RESEARCH ARTICLES

The Pharmacist Aggregate Demand Index to Explain Changing Pharmacist Demand Over a Ten-Year Period

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Objectives. To describe Aggregate Demand Index (ADI) trends from 1999-2010; to compare ADI time trends to concurrent data for US unemployment levels, US entry-level pharmacy graduates, and US retail prescription growth rate; and to determine which variables were significant predictors of ADI.

Methods. Annual ADI data (dependent variable) were analyzed against annual unemployment rates, annual number of pharmacy graduates, and annual prescription growth rate (independent variables).

Results. ADI data trended toward lower demand levels for pharmacists since late 2006, paralleling the US economic downturn. National ADI data were most highly correlated with unemployment ($p < 0.001$), then graduates ($p < 0.006$), then prescription growth rate ($p < 0.093$). A hierarchical model with the 3 variables was significant ($p = 0.019$), but only unemployment was a significant ADI predictor. Unemployment and ADI also were significantly related at the regional, division, and state levels.

Conclusions. The ADI is strongly linked to US unemployment rates. The relationship suggests that an improving economy might coincide with increased pharmacist demand. Predictable increases in future graduates and other factors support revisiting the modeling process as new data accumulate.

Keywords: pharmacist shortage, Aggregate Demand Index, unemployment, workforce, employment, prescription drug growth, pharmacy graduates

INTRODUCTION

Virtually every segment of the US economy has been affected by the severe economic downturn that began in 2007. Before 2009, pharmacy graduates appeared somewhat insulated from the declining economy despite increasing graduate numbers.[1] During 2009, reports of a declining employment market for pharmacists began to surface.[2,3] In 2010, the job market has continued to tighten.[4] In this report, we describe how the pharmacist shortage has changed from the perspective of the Aggregate Demand Index (ADI), a survey that has reported data about the unmet demand for pharmacists for over 10 years.

The ADI is a monthly, state-based survey of the unmet demand for pharmacists. The ADI project was initiated in 1999 by the Pharmacy Manpower Project in response to a rapidly developing shortage of pharmacists at that time. The resulting data allow the tracking of pharmacist employment trends on the national, state, regional, and divisional level over the last decade. The data are reported on the ADI Web site (www.pharmacymanpower.com). ADI data are interpreted as reflecting "unmet demand" rather than "demand" because the survey responses indicate to what extent the available supply of pharmacists meet the demand of open positions; the ADI therefore reflects both supply and demand considerations.

Other resources for tracking changes in the pharmacist workforce include a series of Pharmacy Manpower Projects, and 2 federally sponsored studies.[5-9] These sources have tended to be in agreement with the time trends observed in ADI data. This study concentrates on the ADI because its 10-year dataset can be compared with time trend data from other relevant sources.

The unmet demand for pharmacists is influenced by both market supply and demand factors. In this study, we investigated 2 demand variables relative to the ADI: US unemployment rates and the percentage change (growth rate) in retail prescriptions in the United States. Unemployment rates were chosen because US unemployment rates are closely tied to the overall performance of the economy, while retail prescription growth rates have historically been linked to the demand for pharmacists.[8,10] We also investigated the number of graduates from US

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colleges and schools of pharmacy, who represent an important supply variable that has been particularly volatile over the past decade. Graduate numbers declined early in this decade and are now rapidly rising due to the increase in number of colleges and schools and growth in class sizes at existing schools.[11] All 3 factors are frequently cited as reasons for the changing pharmacist job market.

The purposes of this study were to (1) describe Aggregate Demand Index (ADI) trends from 1999-2010; (2) compare ADI time trends to concurrent data for US unemployment levels, US entry-level pharmacy graduates, and US retail prescription growth rate; and (3) determine which variables were significant predictors of ADI.

