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ORIGINAL CONTRIBUTION

Research Funding at Colleges of Osteopathic Medicine in the United States

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Context: Research is a vital component of a college of osteopathic medicine (COM) portfolio. Previous studies have described research activity at COMs from 1989 through 2004 using data from surveys of COM administrators conducted by the American Association of Colleges of Osteopathic Medicine (AACOM). However, these studies had limitations.

Objectives: To address the limitations of previous studies and to provide more depth of understanding regarding research activity at COMs by (1) documenting changes in research funding at COMs from 2004 to 2009 according to the funding agencies, principal investigators' degrees, and areas of study after considering inflation and (2) examining predictors of research funding at COMs.

Methods: Information about 2004 and 2009 active research grants and contracts, research expenditures, and COM characteristics was obtained from AACOM databases. Descriptive statistics are presented for 20 COMs that completed the survey in both years. The 2004 dollar values were adjusted for the rate of inflation (13.57%). Bivariate and multivariate analyses were used to explore associations between school characteristics (eg, number of faculty), research expenditures, and research funding outcomes (total amount and number of awards) for all COMs completing the survey in 2009 (n=26).

Results: From 2004 to 2009, the total amount of awards increased from 115.2 million to 216.6 million, and the number of awards increased from 450 to 665. Funding rose substantially from foundations (336%), to PhD-DO principal investigators (909%), and for osteopathic manipulative medicine (60%). Total award amounts were positively associated with both research expenditures (P<.001) and the number of faculty (P<.001). Larger research expenditures also were related to securing a greater number of awards (P<.001).

Conclusion: Research activity at COMs continues to advance partly because of investments in research and faculty made by COMs.

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Colleges of osteopathic medicine (COMs) are important contributors to the knowledge base concerning new medicines, health care innovations, and osteopathic manipulative medicine (OMM).[1-3] On a yearly basis, the National Institutes of Health (NIH) allocates billions of dollars for health research, and nearly half of its funds is allotted for research at US medical schools.[4] In 2009, however, of the approximately $11 billion given to medical schools, only about $135 million (1.2%) was granted to COMs.[4] Because of concentrated efforts by the American Association of Colleges of Osteopathic Medicine (AACOM) and the American Osteopathic Association (AOA) to build research infrastructure at COMs and because of standards set forth by the AOA Commission on Osteopathic College Accreditation to advance the knowledge and development of osteopathic medicine through scientific research, descriptive accounts about the latest data on funding at COMs are highly warranted.[5-7]

Clearfield and colleagues[8] and Guillory and Sharp[9] provided detailed descriptions of research funding activity at COMs from 1989 through 2004 using AACOM data. These studies[8,9] provide meaningful information regarding the status of research funding at COMs; however, they have limitations that, if addressed, would improve our understanding of COM research funding. For instance, Guillory and Sharp[9] described only the total amount of active research awards in 1989 and 1999, but no information

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was presented for both years on other interesting factors such as the funding agency or the area of study (eg, OMM). Further, comparisons in these studies[8,9] were made over a 15-year period without adjusting for the rate of inflation, which if considered would provide a more valid representation of temporal differences in dollar amounts. Additionally, to our knowledge, neither study statistically explored the factors related to research funding at COMs.

The purpose of the present study was to address these limitations by providing more detail regarding COM funding activity. Specifically, we sought to (1) investigate all research awards active in 2004 and 2009, including how these awards were distributed across funding agencies, principal investigators by academic degree, and research areas after considering inflation and (2) explore predictors of research funding at COMs using multiple linear regression analyses.

