INTRODUCTION

Recently, US News and World Report rated physical therapy (PT) as one of the 30 best careers, reporting that, next to clergy, PT is ranked highest in job satisfaction [1], making it a desirable profession. The Bureau of Labor Statistics (BLS) reported that the employment of physical therapists (PTs) is expected to grow 27% from 2006 to 2016, faster than the average for all occupations [2]. This growth is attributed to a number of factors, including the rapidly increasing elderly population, advances in medical technology permitting treatment of an increasing number of previously untreatable disabling conditions, new treatments and techniques expanding the scope of PT practice, and widespread interest in health promotion [2]. This projected employment growth suggests that the demand for PT services will increase; but will the supply of PTs keep pace with projected demands?

Human resource planning involves projecting the future supply of resources, in this case PTs, and the future requirements or demands for that service. The major objectives of this planning are to measure PT supply and PT demand, assess the balance between PT supply and PT demand, and project the likelihood of an appropriate balance in PT supply and PT demand [3-5]. There is a dearth of information regarding human resources in PT. The 1995 demand [3-5]. There is a dearth of information regarding human resources in PT. The 1995
volume of Physical Therapy explored issues surrounding PT supply and PT demand in a series of articles [3,6-8]. In 1997, the American Physical Therapy Association (APTA) commissioned a private health care study and analysis consulting firm (Vector Research Inc) to examine the relationship between supply and demand of PTs [9]. The results of the Vector study projected a 30% surplus of PTs by the year 2005 and continuing to 2020. However, the APTA Employment Survey conducted in 2005 revealed that the unemployment rate for PTs was 0.2% [8], suggesting that the predicted surplus did not occur. Although reasons why the surplus did not occur are not clear, presumably dramatic changes in the market (eg, expansion of PT practice areas into nontraditional settings, PT clinicians moving into academic, administrative, or other related fields) and health care policy (eg, direct access to PT services without physician referral, congressional moratoriums delaying implementation of the $1500 cap on Medicare benefits imposed by the Balanced Budget Act [BBA]) prevented the projected surplus.

Since the Vector study, only 2 other studies have examined human resource information related to PT throughout the United States. Chevan and Chevan [10] retrospectively examined PT supply by using publicly available census data to develop a statistical profile of PTs. They found that the number of employed PTs in 1990 had more than doubled compared with the number employed in 1980. In addition, the PT supply ratio (the number of PT jobs per 10,000 persons) had increased from 1.4 to 2.7 in the same time period. It was not known whether this PT supply ratio of 2.7 was adequate to serve the PT needs of the population; thus, no determination of over- or undersupply could be made. Recently, Landry et al [11] retrospectively examined PT supply ratios across the United States and found the national ratio of PTs per 10,000 population increased from 3.8 in 1995 to 6.2 in 2005. It is apparent from these studies that the PT supply ratios increased during the time periods examined.

The APTA recently renewed its efforts to examine human resource issues within the PT profession as the result of anecdotal reports of PT shortages. To begin this process, they examined vacancy and turnover rates in acute care hospitals, skilled nursing facilities, and outpatient PT offices. The results were released in a series of reports in 2008 demonstrating vacancies across the 3 health care settings [12-14]. The vacancy rates for skilled nursing facilities, acute care hospitals, and outpatient PT offices were 18.6%, 13.8%, and 13.1%, respectively. Turnover rates of full-time equivalent PTs were greatest for skilled nursing facilities (85.2%) [14] and lowest for outpatient offices (8.3%) [12]. Turnover rates for acute care hospitals were 15.9% [13]. In addition, approximately one-third of skilled nursing facilities and outpatient clinics took an average 2 to 5 years to fill a vacant position [12,14]. These results suggest there currently is a shortage of PTs across these 3 health care settings. Except for the Vector study, to our knowledge, there are no other studies examining both PT supply and PT demand for the entire nation. In addition, we have not found published studies that forecast future PT supply and PT demand for the United States.

In 2005 the Healthcare First study group was established at the University of California at Irvine to address the shortage of Registered Nurses (RNs) in the state of California. By the use of accessible public databases, forecasting models were constructed to project the demand and supply of RN jobs. The combination of these supply-and-demand models was used to produce regional RN shortage forecasts for future years [15,16]. In 2008 the Healthcare First study group was relocated to the Cleveland Clinic and began to address the distribution and health care workforce at the national level by the use of similar demand-and-supply models developed previously. The authors used the grading methodology as well as supply-and-demand models to examine current surplus/shortage trends in PT across the 50 states of the United States and make predictions of these trends to the year 2030. The results of this current study serve to provide points of discussion for the PT profession, policy makers, and stakeholders when evaluating current and future PT needs to mitigate predicted shortages.

