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RESEARCH ARTICLES

Association Between Increased Number of US Pharmacy Graduates and Pharmacist Counts by State from 2000-2009

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Objective. To determine whether growth in the number of pharmacy graduates and newly accredited schools from 2000 to 2009 were larger in states with fewer pharmacists per population age ≥ 65 years.
Methods. States were aggregated into quartiles based on rank-ordered ratios of in-state pharmacists per 100,000 population aged ≥ 65 years. Quartiles were then compared with respect to the number of new graduates.
Results. The mean cumulative number of graduates was highest in the first quartile of states (those with the greatest need for pharmacists) and lowest in the fourth quartile of states. States with the greatest need for pharmacists had the lowest positive growth in number of pharmacists per population ≥ 65 years. The majority of new schools in 2009 were located in states with relatively low numbers of pharmacists.
Conclusion. The growth in new pharmacy graduates created by expansion in schools as well as in graduates per school helped states meet demand between 2000 and 2009. However, tremendous variation remains in the number of graduates as well as the number of pharmacists across states. The quartile framework is useful for assessing the number of new pharmacy graduates based on pharmacists per population ratios. Based on current dynamics in the supply and demand of pharmacists, frequent monitoring is recommended.

Keywords: pharmacists, workforce, graduates, assessment, states

INTRODUCTION

The beginning of this century marked a period of substantial and persistent demand-driven shortages in the labor market for pharmacists[1,2] as well as unprecedented growth in the number of colleges and schools of pharmacy. Although the current recession in the United States has impacted employment in almost all sectors of the economy, there are demographic trends in the US population that suggest strong demand for pharmacist services in the future, including policies favoring payment for pharmaceutical care and new drug development. Thus, the future balance of pharmacist supply and demand is uncertain.

The number of new graduates from US colleges and schools of pharmacy is an important determinant of the supply of pharmacists in the United States. Changes in pharmacy graduate rates across states should be monitored regularly because the supply of pharmacists from state to state varies and policies affecting pharmacist practice and education activities are made at the state level.[4-7] While changes in the number of graduates have been documented in the literature, most notably with respect to revisions in the most widely cited supply forecasting model for US pharmacists,[3] there has not been a specific examination of state-level counts of pharmacy graduates since 2000.[4] Although some growth in the pharmacist workforce may be attributable to foreign graduates, previously practicing pharmacists reentering the profession, and, on a state level, pharmacist migration between states, new graduates account for the vast majority of new pharmacists joining the US workforce each year. Without an adequate number of new pharmacist graduates entering the workforce to balance the number leaving because of retirement and death, the size of the pharmacist workforce would decline over time. Thus, the number of graduates provides an estimate of the potential of the pharmacist workforce to respond to population-based changes in demand. However, an examination of

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graduate counts alone is limited because it does not provide information about where graduates find their first employment, differences in workforce by gender, and the adequacy of graduate rates to meet current or future demand.[8] As such, pharmacist graduate numbers should be considered only one data element in a broader analysis of pharmacist workforce planning.

Size of the pharmacist workforce is another fundamental data element of a broad analysis. As population is a key factor influencing pharmacist demand, size of the workforce can be assessed at a basic level as a ratio of pharmacists to population. Demand for pharmacists is derived from the demand for goods and services pharmacists produce, such as dispensed prescription drugs and information related to the proper use of prescription and nonprescription drugs. Because older individuals are greater consumers of these goods and services than any other age group,[9,10] the population 65 years and older may be the most appropriate segment to consider in an examination of the pharmacist workforce.[9,10] Hence, ratios of pharmacist to population age 65 years and over that are relatively small can serve as a proxy for a lower supply of pharmacists relative to demand. A low pharmacist-to-older population ratio also may indicate relatively low access to care or a low level of supply relative to an underlying need for services.

One previous study examined trends in pharmacy graduate rates and compared number of graduates to overall population at the state, census division, and census region levels.[4] The authors are not aware of a study that has examined trends in the numbers of pharmacy graduates and compared them to pharmacist-to-population ratios at the state level to determine state response to a relatively low supply of pharmacists.