Methods

In the falls of 2004 and 2009, all COMs in the United States were asked by AACOM to complete standardized reporting forms regarding all currently active internally and externally funded projects.[10] Specifically, college administrators self-reported information about active awards including the award amount, funding agency (eg, NIH), academic degree and department of the principal investigator, activity (eg, research grant), and subject area (eg, biomedical). The only difference between the 2004 and 2009 forms was the format. The 2009 form could be completed electronically whereas the 2004 form could not. For this study, only data pertaining to research grants and contracts and the first principal investigator listed were used. Respondents could identify a second principal investigator if applicable; however, this information was not required and underreporting may have occurred (only 15% of active awards had a second principal investigator listed). Further, we examined data on OMM funding separately from clinical funding to better illustrate details regarding funding in the OMM subject area. Additional data about 2004 and 2009 research expenditures, number of full-time faculty, number of students, and school type (private or public) were also obtained from the AACOM survey. The response rates for the 2004 and 2009 surveys were 100%. The research protocol was reviewed and approved by the human subjects' research review board at the Kansas City University of Medicine and Biosciences.

The Consumer Price Index represents changes in prices of all goods and services purchased for consumption by urban households.[11] Based on the inflation calculator on the US Bureau of Labor Web site (http://www.bls.gov/data/inflation_calculator.htm), we determined that the inflation rate between 2004 and 2009 was 13.57%. All 2004 dollar amounts were adjusted for this inflation rate to reflect 2009 dollar values. For example, the 2004 total award amount of $101.408 million would be equivalent to $115.169 million in 2009 dollars.

Statistical Analysis

Descriptive statistics were calculated as means (eg, average amount per award) or as summations (eg, total amount per award). Data and results from the analyses are given for the 20 COMs that completed the 2004 survey plus an additional 6 that did not exist in 2004, thus giving a sample size for 2009 of 26. Descriptive statistics for these schools are presented as mean (standard deviation) with variable ranges and summations, if applicable. The distributions of skewed 2009 variables were normalized by means of log or square root transformations. Bivariate relationships among continuous variables were examined using Pearson product moment correlation. Point biserial correlation was used for school type (a dichotomous variable) and the continuous variables of interest. To guard against an experimentwise error rate associated with the bivariate correlation procedures, a Bonferroni correction for multiple tests was made. Therefore, the level of statistical significance was set at .007 (0.05 ÷ 7 tests) for bivariate correlations. Two multiple linear regression models were constructed to explore predictors of the total amounts (model 1) and number (model 2) of awards active in 2009. The independent variables were school type (0=private, 1=public), the number of faculty, and research expenditures in dollars; these variables were found to be related to the total amounts and number of awards in the bivariate analysis. The level of statistical significance was set a priori at .05 for the multiple regression analyses, and all analyses were conducted using SPSS statistical software version 20.0 (SPSS for Windows, SPSS Inc, Chicago, Illinois).

Results

Changes in Research Funding Between 2004 and 2009

Provided in *Table 1* are descriptive statistics for select characteristics of the 20 COMs completing the AACOM survey in 2004 and 2009. The workforce of full-time faculty grew (19.9% or 288 faculty) during the 5-year period, as did the amount of funds expended on research (41% increase or $17.0 million). Substantial increases were observed from 2004 to 2009 in the total amount of awards (88.1% or $101.5 million additional), the number of awards (47.8% or 215 awards), and the dollar amount of each award (28.8% or $60,000). In both years of the survey, there was a large spread of ranges for the measured variables. As an example, in 2009 one COM had more than $82.6 million in awards, while another had $0.1 million. Distributions of the total amount of awards were skewed; in 2004, 2 COMs received 51.2% of the awards, and in 2009, 2 COMs received 61.2%

Table 1.
Active Award Data and Research Expenditures for Colleges of Osteopathic Medicine in 2004 and 2009 (n=20)

Variable	2004	2009	Net Change	% Change
Total no. of faculty	1445	1733	288	19.9
Total research expenditures[a]	41.567	58.600	17.033	41.0
Total award amount[a]	115.169	216.621	101.462	88.1
Total no. of awards	450	665	215	47.8
Average amount per award[a]	0.208	0.268	0.06	28.8

[a] All dollar amounts are in millions of US dollars; 2004 dollar amounts are adjusted for inflation (plus 13.57%).

of the awards. Although the majority of COMs (13 [65%]) showed an increase in the total amount of awards from 2004 to 2009, their rank or position relative to other COMs was stable (7 COMs in the top half for total award amounts in 2004 were in the top half in 2009).