**MATERIALS AND METHODS**

In this article, we project PT job shortages by examining the disparity between PT demand and PT supply in all states within the United States (see Table 1 for key term definitions). To accomplish this, forecast models were created for both PT demand and PT supply. Estimates used by this model came from government-maintained, readily accessible, public databases. PT job estimates were largely obtained from the BLS, which uses a survey of employers in all industry sectors to estimate the national and state number of PT jobs. PT jobs include both part-time and full-time workers who are paid a salary and whose job description conforms to the Standard Occupational Classification system used by all federal statistical agencies to classify workers. The BLS estimates do not include self-employed workers, owners or partners in unincorporated firms, or other unpaid workers [17,18]. State and national population estimates and projections were obtained from the U.S. Census Bureau (USCB), which estimates nation and state populations by incorporating birth, death, and migration rates into their decennial survey data [19]. A grading methodology developed previously [15,16] was used as a method for evaluating individual state shortage ratios between 2008 and 2030. States were aggregated into 4 large regions as defined by the BLS [20] to facilitate regional analysis (Table 2).

**Demand Model**

The demand model was designed on the premise that population growth and age would be the principal drivers of
Table 1. Explanation of key terms

<table>
<thead>
<tr>
<th>Key Term</th>
<th>Definition</th>
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<tr>
<td>Report card</td>
<td>A collection of grades assigned to each state on the basis of a grading rubric used for determining stated (2008) or projected (2020 and 2030) PT shortage ratios.</td>
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<td>National mean</td>
<td>5.5 PT jobs per 10,000 people. This value was determined by the number of PTs in the United States per 10,000 people for 2008 (BLS, 2008).</td>
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<tr>
<td>Personal health care expenditure (PHE)</td>
<td>An estimate that takes into account “spending for hospital care, physician and clinical services, dental care, other professional services, home health care, nursing home care, and health care products purchased in retail outlets.” This estimate does not include spending on public health programs, health facility administration, health care research, and the construction of health care facilities (Centers for Medicare &amp; Medicaid Services, 2008).</td>
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<td>Physical therapist (PT)</td>
<td>PT is an occupation profile defined by the BLS. PTs are referred to as health care professionals who diagnose and treat individuals with medical problems that limit their ability to move and perform functional activities. PTs examine each individual and develop a plan by means of treatment techniques to promote the ability to move, reduce pain, restore function, and prevent disability. In addition, PTs work with individuals to prevent the loss of mobility before it occurs by developing fitness and wellness-oriented programs for healthier and more active lifestyles.</td>
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<td>Physical therapy (PT) jobs</td>
<td>A worker who can be classified as a full-time or part-time PT. This is the fundamental unit of measure used to estimate PT populations and is counted through a survey conducted by the BLS every 3 years.</td>
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<td>PT demand</td>
<td>The estimated number of PT jobs needed to meet population needs.</td>
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<td>PT demand ratio</td>
<td>The number of PT jobs needed per 10,000 people.</td>
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<td>PT shortage</td>
<td>The difference between a region’s demand for PT jobs and that region’s supply of PT jobs.</td>
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<tr>
<td>PT shortage ratio</td>
<td>PT shortage per 10,000 people.</td>
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<td>PT supply</td>
<td>The estimated number of PT jobs.</td>
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<td>PT supply ratio</td>
<td>The number of PT jobs per 10,000 people.</td>
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Table 2. US regional groupings from the Bureau of Labor Statistics (17)

