vate insurance received testing, with lower rates among those without private insurance. Vision testing by PCP is critical to identify vision problems impeding learning[4] and amblyopia risk factors before vision loss. Results of this analysis build on studies reporting an association between insurance status and unmet eye care needs.[5] Future work should focus on improving PCP vision screening rates, especially for the 3-to-5-year age group.

Study limitations included eliciting vision testing information from parents and caretakers, who may be unaware whether testing was performed or what vision testing entailed, possibly leading to underestimation or overestimation of the insurance-vision testing association. Additionally, we did not analyze the implications of gaps in insurance coverage for PCP vision testing.[5] Results may have also been affected by the COVID-19 pandemic, during which there were lower preventive services use and continuous Medicaid eligibility.[6]

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**Data Sharing Statement:** See the Supplement.

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## COMMENT & RESPONSE

## Deep Learning, the Retina, and Parkinson Disease

**To the Editor** I read with interest the article by Ahn et al[1] on the application of deep-learning algorithms to retinal photographs in Parkinson disease (PD). While it is intriguing that a deep-learning algorithm can predict the presence and severity of PD with 65% to 75% accuracy, the broader motivation and practical applications for this work are unclear.

The authors[1] write that complex neurologic tests are required to diagnose PD, and therefore, new diagnostic tests are needed. This is true only insomuch as taking a history and performing a neurologic examination are considered complex. PD is a clinical diagnosis for which no imaging or laboratory testing is required. Brain imaging is frequently incorporated into research studies but is not required for a clinical diagnosis according to diagnostic criteria from the International Parkinson Disease and Movement Disorder Society,[2] which have an accuracy of over 90%.[3] Magnetic resonance imaging and I-123 single-photon emission computed tomography scans are occasionally used to distinguish PD from rarer causes of parkinsonism but are frequently not performed[4] and there is no role for magnetic resonance angiography in diagnosing PD. The 2 measures of PD severity in this study are even simpler. Hoehn and Yahr stage is a 5-point scale that grades functional disability based on whether a person's symptoms are unilateral or bilateral and whether they can walk with or without assistance. It can be gleaned from watching someone walk down a hallway for 10 seconds. The Unified Parkinson's Disease Rating Scale is a standardized neurologic examination that takes about 10 minutes to perform. Training is available online through the International Parkinson Disease and Movement Disorder Society website and nonphysician researchers have administered it as part of population-based studies, such as the Aging, Demographics, and Memory Study.

Fundus photography is rapid and efficient, but speed alone should not justify developing an imperfect (and potentially costly) surrogate when the gold standard is already easy to measure. That PD severity can be predicted from retinal photographs at all is remarkable and the authors[1] should be congratulated on this achievement. But as it stands, this work feels like a solution in search of a problem. As a movement disorders specialist, I have not wished for a better way to diagnose

PD, and as a neuro-ophthalmologist, I'm not convinced that the solution lies in the retina.

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**In Reply** We appreciate the thoughtful comments provided by Dr Hamedani on our recent article.[1] Dr Hamedani indicated that Parkinson disease (PD) is a clinical diagnosis for which no imaging or laboratory testing is required. In general, we agree it is possible to diagnose PD without any brain imaging or laboratory tests. However, it is also sometimes necessary to rule out other possible diseases. For example, brain magnetic resonance imaging is essential to rule out vascular parkinsonism, which tends to arise in geographic regions with a high prevalence of cerebral small-vessel disease and white matter hyperintensities (eg, Asian countries).[2] Indeed, there are studies that have shown that brain magnetic resonance imaging and magnetic resonance angiography examinations are required to rule out differential diagnoses and to have a more definitive diagnosis of PD.[3]

Our team attempted to objectively evaluate changes in the retinal images of patients with PD using artificial intelligence; our goal was to present a simple and feasible diagnosis of early-stage PD. To diagnose PD accurately, nortropane positron emission tomography scanning using nuclear medicine isotopes has been established as an essential test,[4] which is widely used in Korea.

Furthermore, Dr Hamedani noted that the 2 measures of PD severity used in this study are quite simple. We wish to clarify that we are not advocating that physical examinations could be substituted for Hoehn and Yahr stage and Unified Parkinson's Disease Rating Scale scores with fundus photography. The purpose of our study[1] was to determine whether deep-learning methods can provide information that the retina can reflect cognitive functional changes in the brain. Although there have been previously published studies about retinal changes in PD,[5] the associations were inconsistent and the studies were based on less accessible and more expensive examinations, such as optical coherence tomography. Our study has shown that by using deep-learning methods on fundus photography, the retina can provide objective information regarding neurofunctional changes in patients with PD.

Additionally, we believe there are possible clinical applications with the maturing of deep-learning technology. Fundus photography is already used for diabetic retinopathy screening in many countries, often performed by optometrists or general practitioners. These health professionals will not be expected to diagnose or screen for PD in their normal work. In Korea, fundus photography is also included in the annual health screening for individuals older than 40 years. So, there is potential for fundus photography as an opportunistic screening tool for PD and other systemic diseases.[6]

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## CORRECTION

**Error in Conflict of Interest Disclosures:** The Invited Commentary "Promises and Pitfalls of Retinal Biomarkers in Systemic Health and Disease,"[1] that was published online July 14, 2022, and in the August 2022 issue, included errors in the Funding/Support section. This article was supported by the National Institutes of Health (grant R01EY030564). This article was corrected online.

**Correction:** This article was corrected on August 10, 2023, to fix errors in the text.

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