The total amount of awards, the number of awards, and the amount of dollars received per award for each funding source were higher in 2009 than 2004 (*Table 2*). The total amount of awards obtained from foundations increased 335.7% ($26.4 million) from 2004 to 2009. This increase was due more to an increase in the dollar amounts of each award (144.6% increase or $227,000) than the number of awards (78% increase or 39 awards). Foundations provided by far the largest increase in awards from a particular funding source; however, fairly large gains were noted in funds from the NIH, the AOA, and other federal agencies. The percentages of total award amounts accounted for by other federal agencies, state or local agencies, the Centers for Disease Control and Prevention (CDC), the US Department of Defense (DOD), pharmaceutical companies, and other groups were lower in 2009 compared with 2004, while total amounts were similar for the NIH (60.1% in 2004 vs 62.3% in 2009) and higher for foundations (2.5-fold higher in 2009). While the total amount of awards from "other" federal agencies and the AOA increased, the dollar amount of each award decreased substantially (31.3% or $158,000 for other federal agencies and 50.0% or $53,000 for AOA). In 2009 there was an absence of funding from the CDC and the DOD, which provided $2.2 million in 2004.

Most of the total dollars awarded were obtained by PhD principal investigators (82.8% or $95.3 million in 2004 and 78.4% or $169.9 million in 2009) followed by DOs (12.5% or $14.3 million in 2004 and 11.6% or $25.1 million in 2009) (*Table 3*). Although the total amount of awards grew for all degree types from 2004 to 2009, increases were most substantial for principal investigators holding PhD and DO degrees (909% or $1.3 million), MD degrees only (515.4% or $8.1 million), and PhD and MD degrees (267.5% or $4.4 million). Each degree type also obtained relatively

Table 2.
Active Award Data by Source of Funding for Colleges of Osteopathic Medicine in 2004 and 2009 (n=20)[a]

	2004		2009			
Source of Funding	Amount (No. of Awards) [% of 2004 total award amounts]	Amount/ Award	Amount (No. of Awards) [% of 2009 total award amounts]	Amount/ Award	% Change in Amount	% Change in Amount/ Award
Foundations	7.853 (50) [6.8]	0.157	34.219 (89) [15.8]	0.384	335.7	144.6
Other Federal	9.602 (19) [8.3]	0.505	14.231 (41) [6.6]	0.347	48.2	-31.3
State/Local	2.853 (10) [2.5]	0.285	3.236 (38) [1.5]	0.085	13.4	-70.2
NIH	69.219 (117) [60.1]	0.592	134.991 (184) [62.3]	0.734	95.0	24.0
AOA	0.317 (3) [0.3]	0.106	0.463 (12) [0.2]	0.053	46.1	-50.0
CDC	0.521 (3) [0.5]	0.174	0	0	-100.0	-100.0
DOD	1.671 (6)[1.5]	0.279	0	0	-100.0	-100.0
HRSA	0	0	0.035 (1) [0.02]	0.035	100.0	100.0
Pharma	8.119 (126) [7.1]	0.064	9.450 (93) [4.4]	0.102	16.4	59.4
Other[b]	15.013 (116) [13.0]	0.129	19.996 (207) [9.2]	0.097	33.2	-24.8

[a] All dollar amounts are in millions of US dollars; 2004 dollar amounts are adjusted for inflation (plus 13.57%).

[b] Includes the American Hospital Association, biotechnology companies, school support, and sources listed as "other" by reporting institutions.