<table>
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<tr>
<th>South</th>
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Table 2. US regional groupings from the Bureau of Labor Statistics (17)

demand for PTs in coming years. The Centers for Medicare and Medicaid published a means of converting demographic changes into a personal health care expenditure (PHE) [21]. By using the USCB age-population projections [22], we were able to forecast future demand for health care services until 2030 as a single dollar amount. By means of a linear regression analysis, this monetary figure was plotted against available BLS-reported PT jobs in the United States for 2000 and 2004 to 2008, resulting in a linear slope of $3.58 \times 10^{-7}$ and standard error of $7.91 \times 10^{-9}$ ($R^2 = 0.998$, 95% confidence interval, $3.36 \times 10^{-7}$ to $3.80 \times 10^{-7}$; $P < .001$). This linear slope was multiplied by the projected yearly change in PHE of each state to produce an estimated change in PT demand for that year. The slope standard error was used to generate upper and lower estimates of PT demand through 2030. With the use of 2008 values as the current PT demand, which is an underestimate of current PT shortages according to prior studies [12-14], the yearly projected change in PT demand in each state was used to produce a demand estimate up through the year 2030. The following equation describes details of the demand model:

$$D_{R,2000} = 5.50 \times \frac{[2008 \text{ Projected State Population}]}{10^4} + 3.58 \times 10^{-7} \times \Delta \text{PHE}_{R,2008, 2009}$$

$$D_{R,2010} = 5.50 \times \frac{[2008 \text{ Projected State Population}]}{10^4} + 3.58 \times 10^{-7} \times (\Delta \text{PHE}_{R,2008, 2009} + \Delta \text{PHE}_{R,2009, 2010})$$

$$D_{R,N} = 5.50 \times \frac{[2008 \text{ Projected State Population}]}{10^4} + 3.58 \times 10^{-7} \times \sum_{n=1}^{N} (\Delta \text{PHE}_{2008, 2009} + \Delta \text{PHE}_{2009, 2010} + \ldots + \Delta \text{PHE}_{N-1,N})$$

where $D_{R,N}$, $D$ = demand, $R$ = region or state, and $N$ = year; $\Delta \text{PHE}_{N-1,N}$ = the change in PHE from 1 year to the next year; and 5.50 is the national mean obtained from BLS (PT jobs per 10,000).
Supply Model

Like the demand model, the supply model assumed that changes in PT supply were determined primarily by age and population growth. With data from the Current Population Survey [23], which is a survey conducted jointly by the BLS and the USCB to assess workforce characteristics, the likelihood of a person in the United States to be employed as a PT was averaged during the past 10 years in the following age groups: 16 to 19, 20 to 24, 25 to 34, 35 to 44, 45 to 54, 55 to 64, and 65 years and older. These 10-year proportions were multiplied by USCB-projected population increases in each age category, providing an estimate of the number of persons in each age group that will assume a PT job each year until the age category, providing an estimate of the number of persons in each age group that will assume a PT job each year until the year 2030. This estimate was summed across age groups for each region or State, and N = year; LA: L = likelihood averaged over 10 years, A = age group; ΔPOP A, N-1, N = age-category–specific population N − population N-1; and BLS2008 = the number of PT jobs reported by the BLS in 2008.

Report Card

The metric used for grading in this work was the PT shortage ratio, which is defined as the difference between PT demand and PT supply per 10,000 persons and demonstrated by the following equation:

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Our model forecasts of PT supply ratios and PT demand ratios are graphically displayed in Figure 2 for each of the BLS-defined regions. These data demonstrate that the PT supply ratios will remain relatively constant, whereas the PT demand ratios will increase, outpacing supply and creating shortages. This finding is especially true for the southern and western regions that currently exhibit shortages.

The PT shortage (the number of PT jobs) from 2008 through 2030 for each BLS-defined region is displayed in Figure 3. It can be seen from Figure 3 that our model forecasts an increase in PT shortages in all regions and states, with the southern and western regions exhibiting the largest increases in PT shortages.

DISCUSSION

Our model forecasts that, on the basis of current trends, demand for PT services will far outpace the supply of PTs within the U.S. According to our model, by the year 2030, most states will have severe PT shortages. These shortages will be most severe in the western and southern regions. This is a very sobering forecast; the cost and expenses associated with training therapists to meet the demand are in the range of billions of dollars. Thus, it requires concerted and persistent efforts in all segments of society, government at all levels, the health care industry, professional societies, academia, and the public at large to put forth sustainable growth plans for meeting the challenges of tomorrow.

Examination of the health care workforce is difficult because of the complexity of factors that affect supply, demand, and balance between supply and demand. Health-care policy is one of these factors. The supply-and-demand models used in this study are determined by health care practice regulated by current policies. Using an approach similar to ours, the APTA Vector Report predicted a PT surplus by the year 2005 [9] that did not appear to occur. The failure of this prediction is attributable in part to changes in health care policy (e.g., institution of and then moratoriums delaying implementation of the Medicare cap imposed by the BBA). If health care policy had remained the same from 1997 to 2005, the Vector Report surplus prediction may have been realized. One key provision of the health care reform bill recently passed by Congress is to insure the uninsured, which presumably will increase access to health care services, increasing demand beyond current predictions.