The primary objective of this study was to determine whether growth in the number of pharmacy school graduates between 2000 and 2009 was larger in states with lower counts of pharmacists relative to the population over age 65 years in 2000. The second objective was to examine whether growth in the number of newly accredited colleges and schools of pharmacy that had not produced graduates by 2009 was larger in states with lower counts of pharmacists relative to the population over age 65 years in 2009.

METHODS

Data Sources

Data on graduates from each US college and school of pharmacy were obtained from the American Association of Colleges of Pharmacy (AACP) for each year from 1990-2009.[11] The AACP collects these data from annual surveys of each college and school of pharmacy for a 100% response rate. This study included only graduates with the first professional degree, excluding those who completed a PharmD after previously obtaining a bachelor's degree in pharmacy. By examining graduates per year from each college or school, the number of colleges and schools of pharmacy producing any graduates in each year from 2000 to 2009 was determined. Colleges and schools of pharmacy were classified as public or private based on AACP information and the authors' knowledge of the schools. Colleges and schools of pharmacy that had received Accreditation Council for Pharmacy Education (ACPE) candidate accreditation status but had no graduates in 2009 were identified. Accreditation status was obtained from ACPE, and graduate numbers were obtained from the AACP's annual listings of graduates from individual pharmacy colleges and schools. [12]

Data on total first professional degree enrollment (ie, total enrollment, or number of students enrolled in each year of the first professional degree curriculum) in US colleges and schools of pharmacy were obtained from AACP for 2009. Total enrollment data were obtained for colleges and schools of pharmacy that had produced graduates in 2009 and for institutions that had candidate accreditation status but no graduates in 2009.[13]

National and state populations for individuals 65 years and older for 2000 and 2009 were determined from US Census tables.[14] Counts of the number of pharmacists in each state in 2000 and 2009 were obtained from the annual *Survey of Pharmacy Law* for 2001 and 2010.[15,16] Each annual edition contains a table listing the number of licensed pharmacists with in-state addresses for each state and the District of Columbia for the preceding year. The data are compiled by the National Association of Boards of Pharmacy (NABP) based on data provided by each state's pharmacist licensing board. In-state addresses are required to avoid the issue of pharmacists being licensed in multiple states. Similar data have been used in a previous report examining patient access to pharmacists.[17]

Data Analysis

Changes in the number of graduates were examined at the state level by aggregating school-level data to the state level. The pharmacy school located in the District of Columbia, which was considered a state for the purposes of this study, was included, but the institution in Puerto Rico was excluded. For each state for 2000 and 2009, the number of graduates per 100,000 population aged 65 years and older (graduates per population $\geq$ 65 years) and cumulative number of graduates were determined.

Ratios of pharmacist per population $\geq$ age 65 years were determined for each state for 2000 and 2009, and states were placed into quartiles based on the ratios for

2000. For each state and quartile of states between 2000 and 2009, the cumulative number of graduates and mean change in pharmacist and graduates per population ≥ age 65 years were examined.

Changes in the capacity to produce pharmacy graduates in each state and each quartile of states also were examined by determining the number of colleges and schools of pharmacy in 2000 and 2009 within each state and within each quartile. Mean numbers of graduates per school in 2000 and 2009 for each quartile were determined by dividing the number of graduates by the number of college and schools producing graduates.

To analyze how recent changes in the number of colleges and schools of pharmacy differed by each quartile of states, states were divided into quartiles based on the distribution of pharmacists per population ≥ 65 years in 2009. Total numbers of colleges and school of pharmacy in 2000 and 2009 for each state within each quartile were then calculated. Mean number of graduates per school in 2000 and 2009 for each quartile was determined by dividing the number of graduates by the number of schools producing graduates. The total number of accredited colleges and schools of pharmacy with no graduates in 2009 was determined for each state and each quartile of states by summing schools across states within each quartile. A further analysis included total enrollment in all schools in 2009 for each state within each of these 2009-based quartiles.