METHODS

ADI data are submitted monthly by a team of panelists directly involved in the hiring of pharmacists. Panelist organizations represent community pharmacy, institutional pharmacy, managed care pharmacy, federal pharmacy, pharmacist search firms, and contract pharmacy firms. An earlier study describing ADI methodology, reported that ADI panelist organizations represented about 25% of US pharmacist positions.[12] ADI methodology has remained the same since the project started in August 1999. Monthly, panelists submit estimates of the difficulty encountered in filling open pharmacist positions in each state where their organization operates. The estimates are based on a 5-point rating system where 5 = high demand: difficult to fill open positions; 4 = moderate demand: some difficulty filling open positions; 3 = demand in balance with supply; 2 = demand is less than the pharmacist supply available; and 1 = demand is much less than the pharmacist supply available. Panelist ratings for each state are averaged to determine monthly state ADIs. The national ADI as well as regional and divisional demand indices are based on state ratings that are adjusted for population. Data are reported monthly on the ADI Web site (www.pharmacymanpower.com). Since 1999, over 39,000 state-level ratings, an average of 307 ratings per month, have been used to determine ADI levels.

We examined the relationships among 3 independent variables from 1999 to 2010: US unemployment rate, numbers of US entry-level pharmacy graduates, and US retail prescription growth rate with ADI as the dependent variable. Unemployment data were obtained from the US Bureau of Labor Statistics.[13] Data on first-professional degree pharmacy graduates were obtained from the American Association of Colleges of Pharmacy (AACP).[11] Retail prescription growth rate data were provided by the National Association of Chain Drug Stores Foundation and did not include any data for 2010 (personal communication, Laura Miller, PhD, Economist, National Association of Chain Drug Stores Foundation, May 15, 2010). Population data were obtained from the Bureau of the Census.[14,15] Data for the remaining variables extended into early 2010. ADI data from August 1999 through March 2010 were included.

Analysis

For graphic representation, ADI data were transformed from a 5-1 scale where 5 related to the highest level of unmet demand to a 1-5 scale where 1 related to the highest level of unmet demand. This transformation ("inverse ADI") allowed a better visual portrayal of the relationship between the ADI and 2 explanatory variables.

Data were analyzed using Pearson correlation coefficients and bivariate linear regression analyses to study the independent relationships of the variables with ADI. A series of multivariate regression models also were created using annual US unemployment, annual number of US pharmacy school graduates, and annual prescription growth rate as the independent variables. For the hierarchical multivariate model, independent variables were entered into the model based on the strength of their correlation with the dependent variable ADI. Semi-partial correlations were examined to identify the unique contribution of each predictor variable. The resulting model was used to calculate predicted ADI levels for a range of unemployment rates from 5% to 15%.

Multicollinearity between the independent variables was checked using the variance inflation factor (VIF). Autocorrelation, a problem common with time series data, was checked using the Durbin-Watson statistic. Correction of the estimates in models in which autocorrelation was detected were made using the maximum likelihood method.

To examine whether results were dependent upon arbitrary geographical designations, correlations were calculated using annual unemployment and ADI data at the regional (Northeast, South, Midwest, and West), division (New England, Middle Atlantic, South Atlantic, East South Central, West South Central, West North Central, West South Central, Mountain, and Pacific) and state (50 states and the District of Columbia) levels. For each level (region, division, state), we determined the percentage of constituents in which unemployment was significantly correlated with the corresponding ADI. For example, for the 4 regions, we determined whether the correlation between each region's unemployment data and corresponding ADI data was significant. For calculations involving more than 1 state (regions and divisions), coefficients were weighted to adjust for differences in state population. Subsequent population-adjusted fixed-effects models also were created using annual unemployment ADI data as the dependent variable, and division, region, or state as the independent variables. Goodness of fit for each model was assessed using Akaike's information criterion (AIC).[16]

RESULTS

ADI levels were at their highest values in the early 2000s when the pharmacist shortage was particularly severe (Figure 1).[12] In January 2000, the national ADI was 4.33 and 12 states had demand indices rounding to 5 (difficult to fill open positions). These were, in rank order, Minnesota, Kentucky, Michigan, Wisconsin, California, Tennessee, West Virginia, Florida, Illinois, Texas, Ohio, and Georgia. Only 4 states had demand indices rounding to 3 (balance between supply and demand): Hawaii, Montana, Wyoming, and Nebraska. ADI levels fell slowly through the first half of this decade, and by January 2005, the national ADI had fallen to 3.98 and only 2 states had demand indices rounding to 5: North Carolina and West Virginia. States with indices rounding to 3 or less had increased to 12 and included Montana, South Dakota, Hawaii, Wyoming, Rhode Island, Arkansas, North Dakota, Delaware, Iowa, Oregon, Vermont, and Mississippi.

