United States Medical School Graduate Interest in Radiology Residency Programs as Depicted by Online Search Tools

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Recent media publications have indicated a tough job market in medical specialty positions for medical school graduates, specifically in the field of radiology. Internet search tools, such as Google Trends, have proved useful in the prediction of certain diseases on the basis of the search volume index for a specific term. The authors hypothesized that online search tools might be useful in the prediction of US medical school graduates' interest in residency positions in radiology. Google Trends indicated an increase over time in searches for "radiology salary" and a decrease over time in searches for "radiology residency." National Resident Matching Program results for diagnostic radiology showed an increase from 2004 to 2009 in the percentage of US graduates entering radiology but a dramatic drop from 2010 to 2013. This occurred even while the total number of US graduates active in the National Resident Matching Program increased. This finding might have been foretold on the basis of online query result trends. Online search data may be a useful insight into the interests of US medical school graduates and may be predictive of unfilled radiology residency positions and eventual increased shortages of community radiologists coming from US medical schools.

Key Words: Radiology and radiologists, residency, online search tools, employment, reimbursement

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INTRODUCTION

Recent media publications have indicated a difficult job market for medical specialty positions available to medical school graduates, specifically in the field of radiology. Featured in an article in the *New York Times*, St Barnabas Hospital in the Bronx in New York City was forced to prematurely terminate its residency program, leaving doctors untrained, in debt, and willing to pay to work to finish their residency training. This closure was a result of the cheaper cost alternative of outsourcing to domestic teleradiology companies [1]. Anzilotti et al [2] predicted a shortage of radiologists in the near future, while an ACR letter to the Senate in 2013 by Paul Ellenbogen, MD, stated that radiologists were unable to provide community-based care as a result of recent government policies cutting diagnostic radiology reimbursement 12 times since 2006 [3]. Expanded scholarships and loan repayment programs, as well as increased reimbursements for primary care, have drawn more medical school graduates to primary care rather than specialties such as radiology [4]. In addition, the uncertainty associated with the Patient Protection and Affordable Care Act may also have an impact on future reimbursement and add to the difficulty of graduates' finding jobs within diagnostic radiology.

Also highlighted in recent media has been Google Trends, a free online search tool that shows users how often a particular search occurs over time. Google Trends [5] has proved useful in the prediction of many epidemiologic issues, from influenza outbreaks [6-8] to interest in corrective eye surgery [9], on the basis of the search volume index (SVI) for a specific term. We hypothesized that similar online search data might be useful in the prediction of unfilled residency positions in radiology. The purpose of this study was to track US medical school graduates' interest in entering the field of radiology by comparing online search data and National Resident Matching Program (NRMP) results [10].

METHODS

The Google Trends tool [5] was used to analyze searches for "radiology residency" and for "radiology salary" from 2004 to the present. The search was conducted on April 6,