RESULTS

Figure 1 illustrates a substantial rise in the number of first professional-degree graduates from US colleges and schools of pharmacy between 1990 and 1996, followed by a decline through 2001 and a pronounced rise from 2001 to 2009. A summary of changes in pharmacy graduates and pharmacist-to-population ratios is provided in Table 1. The cumulative number of graduates between 2000 and 2009 (N=85,559) is equivalent to 30.3% of the sum across each state of the number of in-state licensed pharmacists in the United States in 2009 (n=282,736). Although the actual number of graduates increased by 50% between 2000 (78 schools with 92 graduates/school = 7,176 graduates) and 2009 (92 schools with 117 graduates/school = 10,764 graduates), the ratio of graduates per population ≥ 65 years increased only 33.3% between 2000 and 2009 because of growth in the population ≥ 65 years of age. Fourteen new colleges and schools of pharmacy, all but 3 of which were private institutions, began producing pharmacy graduates between 2000 and 2009. The pharmacist per population ≥ age 65 years increased by 5.1% between 2000 and 2009, reflecting substantial growth in the number of pharmacy graduates. The number of licensed pharmacists in the United States also increased between 2000 and 2009 by 45,678 pharmacists (19.3%).

Table 1 also provides a summary of study variables for each quartile of states based on the pharmacists per population ≥ age 65 in 2000. Quartile 1 represents states that had the lowest number of pharmacists per population ≥ age 65 in 2000, and states in quartile 4 had the highest number of pharmacists in the same population. Five of the 6 states without colleges and schools of pharmacy between 2000 and 2009 were in quartile 1, suggesting the importance of an in-state pharmacy school to the ratio of pharmacists to population ≥ age 65.

Several variables in Table 1 differed across state quartiles. The mean cumulative number of graduates based on states producing graduates between 2000 and 2009 was highest in quartile 1 (n=2,385) and lowest in quartile 4 (n=1,632). The change in number of graduates between 2000 and 2009 was largest in quartile 1 (n=1,108) and smallest in quartile 4 (n=663). One factor contributing to the increase in the number of graduates in quartiles 1 and 2 was the addition of 6 and 5 new colleges and schools of pharmacy, respectively.

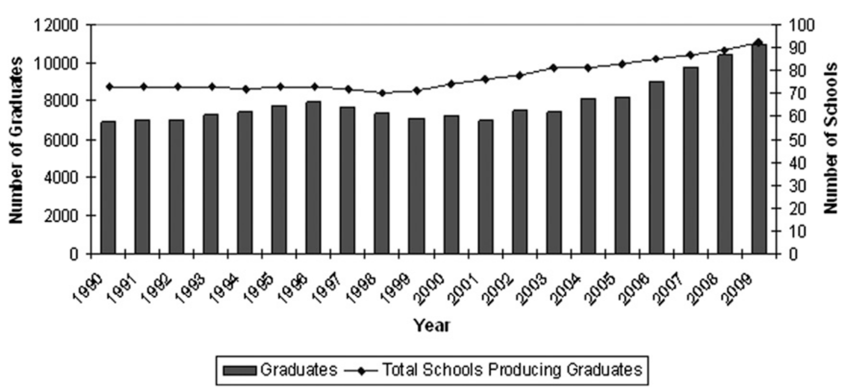

Figure 1. Total US Colleges and Schools Pharmacy Producing Graduates and US Pharmacy School First Professional Degree Graduates by Year, 1990-2009 (Based on data from the American Association of Colleges of Pharmacy).

Table 1. Summary of the Characteristics of Pharmacy Graduates and Pharmacists from 2000-2009 by Quartile of Pharmacists per Population ≥ 65 years in 2000

