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Opportunistic Detection of Splenomegaly Using Automated AI-Based Measurements and Reporting of Organ Volumes in the Clinical Workflow

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Introduction/Background

Splenomegaly, an enlargement of splenic size and weight with a prevalence of 2% in the US, reflects a disruption of the organ's complex role in immunological defense and hematopoiesis (1,2). Due to a broad array of underlying conditions such as hyperplasia, passive congestion, and infiltrative disease, it is often differentially diagnosed by CT imaging (3). Due to its widespread availability, opportunistic screening using CT captures information about clinical conditions when people are imaged for other reasons (4) and can augment the radiology workflow with detailed quantitative imaging traits (radiomics) that are cumbersome to obtain in traditional workflows that do not support computational imaging (5,6). Opportunistic screening for splenomegaly was performed in a disease-agnostic medical population (7), however, associations with other diseases were missing. To address these issues, we built and deployed an end-to-end opportunistic screening workflow using AI-based automated image analysis embedded in the radiology clinical workflow (8). We validate the system by measuring spleen volumes and demonstrating associations with systemic multi-organ diseases using a phenome-wide association study in patients that underwent CT at our institute in the last year.

Methods/Intervention

In an IRB-approved study, spleen volumes were estimated for 13,636 individuals from CTs using TotalSegmentator (9). Splenomegaly assignments were determined if a patient had an ICD diagnosis for the condition (ICD-10 = R16.1 or R16.2, ICD-9 = 789.2) prior to when the CT scan was performed. A phenome-wide association study was performed against phecodes adjusting for sex, age, age^2, principal components 1-10, and BMI.

Results/Outcome

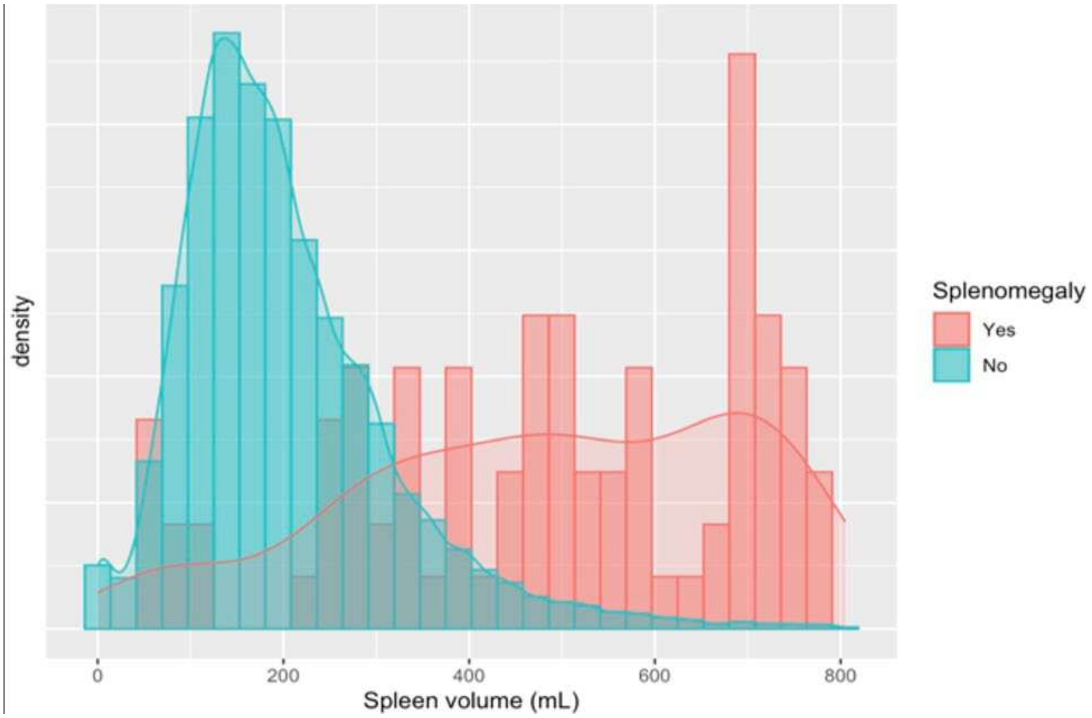
AI-based spleen volume measurements were 484.3 ± 206.2 mL (mean ± sd) and 202.5 ±114.9 mL for splenomegaly vs. other patients, respectively (Figure 1). Increased spleen volumes were strongly associated with over 50 clinical entities including digestive system diseases and multi-organ diseases including infections, endocrine disease, and kidney disease (Figure 2).