There was a rapid upswing in the ADI starting in fall 2005 that persisted for over a year. The time period coincided with the introduction of the Medicare Part D outpatient pharmacy benefit and hurricanes Rita and Katrina. All of these historic events created demand for pharmacists and pharmacy organizations that was unanticipated or did not provide adequate time for the pharmacy educational system to train additional pharmacists. The upswing reached a peak in August 2006 with the ADI reaching 4.31. States with demand levels rounding to 5 at that time included: North Dakota, Arizona, Missouri, California, New York, Texas, Kentucky, Alabama, and Oregon. Meanwhile only 2 states were at the 3 level: Arizona and Massachusetts. Since late 2006, ADI levels have been steadily falling. In February 2010, there were no states at the 5 level, 31 states at the 3 level (balance between supply and demand), and 2 states at the 2 level (demand less than the pharmacist supply available): Hawaii and Wyoming. Meanwhile, reports have corroborated a decline in pharmacist jobs across the US.[4]

Figure 2 shows time trends for ADI data versus US unemployment rates using the "inverse" ADI as described above. Figure 3 compares inverse ADI data to pharmacy graduates. Figure 4 compares ADI data to retail prescription growth rate. Table 1 presents the Pearson correlation matrix for the study variables. Both unemployment and numbers of graduates were significantly related to the ADI. The Pearson correlation between unemployment and ADI suggests a strong link between the unmet demand for pharmacists and unemployment levels.

Bivariate regression analysis suggests that unemployment rate is the strongest predictor of the ADI (adjusted $r^2 = 0.836$, $p < 0.001$), followed by number of pharmacy graduates (adjusted $r^2 = 0.497$, $p < 0.006$), and prescription growth rate (adjusted $r^2 = 0.202$, $p < 0.093$). Nonlinear form functions (eg, cubic and quadratic expressions), as well as categorical representation of the

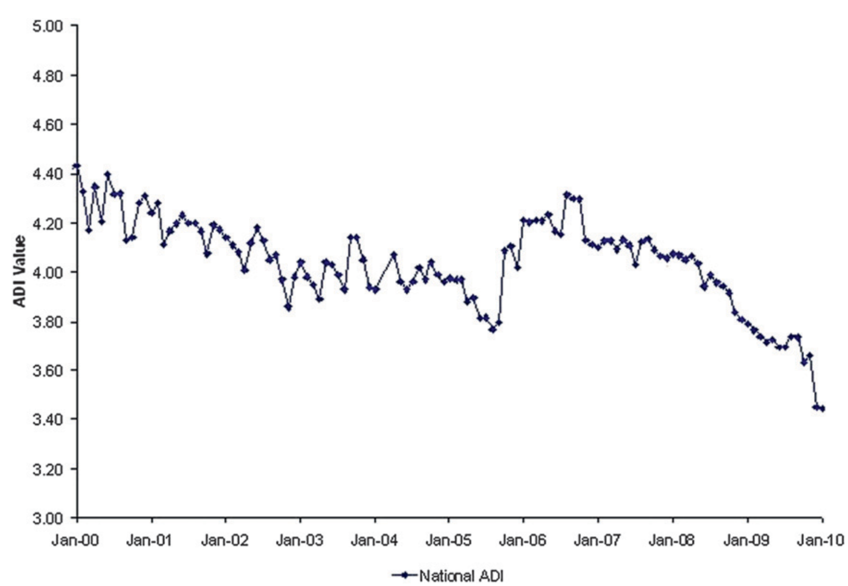

Figure 1. Mean Annual National ADI: 1999-2010. Range shown is from "3" = balance between supply and demand to "5" = difficult to fill open positions.

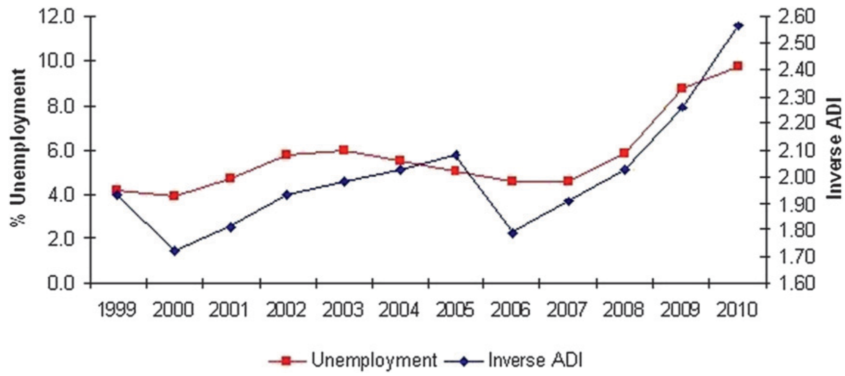

Figure 2. The ADI and US unemployment rates are compared from 1999 to 2010 (r = 0.923). Partial data were available for 1999 and 2010. This chart uses an "inverse" ADI (described in the text) to better visualize the relationship.