Quartiles and States (Lowest to Highest)	Cumulative Graduates: 2000-2009	Graduates[a] 2009	Change in Graduates[a] 2000-2009 (%)	Number of Pharmacy Schools: 2000 (Mean grads per school)	Number of Pharmacy Schools: 2009 (Mean grads per school)	In-state Pharmacists[a] 2009	Change in In-state Pharmacists,[a] 2000-2009, (%)
United States	85,559	27.6	6.9 (33.3)	78 (92.0)	92 (117.0)	712.1	34.6 (5.1)
Quartile 1 (n = 13)	**19,082**	**27.4[b]**	**9.0 [b] (48.9)**	**15 (92.3)**	**21 (118.7)**	**590.9**	**35.5 (6.4)**
Maine	0	0	0	0	0	405.1	26.2 (6.9)
Florida	4,844	21.3	10.8 (101)	3 (100)	4 (179)	523.0	67.3 (14.8)
Vermont	0	0	0	0	0	512.3	-2.5 (-0.5)
Delaware	0	0	0	0	0	479.7	-39.2 (-7.6)
Arizona	1,569	23.4	15.0 (179)	1 (56)	2 (104)	627.1	101.1 (19.2)
Missouri	2,163	26.9	1.4 (5.6)	2 (97)	2 (1110)	637.8	70.9 (12.5)
West Virginia	675	25.1	6.0 (31.1)	1 (53)	1 (73)	640.5	38.3 (6.5)
Connecticut[c]	693	19.2	19.2	1 (0)	1 (98)	606.1	2.5 (0.4)
New Hampshire	0	0	0	0	0	696.2	90.0 (14.8)
Hawaii	0	0	0	0	0	565.8	-41.3 (-6.8)
Iowa	2,081	54.4	7.6 (16.3)	2 (102)	2 (122)	724.0	111.9 (18.3)
Oregon	764	30.7	8.4 (37.3)	1 (49)	2 (75)	652.0	38.8 (6.3)
California	6,293	18.2	3.5 (24.0)	4 (132)	7 (112)	611.8	-2.28 (-0.4)
Quartile 2 (n = 13)	**26,160**	**32.5**	**7.8 (31.6)**	**23 (101.7)**	**28 (117.9)**	**706.6**	**53.5 (8.2)**
New York	5,824	28.8	4.8 (20.0)	4 (147)	4 (190)	636.4	10.7 (1.7)
Illinois	3,377	27.3	7.8 (39.9)	2 (147)	3 (145)	725.9	94.2 (14.9)
New Mexico	763	30.2	-24.0 (-44.3)	1 (115)	1 (86)	595.7	-42.3 (-6.6)
Wisconsin[c]	1,045	15.7	15.7	1 (0)	1 (120)	668.9	25.7 (4.0)
Virginia	1,961	31.1	15.4 (97.4)	2 (63)	4 (76)	719.2	74.6 (11.6)
Utah	412	20.9	2.9 (16.7)	1 (34)	1 (43)	629.6	-17.0 (-2.6)
Kansas	963	27.3	1.2 (4.6)	1 (93)	1 (102)	763.4	111.3 (17.1)
Arkansas	773	23.3	4.3 (22.6)	1 (71)	1 (95)	734.9	79.6 (12.1)
Michigan	2,493	22.4	-.90 (-3.7)	3 (95)	3 (99)	724.9	65.9 (10.0)
Montana	574	44.9	-4.6 (-9.4)	1 (60)	1 (59)	755.2	92.9 (14.0)
South Dakota	528	52.7	13.8 (35.6)	1 (42)	1 (60)	875.5	196.7 (29.0)
Pennsylvania	6,696	44.8	12.1 (37.0)	5 (126)	6 (136)	766.4	92.9 (13.8)
Nevada	751	52.3	52.3	0	1 (123)	589.9	-90.2 (-13.3)
Quartile 3 (n = 13)	**22,360**	**34.4**	**8.6 (33.3)**	**22 (86.4)**	**24 (117.0)**	**775.7**	**61.5 (8.6)**
Ohio	3,833	29.8	3.4 (12.7)	4 (100)	4 (118)	768.0	81.9 (11.9)
North Dakota	1,604	42.8	9.8 (30.0)	1 (60)	1 (78)	775.3	80.7 (11.6)
Oklahoma	698	80.6	17.1 (27.0)	2 (75)	2 (105)	861.0	159.3 (22.7)
Idaho	517	33.8	-.50 (-1.5)	1 (50)	1 (56)	643.8	-68.9 (-9.7)
Minnesota	1,130	23.4	9.1 (63.5)	1 (85)	1 (155)	819.8	106.9 (15.0)
South Carolina	1,295	33.7	21.6 (177)	2 (29)	2 (100)	719.2	5.4 (.76)

(*Continued*)

Table 1. (*Continued*)