Conclusion

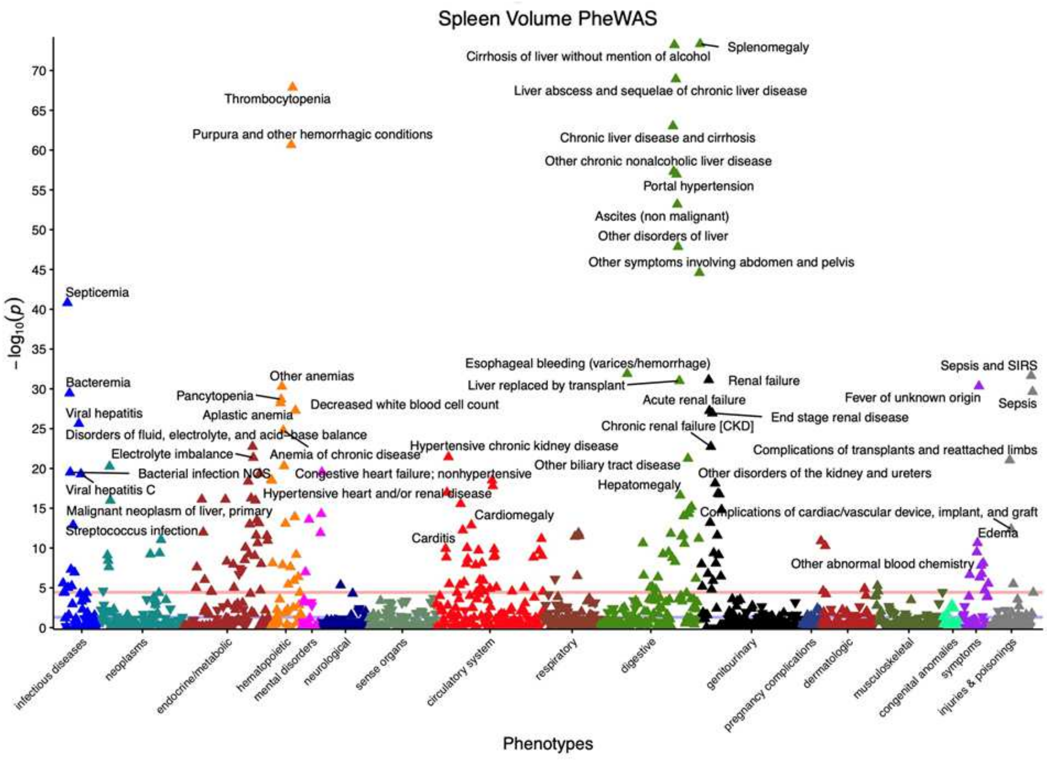
Opportunistic screening for splenomegaly using an AI-based was validated with physician-determined enlarged spleen in a clinical population with systemic multi-organ diseases. PheWAS results serve as a nexus for future discovery and support the use of genetic analysis (GWAS).

Statement of Impact

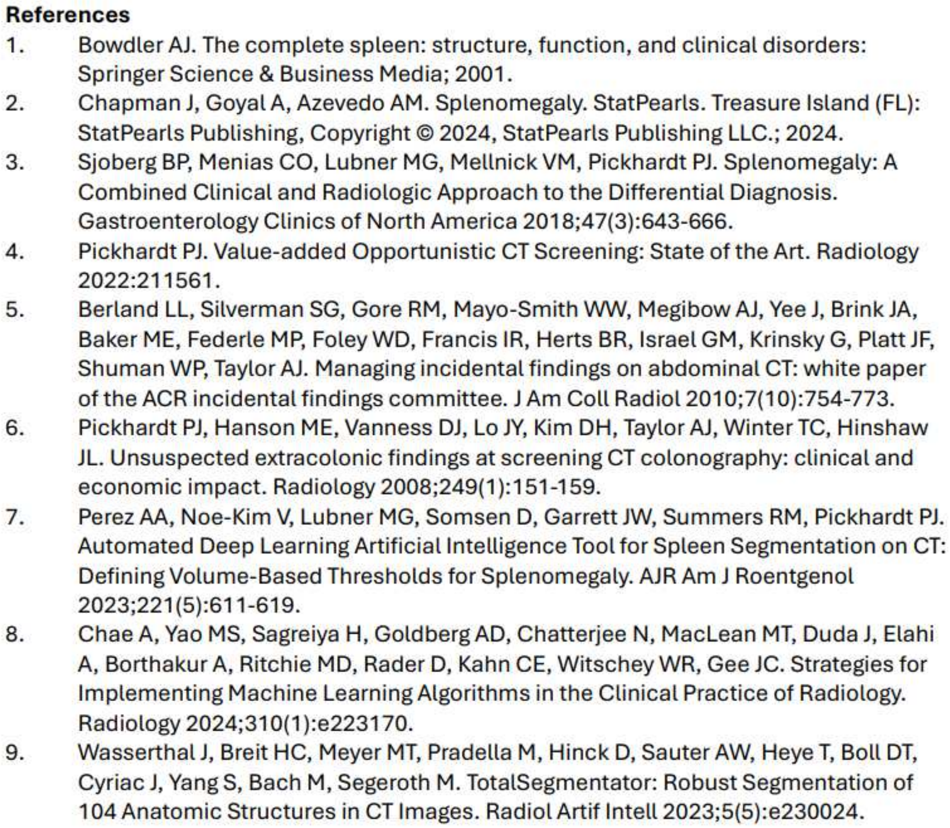
AI-based measurements of spleen volume from CT images can be used to opportunistically screen patients for splenomegaly.



Probability density function of spleen volume for the two groups of patients. Note due to different totals in each group, the size of the bars are not comparable between the groups.



PheWAS showing association of enlarged spleen volume with various phecodes grouped and colored by phenotypes. Threshold for significance is above line at -log10(p) = 4.



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Keywords

Splenomegaly; Segmentation; Phenome-wide association study