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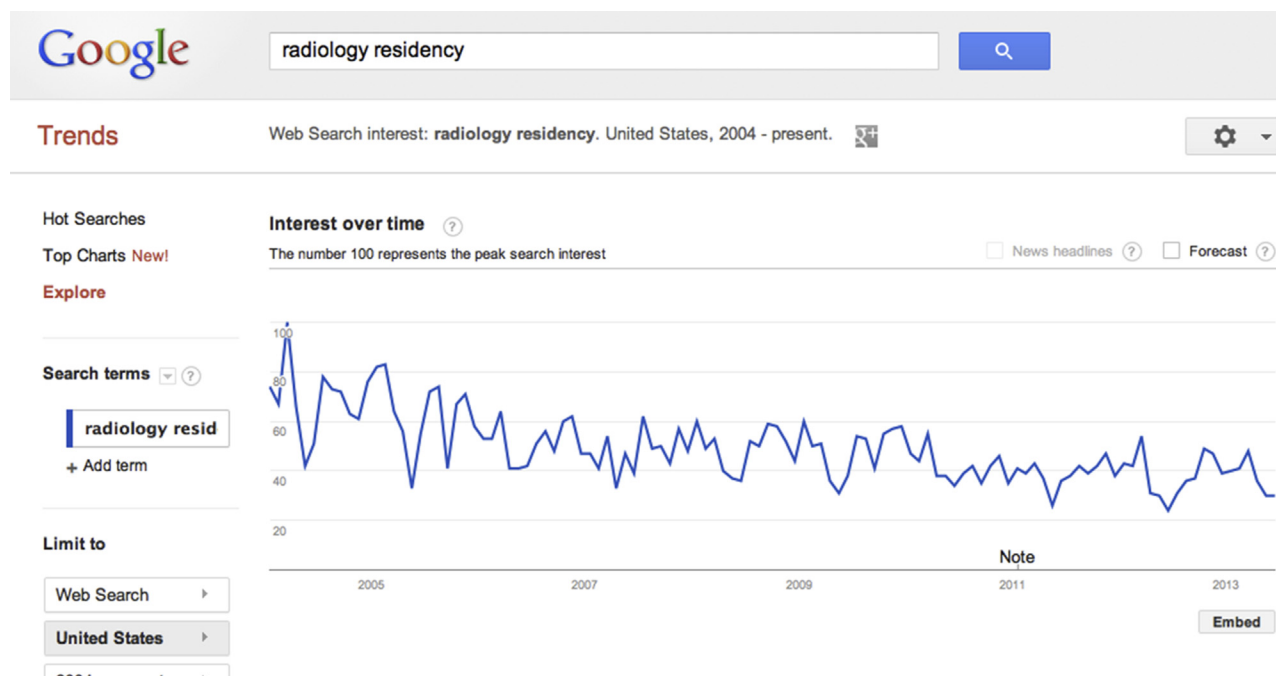
Fig 1. The query "radiology residency" is shown to statistically decrease in volume of searches over time from 2004 to 2013. These data were retrieved from Google Trends on April 6, 2013, and are available to the public at http://www.google.com/trends.

2013. Google Trends returns an SVI, ranging from 0 to 100, representing relative interest over time, or the probability that a user searched for a specific term. Results from the United States only were used in this study.

NRMP data were simultaneously obtained online from available data for 2004 to 2013 [10]. Data were taken from all diagnostic radiology residency programs in the United States. Data collected included the number of positions offered in radiology, the total number of positions filled, and the number of positions filled by US graduates. The percentage of filled positions by US graduates was calculated.

The relationships "radiology residency" and "radiology salary" were evaluated over time using an autoregressive integrated moving average (ARIMA) time-series analysis conducted using JMP version 10 (SAS Institute Inc, Cary, North Carolina). The best-fitting models were determined by the smallest Akaike information criterion values. The notation for the ARIMA model is ARIMA(p, d, q). The autoregressive term is dictated by p and specifies if the data values are autocorrelated, or affected by preceding values. When $p = 0$, there is no autocorrelation, whereas when $p = 1$, the value is affected by the previous value. Nonseasonal differences, dictated by d, indicate what type of adjustment is needed to achieve a stationary mean. When $d = 0$, the mean is stationary; when $d = 1$, there is a linear trend; and when $d = 2$, there is a quadratic trend. Finally, the moving average is dictated by q, or the number of lagged forecast errors. For example, when $q = 0$, there are no random shocks in the data. R^2 values, which estimate the proportion of variation in a trend line that can be explained by a model, were reported for each model [11].

RESULTS

The Google Trends tool revealed a decreasing trend over time for the relative number of searches for "radiology residency" (Fig. 1). There was a rapidly increasing trend from 2008 to 2010 for the relative number of searches for "radiology salary," which slightly decreased in 2011 and remained relatively stable through the beginning of 2013 (Fig. 2). The query "radiology residency" was shown to decrease over time using the best-fitting ARIMA(1, 1, 1) model ($R^2 = 0.78$). The query "radiology salary" was shown to increase over time using the best-fitting ARIMA(0, 1, 1) model ($R^2 = 0.84$).

In Figure 3, NRMP data showed an increase in diagnostic radiology residency positions filled by US medical graduates from 2005 until 2009. Beginning in 2010, there was a dramatic decrease, continuing through 2013. Figure 4 displays the number of active US students and graduates participating in the NRMP. This number includes all US allopathic and osteopathic students and graduates. These data were shown to steadily increase from 2004 through 2013 using linear regression ($R^2 = 0.95$).

DISCUSSION

The volume of search queries in the United States for "radiology residency" has decreased since 2004. Similarly, beginning in 2010 and continuing to 2013, the