Quartiles and States (Lowest to Highest)	Cumulative Graduates: 2000-2009	Graduates[a] 2009	Change in Graduates[a] 2000-2009 (%)	Number of Pharmacy Schools: 2000 (Mean grads per school)	Number of Pharmacy Schools: 2009 (Mean grads per school)	In-state Pharmacists[a] 2009	Change in In-state Pharmacists,[a] 2000-2009, (%)
Massachusetts	4,234	58.6	23.5 (67.0)	2 (151)	3 (177)	727.6	11.0 (1.5)
Kentucky	935	21.7	6.3 (40.6)	1 (78)	1 (120)	810.5	90.6 (12.6)
Tennessee	1,085	19.6	5.8 (42.2)	1 (97)	1 (160)	818.9	98.5 (13.7)
Washington	1,563	23.0	3.3 (16.5)	2 (66)	2 (90)	790.5	69.3 (9.6)
Indiana	2,576	34.3	-.90 (-2.7)	2 (133)	2 (138)	755.2	30.9 (4.3)
North Carolina	2,215	25.9	8.2 (46.1)	2 (86)	3 (99)	821.4	96.9 (13.4)
Mississippi	675	19.4	4.9 (33.5)	1 (50)	1 (73)	772.4	36.5 (5.0)
Quartile 4 (n = 12)	**17,957**	**51.6[b]**	**6.2[1] (13.7)**	**18 (85.6)**	**19 (116.0)**	**865.5**	**-39.5 (-4.5)**
Nebraska	1,860	90.8	24.0 (36.0)	2 (78)	2 (110)	836.4	93.9 (12.6)
Texas	3,830	17.6	2.5 (16.2)	4 (79)	4 (112)	781.6	29.5 (3.9)
Maryland	1,057	17.2	1.3 (8.2)	1 (95)	1 (121)	804.3	36.8 (4.8)
Wyoming	458	71.8	-9.7 (-11.9)	1 (47)	1 (46)	730.5	-44.3 (-5.7)
Alabama	1,891	36.1	17.9 (97.7)	2 (53)	2 (116)	875.9	80.0 (10.1)
Colorado	956	23.8	-.69 (-2.8)	1 (102)	1 (123)	880.3	53.5 (6.5)
Rhode Island	820	59.9	6.7 (12.6)	1 (81)	1 (94)	611.4	-275.7 (-31.1)
Louisiana	2,084	40.8	-1.9 (-4.5)	2 (111)	2 (118)	825.6	-108.8 (-11.6)
New Jersey	1,629	21.0	13.4 (178)	1 (84)	1 (256)	846.8	-141.0 (-14.3)
Alaska	0	0	0	0	0	862.2	-154.6 (-15.2)
Georgia	2,602	34.8	5.6 (19.2)	2 (115)	3 (111)	967.9	-165.2 (-14.6)
District of Columbia	770	153.5	8.9 (6.2)	1 (101)	1 (95)	1,363	121.6 (9.8)

Note: The sum across each state of the number of in-state pharmacist licenses was 237,058 in 2000 and 282,736 in 2009.

Quartile 1 are states in the bottom 25th percentile of the in-state pharmacists per ≥ 65 population ratio. Quartile 4 are states in the top 25th percentile of the in-state pharmacists per ≥ 65 population ratio. Confidence intervals for each variable in each quartile are available from the authors upon request.

[a] Ratio is per 100,000 population 65 years and older.

[b] Mean calculated only using states that produced any graduates between 2000 and 2009. 95% confidence intervals in brackets.

[c] Connecticut and Wisconsin had no graduates in 2000 despite having one accredited pharmacy school in each state. The lack of graduates was due to the implementation of an all PharmD degree. In 1999 and 2001 Wisconsin had 97 and 100 graduates, respectively. In 1999 and 2001 Connecticut had 94 and 54 graduates, respectively.

Despite the largest increase in pharmacy graduates and in-state licensed pharmacists, Quartile 1 had the lowest mean number of pharmacists per population ≥ age 65 in 2009 and the smallest positive growth in the ratio of pharmacists in that population between 2000 and 2009. The large increases in ratio of pharmacists per population ≥ age 65 years between 2000 and 2009 in several quartile 1 states (Iowa, Missouri, Arizona, Florida, and West Virginia) are attributable primarily to growth in the number of in-state graduates produced. The 5 states with the greatest increase in number of in-state licensed pharmacists between 2000 and 2009 were Florida, California, Texas, North Carolina, and Illinois.