Abbreviations: NIH, National Institutes of Health; AOA, American Osteopathic Association; CDC, Centers for Disease Control and Prevention; DOD, US Department of Defense; HRSA, Health Resources and Services Administration; Pharma, pharmaceutical companies.

Table 3.
Active Award Data by Academic Degree of Principal Investigator for Colleges of Osteopathic Medicine in 2004 and 2009 (n=20)[a]

	2004		2009			
Academic Degree	Amount (No. of Awards) [% of 2004 total award amounts]	Amount/ Award	Amount (No. of Awards) [% of 2009 total award amounts]	Amount/ Award	% Change in Amount	% Change in Amount/ Award
PhD	95.297 (272) [82.8]	0.350	169.855 (417) [78.4]	0.407	78.2	16.3
DO	14.279 (134) [12.5]	0.107	25.095 (137) [11.6]	0.183	75.7	71.0
MD	1.562 (24) [1.4]	0.065	9.612 (59) [4.4]	0.163	515.4	150.8
PhD and DO	0.145 (9) [0.1]	0.016	1.463 (27) [0.7]	0.054	909.0	237.5
PhD and MD	1.632 (5) [1.4]	0.326	5.997 (13) [2.8]	0.461	267.5	41.4
Other[b]	2.309 (15) [2.0]	0.154	4.599 (12) [2.1]	0.383	99.2	148.7

[a] All dollar amounts are in millions of US dollars; 2004 dollar amounts are adjusted for inflation (plus 13.57%).
[b] Includes degrees listed as “other” by reporting institutions (eg, nursing, masters, physicians assistant).

higher dollar amounts for each award funded in 2009, with the largest increase being $38,000 per award for principal investigators with PhD and DO degrees (237.5% increase).

Most of the total amount of awards in 2004 (78.5% or $90.4 million) and 2009 (63.3% or $137.2 million) went to biomedical research (*Table 4*). No clinical research awards were reported active in 2004, while $48.7 million in clinical research awards was identified in 2009. The largest rise from 2004 to 2009 in funding occurred in the area of drug research, with increases of 173.7% or $9.8 million in the total amount of awards and 181.6% or $89,000 in the amount per award. Increases in funding amounts for biomedical (51.7% or 81 additional awards in 2009), behavioral (65.7% or 10 additional awards in 2009), and OMM (60.2% or 6 additional awards in 2009) research were also noted with increases in award amounts for biomedical (15.5% or $54,000) and OMM (25.2% or $38,000) and a decrease for behavioral research (-21.5% or -$118,000). Fairly large decreases in the total amount of awards (-81.9% or -$9.1 million) and dollars per award (-72.5% or -$170,000) for other research areas were observed.

Predictors of Research Funding in 2009

Selected descriptive statistics for the 26 COMs completing the AACOM survey in 2009 are displayed in *Table 5*. Acceptable skewness statistics (values <2.0) were noted for skewed 2009 variables (total award amounts, total number of

Table 4.
Active Award Data by Research Area for Colleges of Osteopathic Medicine in 2004 and 2009 (n=20)[a]

	2004		2009			
Research Area	Amount (No. of Awards) [% of 2004 total award amounts]	Amount/ Award	Amount (No. of Awards) [% of 2009 total award amounts]	Amount/ Award	% Change in Amount	% Change in Amount/ Award
Biomedical	90.393 (259) [78.5]	0.349	137.155 (340) [63.3]	0.403	51.7	15.5
Drug	5.642 (114) [4.9]	0.049	15.441 (112) [7.1]	0.138	173.7	181.6
Behavioral	4.942 (9) [4.3]	0.549	8.189 (19) [3.8]	0.431	65.7	-21.5
OMM	3.181 (21) [2.8]	0.151	5.097 (27) [2.4]	0.189	60.2	25.2
Clinical	0	0	48.738 (136) [22.5]	0.358	100	100
Other[b]	11.065 (47) [9.6]	0.235	2.001 (31) [0.9]	0.065	-81.9	-72.5

[a] All dollar amounts are in millions of US dollars; 2004 dollar amounts are adjusted for inflation (plus 13.57%)
[b] Includes areas listed as “other” by reporting institution.