independent variables, did not improve model fit (as examined using adjusted r^2). These findings suggested that a linear representation of the model was appropriate.

Results from the full multivariate regression model showed that while the overall model was significant ($p = 0.019$), only unemployment rate ($p = 0.021$) remained a significant predictor of ADI after controlling for the other independent variables (Table 2). Similarly, in a stepwise selection model, only unemployment rate was retained during the selection process ($p < 0.15$ to enter and $p < 0.05$ to remain). VIFs for all variables were below 5.0 and considered acceptable in terms of multicollinearity; therefore, no variables were removed a priori from the multivariate analyses due to collinearity. Of the 3 independent variables, autocorrelation was determined to be a significant concern only for the number of pharmacy graduates variable (Durbin-Watson = 1.17, $p = 0.024$). Corrections using a maximum likelihood approach did not alter the significance of unemployment rate in the multivariate models. The resulting model generated ADI values of 4.01 for 5% unemployment, 3.61 for 10% unemployment, and 3.13 for 15% unemployment.

Table 3 shows the results of regional, division, and state-level analyses of relationships between the ADI (dependent variable) and unemployment. Progressing from the largest geographic entities (national) to the smallest (state), the percentage of significant correlations decreases: from 100% for the national, to 75% for the regional level, to 78% at the division level, to 65% at the state level. Fixed effects models, where all regions, divisions, or states are represented in the model, were all significant ($p < 0.0001$). As shown in Table 3, the progressively smaller AIC values reflect better fit in the models as the amount of data increases. We interpret these analyses to show that the relationship between ADI and unemployment remains significant across progressively smaller geographic units, but the likelihood that an individual unit's ADI (for example, a single division) will be significantly correlated to that division's unemployment rate decreases as fewer states are included in the analysis.

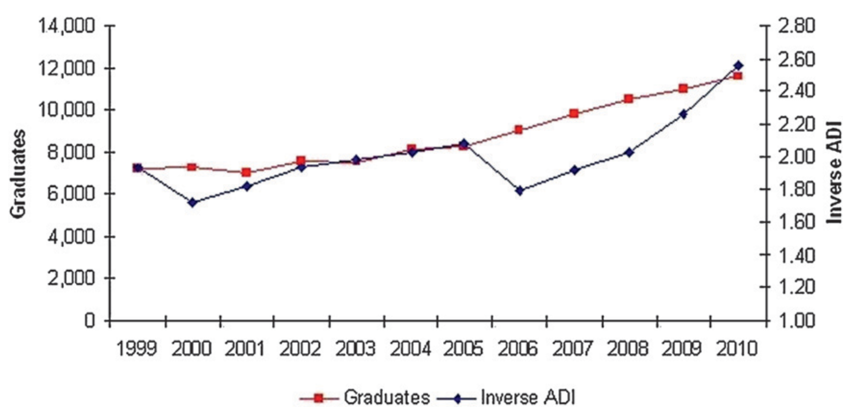

Figure 3. The ADI and entry-level pharmacy graduates are compared from 1999 to 2010 (r = 0.76). Partial ADI data were available for 1999 and graduates are estimated for 2010 based on AACP data. This chart uses an "inverse" ADI (described in the text) to better visualize the relationship.