In quartile 4, the mean number of pharmacists per population ≥ age 65 in 2009 was highest across the quartiles; however, the ratio of pharmacists per population ≥ age 65 decreased by 4.5% between 2000 and 2009. Half of the states in quartile 4 experienced a decrease in the number of pharmacists per population ≥ age 65 between 2000 and 2009. Only 4 states (Rhode Island, New Jersey, District of Columbia, and Louisiana) experienced a decrease in the number of in-state licensed pharmacists between 2000 and 2009. The increase in number of in-state licensed pharmacists in quartile 4 was the smallest across the 4 quartiles.

Table 2 contains information about the number of colleges and schools of pharmacy and mean graduates per school in 2009, the number of new colleges and schools of pharmacy not producing pharmacy graduates as of 2009, and total first-degree enrollment in 2009. Table 2 data are for the entire United States and by quartiles of states based on the ratio of in-state pharmacists per population ≥ age 65 in 2009 rather than in 2000. Colleges and schools of pharmacy in quartile 1 had the largest mean number of graduates per school (n=132.4), nearly 14% higher than the next highest mean. As of 2009, there were 21 new colleges and schools of pharmacy with candidate accreditation status in the United States that had not yet graduated students. All but 3 (85.7%) of the 21 new colleges and schools of pharmacy were private institutions. Only 6 (28.6%) of the 21 new schools are located in states in quartile 1, and 9 (69.2%) of the 13 states in quartile 1 did not have a new college or schools of pharmacy with candidate accreditation status as of 2009.

Enrollment numbers allowed us to estinate the number of future graduates attributable to expansion of current colleges and schools of pharmacy as well as the addition of new colleges and schools of pharmacy. Despite experiencing the most growth in new colleges and schools of pharmacy, quartile 3 had the lowest mean pharmacy college and school enrollment in 2009. Quartile 1 states had the highest mean enrollment per pharmacy school but the lowest ratios of pharmacist per population ≥ age 65 years.

DISCUSSION

Between 2000 and 2009, the cumulative number of graduates from US colleges and schools of pharmacy was about 12,000 (16.2%) higher than the previous 10-year period. In contrast to the 1990s, growth in the number of graduates between 2000 and 2009 was highly linear. The linear nature of growth is attributable to expansion in both the number of colleges and schools of pharmacy in the United States and growth in class size among institutions that existed in 1990. Based on available information regarding the number of accredited programs and enrollment figures, the number of pharmacy graduates is estimated to grow at the current or a higher rate over the next few years. However, sustaining this growth rate may be challenged by pharmacy colleges and schools' ability to provide adequate numbers of qualified faculty members and preceptors and whether the supply of graduates exceeds ongoing demand.[18]

In contrast to previous research, one of the current study's objectives was to associate growth in the number of pharmacy graduates with level of pharmacist supply by examining changes in the number of graduates relative to the ratio of pharmacists per population ≥ age 65. An underlying assumption in our analysis is that this ratio serves as a crude proxy for supply relative to demand, access to, and/or need for pharmacists. Our results suggest that, based on the proxy, several measures of change in the number of pharmacy graduates between 2000 and 2009 were consistent with respect to the levels of demand for pharmacists across states in 2000. Expansion of existing colleges and schools of pharmacy and the establishment of new, mostly private colleges and schools of pharmacy that produced pharmacy graduates between 2000 and 2009 helped meet the demand for pharmacists in states that appeared to have the greatest need for them. Unfortunately, the graduate growth rate in states with the greatest demand for pharmacists did not translate to relative growth in the number of pharmacists per population ≥ age 65 years. Eight states with the lowest ratios of pharmacists in this population in 2000 were still among the lowest in 2009. Given that only 6 of the 21 newly accredited pharmacy schools are located in these states, future research should continue to monitor the pharmacist workforce in states with the greatest need to assess changes in the ratio of pharmacists to population ≥ age 65 years.