To evaluate the effects of health care reform and other health care policies, strategies need to be developed to effectively monitor supply and demand of the health care workforce. These strategies should be at the state and national levels, be ongoing, and be collaborative among key stakeholders. For example, Texas nursing leadership worked with key stakeholders to pass legislation addressing the nursing shortage in Texas [25]. This collaborative effort led to development of a statewide health council focused on health
professional workforce planning. This council serves as a resource to develop legislation and facilitate projects to ensure that health care services and resources are available throughout the state of Texas [25]. To determine the supply and distribution of health care workers, the state of North Carolina established a comprehensive and continuously maintained database (North Carolina Health Professions Data System) that tracks supply and demand of licensed health professionals within the state [26]. Reports released from these data include historical examination of supply ratios throughout the state reporting distribution disparities in counties, urban and rural areas, vacancy rates, and recommendations for policy makers and educators [26-28]. The work in Texas and North Carolina are examples of health care workforce planning that could be adopted by states throughout the United States to establish state and federal policies to ensure adequate supply of health professionals.

State and federal policies may also be used to mitigate regional disparities in the distribution of PTs. In the current study, all states that received a PT shortage ratio grade of C or lower had population densities of less than 448 persons per square mile, and 27 of these 30 states had population densities of less than 147 persons per square mile [29]. For example, Massachusetts and Connecticut had low shortage ratios with high population densities (833 and 723 persons per square mile, respectively), whereas Nevada and Alabama had high shortage ratios with low population densities (24 and 92, respectively). Although this trend was not true for all states (eg, Vermont had a low shortage ratio and low population density, 67 persons per square mile), in general, the states that exhibited current PT shortages represented more rural areas.

The authors of previous studies have demonstrated similar distribution disparities across the nation [10,11] and

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**Figure 2.** Projected PT supply ratio and PT demand ratio for each aggregate BLS-defined region (see Table 2). Shaded regions indicate years in which PT supply ratio meets or exceeds PT demand ratio according to our model forecasts.
Solutions to mitigate PT shortages may be found by examining what these other professions have done. For example, evidence linking hospital nurse staffing to patient outcomes and improving quality and safety of patient care has demonstrated to stakeholders that adequate numbers of well-trained nurses will aid in achieving higher quality health care delivery systems [39]. Developing standard outcome measures of PT, providing evidence that PT is critical to high-quality health care delivery, and educating stakeholders will strengthen the profession. Improving the workplace to aid retention of PTs is also critical to mitigating shortages. For nursing, this has been accomplished in part by instituting the Magnet Hospital Recognition Program (American Nurses Credentialing Center) in which organizations are recognized for excellence in nursing practice and patient care [39]. This has improved job and career satisfaction among nurses, aiding retention efforts [39]. The APTA has examined PT turnover rates in 3 practice settings [12-14] and reported greater turnover rates in acute care hospitals and skilled nursing facilities than in outpatient private practices. Identifying the reasons for high turnover rates would be prudent to develop initiatives aimed at retention of skilled practitioners in these practice settings.

Another mechanism for mitigating shortages may be through foundations and private sector initiatives. The private sector could provide resources to test initiatives aimed at improving the workplace, conduct studies on quality of PT services, and support PT education. Private initiatives could aid in increasing public awareness of the PT shortages, convey positive images of the PT profession to the public, and raise funds for PT education. This was accomplished for nursing and resulted in strengthening the nursing profession and reducing shortages [39]. Increasing access to health care occupation education through e-learning technologies, better collaborations between clinical sites and educational programs, and creative public/private partnerships as demonstrated in Iowa [43] and Oregon [44] will also help mitigate health care workforce shortages.