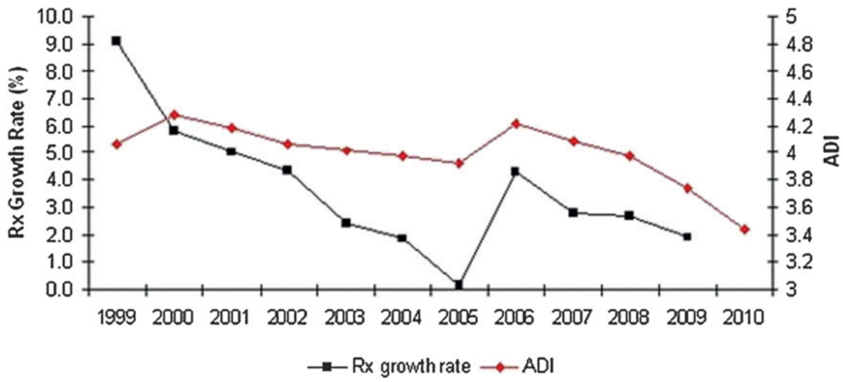

Figure 4. The ADI and US retail prescriptions in millions are compared from 1999 to 2009 (r = 0.54). Partial ADI data were available for 1999.

DISCUSSION

ADI trend data suggest that between 1999 and 2010 there was a net decrease in the unmet demand for pharmacists. In February 2010, the national ADI had not yet reached the "3" level, which would reflect a national balance between supply and demand for pharmacists. However, approximately half the states were reported to be in balance between supply and demand for pharmacists, a dramatically different picture from 2000. Over the time from 1999 to 2010, different states have emerged as having more or less severe pharmacist shortages. The upturn in unmet demand that started in fall 2005 and lasted until late 2006 remains incompletely explained, although the introduction of Medicare Part D and 2 natural disasters (hurricanes) that seriously interrupted the flow of medications in the South are potentially contributing factors. The subsequent ADI downturn starting in late 2006, however, closely parallels the national economic downturn, which was officially designated as a recession in December 2007.[17]

Time trend ADI data have enabled the study of relationships between the unmet demand for a health professional group (pharmacists) and national economic and educational trends over a 10-year period that has seen dynamic change. Our analysis found a strong relationship between the ADI data and US unemployment rates across the 10-year period. A plausible explanation lies in the relationship between employment and health insurance coverage. When unemployment rises, fewer people have health insurance and the demand for most health services, including medications and pharmacy-related services, decreases. Based on this relationship, we might expect that economic improvement, if accompanied by increased employment levels, could reverse the future direction of the ADI. The large variation in unemployment rates over the period studied (range: 3.9% to 10.1%) and the strength of the relationship between the ADI and unemployment argue for continued monitoring of the relationship between these variables.

The additional analysis of the relationship between ADI and unemployment at the regional, division, and state levels was done to test the strength of the relationship in smaller geographic units, for example, states. The relationship remained strong at the regional and division level. At all levels, the relationship remained significant in the model, but we found examples of a single region, 2 divisions, and several states where the relationships were not significant. We suggest that unemployment as an ADI predictor is best utilized at the national level.

A previous report found that retail prescriptions were a significant predictor of pharmacist positions of all types at the state level.[18] Whether at the state or national level,

Table 1. Pearson Correlation Matrix for Study Variables

	ADI	Unemployment	Graduates	Rx Growth Rate
ADI	1.00	-0.923[a]	-0.736[b]	0.531
Unemployment		1.00	0.751[c]	-0.434
Pharmacy School Graduates			1.00	-0.490
Rx Growth Rate				1.00

[a] $p < 0.001$
[b] $p < 0.01$
[c] $p < 0.005$

Table 2. Multivariate Regression Model to Predict the Aggregate Demand Index (ADI)

Label	B (SE)	t	*P*		
Constant	4.490(0.235)	19.111	0.001		
Unemployment Rate	-0.083 (0.028)	-2.951	0.021		
Pharmacy School Graduates	-4.33E006(0.00)	-0.159	0.878		
Prescription Growth Rate	0.012(0.014)	0.862	0.417		
	Sum of Squares	**df**	**Mean Square**	**F**	***P***
Regression	0.167	3	0.056	6.623	0.019
Residual	0.059	7	0.008		
Total	0.226	10			

Dependent variable = ADI

the relationship between ADI and prescriptions has strong economic ties as outlined in the logic above. On the other hand, US population demographics predict increasing prescription medication use based on the numbers of aging baby boomers, health care reform, and changes in Medicare Part D.[19]

While we found similar time trends between the ADI and annual prescription growth rates, prescription growth rates were not a significant predictor of ADI in bivariate analysis and did not add significantly to the model as a predictor when all variables were forced into the model. One explanation may be that prescription growth rates are influenced by variables less directly tied to pharmacist demand. Examples include the transition of highly used prescription drugs from prescription to nonprescription status and the rapid reduction in use of prescription medications for which research uncovers unanticipated adverse consequences. The multiplicity of factors affecting retail prescription numbers may help explain why this variable is a less strong predictor of ADI than unemployment. Overall, however, the level of prescription medication use influences the demand for pharmacists and for this reason remains an important variable to monitor.

