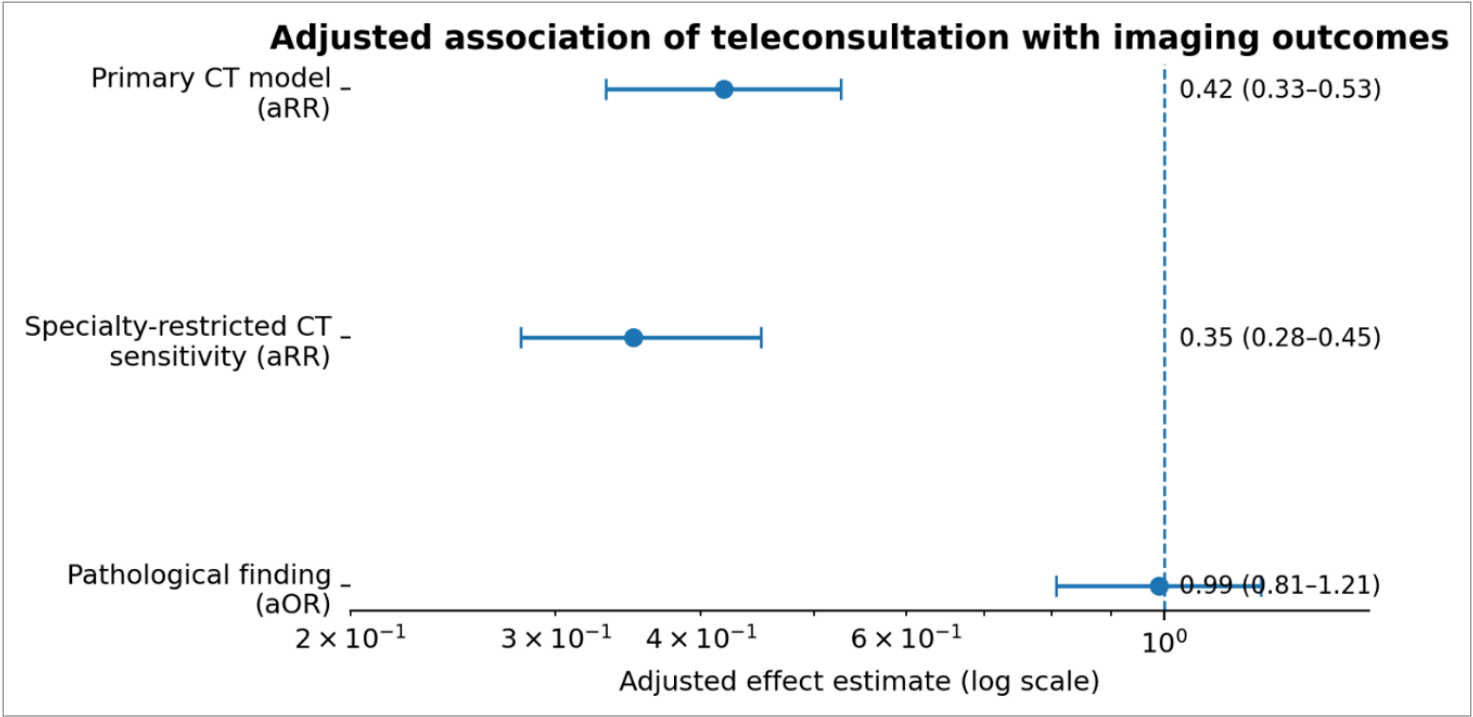


Figure 4

Adjusted association of teleconsultation with imaging outcomes

Primary CT model: modified Poisson regression adjusted for age, sex, specialty, anatomical region, geography, and referral status with patient-clustered robust standard errors. The specialty-restricted sensitivity analysis was directionally consistent. Pathological findings showed no adjusted difference.