Limitations/Assumptions

There are several limitations and assumptions inherent in our models. First, the demand model is determined only by age and population growth, assumes that growth is linear, and assumes that it is the same across all states. Although this assumption is simplistic, it is a first attempt to use available, credible data to examine both supply and demand for the entire country. Although population size and age are fundamental components of health care utilization in a number of national workforce projections [45], health insurance status, regional variations in service costs, and even regional industry composition all play roles in determining PT demand. We did not account for these other factors in our demand model. Another limitation of the demand model is that it assumes a

Programs exist to address health care workforce distribution disparities for health professions other than PT. For example, the National Health Service Corps is a federal program that provides loan repayment and scholarships for primary care providers (physicians, nurse practitioners, certified midwives, physician assistants, dentists, dental hygienists, and mental health workers) who commit to work in Health Professional Shortage Areas [34]. Students at the University of Minnesota are immersed in rural medical practice for 36 weeks; this program has resulted in successfully graduating rural primary care physicians [35]. The state of Wisconsin established a consortium to study the misdistribution of primary care providers within the state [36]. The Wisconsin consortium developed recommendations resulting in health care education program changes, development of pilot programs designed to meet the health care needs of underserved populations, and the restructuring of loan repayment programs designed to attract primary health care providers to underserved regions. Currently, none of these programs include PT. Implementation and expansion of these types of programs to include PT would serve to reduce and eventually eliminate the misdistribution of PTs, ensuring that the health care needs of the underserved are met.

The problem of health care workforce shortages is not unique to PT but has been observed in other health professions (eg, nursing [15,16,37-39] and medicine [40-42]).
static health care economic and policy structure. Because health care coverage is linked to employment, fluctuations in the economy that affect employment will affect PT demand. Medicare and Medicaid policies, established by federal and state policy makers, influence access to PT and reimbursement for PT services. As demonstrated with the BBA, the number of PT jobs is greatly influenced by changes in health care policy. Health care reform policies recently passed by Congress and the current economic recession have the potential to significantly affect our model predictions. With the increasing focus on health and wellness and prevention, the scope of PT practice has changed, creating additional demand for PT services in other settings such as health clubs, professional athletic organizations, and senior centers that did not exist previously [46,47]. Direct access to PT (instead of via referral) has the potential to increase demand because access to PT services by the general public would be easier. Another factor affecting our demand model is the use of 1999 PHE from the Centers for Medicare & Medicaid Services. Older age groups tend to have greater PHEs than younger age groups because of the development of chronic conditions associated with aging [21]. It has been reported that chronic disability is decreasing [48]. Reducing the prevalence of chronic conditions may impact PHE and may affect our demand projections.

Our supply model also incorporates a number of key assumptions that may limit its conclusions. The primary assumption is that PT job supply is driven by age, population growth, and historic likelihood of specific age groups to be employed as a PT. It does not incorporate workplace settings, part-time or full-time employment status, the impact of gender or ethnic factors on PT jobs, interstate migration of PTs, international recruitment of PTs, or state and national economic and political factors that impact desirability of PT employment. For example, the number of applicants to PT programs declined from 1995 to 2002 [49], possibly because of the reduction of PT jobs after the BBA was passed. Since 2002, the number of applicants to PT programs has been increasing [49], potentially because of continued reports that PT is a desirable profession.

Finally, our grading system is determined via the current national PT supply ratio of 5.50. We assigned a letter grade of C to this ratio because this was the national ratio in 2008. Anything above a letter C was considered to be a surplus (or at least less of a shortage); a letter grade of C would suggest a balance between PT supply and PT demand. This is most likely not the case, given the many job postings across the nation, sign-on bonus incentives, and the 2008 APTA workforce study reporting significant proportions of job vacancies [12-14].

CONCLUSION

The forecasts in this study suggest that shortages of PTs currently exist in many states across the nation and that these shortages will increase over the next 2 decades. These results should be used as points of discussion for policy makers and stakeholders to examine the issue of PT supply and PT demand. Follow-up studies need to be performed to validate our model, confirm our current results, and develop more complex models that incorporate other factors affecting supply and demand not accounted for in our model. It is important that adequate models of supply and demand for the PT profession be developed. These models should be used in ongoing assessment of PT distribution to identify underserved regions, practice settings, and populations. In addition, ongoing determination of shortages/surpluses needs to occur in order to adequately forecast future trends. Monitoring these trends over time is critical for planning and policy making to ameliorate severe shortages or surpluses and maintain an appropriate balance between PT supply and PT demand that meets population needs.

ACKNOWLEDGMENTS

The authors thank Amanda Chiu for assistance with data processing, Walter Liau and Daniel Chen for coordinating the research program, and Vinoth Ranganathan for editorial comments and assistance.

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