The number of pharmacy graduates showed similar time trends to the ADI, and we found this to be a significant ADI predictor in bivariate analysis. However, the multivariate models did not find the number of pharmacy graduates to be a significant variable. We would point out that while pharmacy graduates varied substantially over the period studied, the strong upward trend in graduates was just beginning during the latter half of this decade. Pharmacy graduate trends over the next decade are likely to be different than those of the decade studied. For this reason, this variable's contribution to pharmacist demand as measured by the ADI should be monitored going forward.

Over the short term, changes in number of graduates have a relatively small impact on unmet demand. There are approximately 268,000 pharmacists in the national workforce and about 11,000 new graduates in 2010.[19] An increase (or decrease) of even 20% in new graduates (± approximately 2,200 FTEs) creates a relatively small impact on the overall workforce size (< 1%). Retirement age can similarly increase the pharmacist supply; for example, delayed retirement, as observed in a 2009 survey[7], for even 2 years would result in an estimated 3,200 full-time equivalents increase in the size

Table 3. Correlation of ADIs with Unemployment at the National, Regional, Division, and State Level and Goodness of Fit for Fixed Effect Models

Unit	Significant Correlation to ADI, %	Statistical Significance for Correlations, *p*	AIC (Fixed Effect Model Significance, *p*)
National	100	< 0.0001 for the entire US	782.7 (<0.0001)
Regional	75	< 0.0001 for the Northeast, South, and Midwest regions	714.6 (<0.0001)
Division	78	< 0.05 for 7 of 9 divisions —except the West South Central and Pacific divisions	627.8 (<0.0001)
State	65	< 0.05 for 33 of 51 (50 States plus DC) states—except Alabama, Alaska, Arkansas, Delaware, Washington DC, Idaho, Maine, Missouri, Montana, Nebraska, New Mexico, North Dakota, Rhode Island, Vermont, Washington, West Virginia, Wisconsin, and Wyoming.	254.7 (<0.0001)

of the workforce in 2010.[9] A greater impact is seen when pharmacists change their work patterns, working greater or fewer hours per week. For example, a 10% reduction from a 40-hour work week or working 4 fewer hours each week across the entire workforce would result in a loss of over 26,000 FTEs. Increases in the percentage of pharmacists working part-time, therefore, have a strong impact on overall workforce availability. Over the longer term, however, increases in graduates have an increasingly large impact because the larger cohorts will remain in the workforce throughout their practice life.

Limitations

ADI survey data are provided by those who hire pharmacists; thus, they might tend toward reporting greater difficulty in filling open positions. If surveyed, educators and others working with students, PharmD graduates, and pharmacists seeking positions might report greater difficulty in finding open positions. There were also limitations in the availability and therefore the comparability of data. For 1999, ADI data were only available from August through December. Retail prescription data were not available for 2010 and actual graduate data for 2010 were not available, but AACP estimates based on current enrollments generally are reliable. Finally, the shocks to the pharmacist demand-supply system that have occurred, such as natural disasters and major changes in health care policy, make precise long-term predictions difficult.

CONCLUSION

Decreasing unmet demand for pharmacists, as measured by the ADI, has been in evidence beginning in late 2006. The findings of this study establish quantifiable relationships between ADI trend data and US unemployment, US pharmacy graduates, and US prescription growth rates. At present, the best model for predicting ADI incorporates only one of these variables, unemployment, and the relationship persists at smaller geographic units such as regions and divisions. This parsimonious relationship suggests that an improving economy, with decreased unemployment levels, may again make filling open pharmacist positions more difficult, as was observed during 2 periods between 1999 and 2010. Several factors suggest that all 4 variables should continue to be monitored and that the modeling process should be revisited as new data for each of the variables accumulate. Periodic revisions of the ADI model using these data can provide valuable information to employers, educators, practitioners and health workforce planners.

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