This study's approach to and results of analyzing trends in pharmacy school graduates provide useful insights into future pharmacy workforce planning. As of 2009, 6 of the 10 states expected to have the greatest

Table 2. Number of Pharmacy Schools and Mean Number of Graduates in 2009 by Quartile of Pharmacists per Population ≥ 65 Years of Age in 2009

Quartile and States	Mean In-state Pharmacists per Population ≥ 65 Years of Age in 2009[a]	Mean No. Pharmacy Schools in 2009 (Mean No. Graduates per School)	Pharmacy Schools With Candidate Accreditation Status and No Graduates in 2009	Pharmacy School Enrollment in 2009,[d] Mean (SD)
Total	712.1	92 (117.0)	21	53,881 (476.8)
Quartile 1 (lowest[b]): Maine (2), Delaware, Vermont, Florida, Hawaii (1), Nevada, New Mexico, Connecticut, Rhode Island, California (1), Arizona, Utah, New York (2)	568.8 [531.0-606.6][c]	22 (132.4) [95.8-169.0] [c]	6	14,546 (519.5)
Quartile 2: Missouri, West Virginia (1), Idaho, Oregon, Wisconsin, New Hampshire, South Carolina, Virginia, Iowa, Michigan, Illinois (1), Massachusetts, Wyoming.	693.1 [672.3-713.9][c]	25 (107.0) [85.8-128.2] [c]	2	12,974 (480.5)
Quartile 3: Arkansas (1), Montana, Indiana, Kansas, Pennsylvania (1), Ohio (2), Mississippi, Oklahoma, Texas (2), Washington, Maryland (1), Kentucky (1), Tennessee (4).	776.7 [763.6-789.8][c]	27 (116.0) [101.1-130.9] [c]	12	17,247 (442.2)
Quartile 4 (highest[b]): Minnesota, North Carolina, Louisiana, Nebraska, New Jersey, North Dakota, Alaska, South Dakota, Alabama, Colorado (1), Georgia, District of Columbia.	903.3 [819.1-987.5][c]	18 (115.8) [85.3-146.3] [c]	1	9,114 (479.7)

[a] Ratio is per 100,000 population 65 years and older.
[b] Quartile 1 are states in the bottom 25th percentile of the in-state pharmacists per ≥65 population ratio. Quartile 4 are states in the top 25th percentile of the in-state pharmacists per ≥65 population ratio.
[c] 95% confidence intervals in brackets.
[d] Total enrollment consists of enrollment in those accredited colleges and schools of pharmacy with graduates and those with no graduates in 2009.

increase in population ≥ age 65 years by 2030 (Florida, California, Texas, Arizona, New York, North Carolina, Georgia, Virginia, Pennsylvania, and Illinois) appear to have the greatest need for pharmacists. That is, these states had ratios of pharmacists per population ≥ age 65 in the lower half of the distribution across all states, 4 of which were in the lowest quartile. It will be important to evaluate whether and how these states will be able to expand their supply of pharmacists to meet the growing need, especially in the population ≥ 65 years of age. One approach is to increase the number of graduates produced by the states' colleges and schools of pharmacy. This goal may be most easily accomplished in the 3 states with new colleges and schools of pharmacy that recently obtained candidate accreditation status. Another approach is to recruit graduates from states with relatively high ratios of pharmacist per population ≥ age 65. This could be a difficult task, however, as past research has shown that a strong majority of pharmacy students attend school in state.[4]

Several factors may affect whether, when, and how much pharmacy school class sizes should be increased, including: the steady growth in the number of graduates between 2000 and 2009, the growth expected to continue beyond 2009 because of expansion in the number of colleges and schools of pharmacy, the location of some newly accredited colleges and schools, and the recent economic recession. In the short term, new graduates are likely to face a tougher job market than graduates had prior to the recession. College and schools located in states with relatively high ratios of pharmacists per population ≥ age 65 could encourage students to consider employment opportunities in states with the lowest ratios of pharmacists for this population. College and schools located in states with relatively high ratios of pharmacists per population ≥ age 65 years could also recruit students from states with a greater demand for pharmacists in hopes that they would return to their home states to find employment. It will be important to monitor how colleges and schools react to changes in the pharmacy marketplace over time.

Although the current recession complicates short-term planning, the long-term demand for pharmacy services will likely continue to grow as the population ages. As such, there is a need to develop effective strategies for long-term pharmacist workforce planning. One possibility is establishing a benchmark for the ratio of pharmacists per population ≥ age 65 that reflects desired goals for market equilibrium and quality of care. This benchmark could then be used by schools or states to help calculate the need for pharmacists in a given area. Data on pharmacist retirement and state-to-state migration also should be assessed and used in combination with graduate rates to plan for the expansion or contraction of the local, regional, or national pharmacist workforce. Demographic factors such as population growth and morbidity that affect pharmacist demand also can be assessed and used in combination with pharmacist data to better identify workforce needs. Data that can be used for long-term planning are available from each state. School administrators and pharmacy workforce planners and researchers should expand on the approach used in the current study to provide new information about and useful insights on how to improve the pharmacist workforce.

This study had some limitations. The AACP and Census Bureau data are the best available measures of state graduate rates and population, but they do not provide some data that would be useful in analyses such as those in the current study; both data sources have been revised in the past and may be revised in the future per internal review. The AACP data are based on graduates receiving their first degree and, as such, do not capture those getting additional degrees in this time period, although this may not be significant because there were relatively few in each year of the current study. Another possible limitation is that the current results are based on where students graduated, not where they first practiced, as the latter information was not available.

We used the population of people age 65 years and older as a general indicator of demand for pharmaceuticals and pharmacy-related services, and/or the need for pharmacists. An important limitation is that the population over 65 years may be healthier in certain states and thereby demand and/or require fewer services. Measurement could be improved with better data regarding the disease and comorbidity prevalence in the local population. Furthermore, relatively low ratio values may be attributable to the availability of similar or substitutable services from other sources, and pharmacist productivity may differ across states because of technological or other structural differences. More detailed data are required for a more comprehensive assessment.

It is difficult to find data representing state-level counts of pharmacists across time. The current study used data about the number of licensed pharmacists provided by each state to the NABP. Most states provide updated data to NABP annually, but unchanged pharmacist population data over several consecutive years in some states suggests that the available data were not current. According to the NABP data used in this study, there were 282,736 unduplicated licensed pharmacists in the United States in 2009. Another study estimated the total number of pharmacists to be 246,200 in 2009.[19] Whether there are corresponding differences in state-level pharmacist workforce numbers is unknown. One reason for the difference could be that the NABP numbers represent all licensed pharmacists and do not account for pharmacists who are temporarily out of the workforce or are retired but keeping their licenses for possible reentry into the workforce. An additional limitation is that only in-state licensed pharmacists were counted (ie, pharmacists whose residence and license were in the same state) as it is possible for pharmacists to be licensed in their state of residence but also licensed in and employed in other states.

Another data element not included in this study was the number of pharmacists who leave the workforce annually within each state. This number would have been useful because the pharmacist population in a given state typically grows only if the number of new graduates exceeds losses from the workforce. The current study's results show that between 2000 and 2009 the national pharmacist workforce expanded by 45,678 pharmacists with 85,432 graduates. The current study estimated a national annual loss rate of 1.6% of the total pharmacist population. Whether this rate is the same for each state is unknown and likely depends on numerous factors, including the demographic characteristics of pharmacists.

CONCLUSIONS

The supply of new graduate pharmacists is in an extended period of substantial growth. However, the distribution of growth remains uneven across geographic areas in the United States. Relating the number of pharmacy graduates to the ratio of pharmacists to population provides insight into whether the number of graduates is adequate to meet the demand for pharmacists. Individuals involved with policy decisions about the pharmacy workforce should consider additions to and exits from the pharmacist workforce within and across states based on pharmacist-to-population ratios to help assess whether the size of the workforce will meet the long-term need. Meanwhile, because of the recession, the short-term job prospects for new graduates are a concern that should be monitored. Future research should continue to examine whether the growing numbers of graduates are meeting the demand for pharmacists, and how meeting the demand for pharmacists impacts enrollment at colleges and schools of pharmacy as well as patient care.

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