Abbreviation: OMM, osteopathic manipulative medicine.

Table 5.
Descriptive Statistics for Colleges of Osteopathic Medicine That Completed the 2009 AACOM Survey (N=26)

Variable	Mean (SD)	Range	Sum
No. of enrolled students	679 (265)	302-1182	17,655
School age, y	37.5 (37.6)	3-117	NA
No. of faculty	72.8 (68.5)	18-325	1893
Research expenditures[a]	2.304 (5.485)	0-26.701	59.900
Total award amounts[a]	8.341 (18.654)	0-82.626	216.876
Total no. of awards	25.8 (42.2)	0-193	672

[a] All dollar amounts are in millions of US dollars.

Abbreviations: AACOM, American Association of Colleges of Osteopathic Medicine; SD, standard deviation.

awards, number of faculty, and research expenditures) after normalizing their distributions. Total research expenditures, total award amounts, and the total number of awards were not much higher in 2009 than 2004 awards, even with the addition of 6 new COMs ($1300 for expenditures, $255,000 for award amounts, and 7 awards). Also notable in this table is the robustness of variance indicators (standard deviations and ranges) for all variables. For instance, 1 COM expended $0 on research while another expended more than $26 million on research in fiscal year 2009. Likewise, the total amount of awards ranged from $0 at 2 COMs to more than $82 million at 1 COM. The $82 million received for research by the COM that led in research funding was approximately $32 million higher than the COM with the second highest amount of research funding. There were 20 private (76.9%) and 6 public (23.1%) COMs.

Correlation coefficients derived for the purpose of examining the bivariate relationships among school demographics and award data are presented in *Table 6*. The total amount of awards and number of awards were statistically significant for and positively correlated with research expenditures and the number of faculty. In addition, public COMs obtained more award dollars and awards, expended more on research, and had larger faculties than private COMs.

The results of the multiple regression analyses are given in *Table 7*. The tolerance and variance inflation factors were within acceptable ranges, thus indicating colinearity, and did not compromise the models.[12] In model 1, faculty number and research expenditures were statistically significant predictors of the total amount of awards. These 2 variables plus school type explained 79.0% of the variance in the total amount of awards. Research dollars expended was the only statistically significant predictor of the number of awards (model 2). The variables contained in model 2 accounted for 81.0% of the variance in the number of awards. Although school type was not a statistically significant predictor of the total amount or number of awards, being a public COM was associated with having $4.9 million more in awards and 12.7 additional awards than that of being a private COM.

Comment

The purpose of the present study was to examine research funding at COMs. Specifically, we used data from AACOM surveys of college administrators to compare active research awards in 2009 with active research awards in 2004. The total amount of awards, the number of awards, and the amount of dollars obtained per award increased from 2004 to 2009, which is consistent with findings of previous studies on COM research funding.[8,9] A unique aspect of this study was the examination of research expenditures, the number of faculty, and school type as predictors of research funding. In general, increasing numbers of faculty and expending more dollars on research enhanced research productivity as evidenced by funding procurement.

Previous reports[8,9] indicated the total amount of awards at COMs increased $9.9 million between 1989 and 1999 and $74.9 million between 1999 and 2004. We also noted substantial increases in funding ($101.5 million) and investments in research (41%) between 2004 and 2009 even after adjusting for the effects of inflation, which was not done in the previous studies. Similar patterns of funding were evident among the 3 studies such as major contributions from the NIH (54.9% in 1999, 59.6% in 2004, and 62.3% in 2009), the skewed distribution of research funding toward 2 to 3 COMs, and virtually nonexistent support from the CDC, the DOD, and the Health Resources and Services Administration. A primary difference between studies involved the contributions of foundations to COM research. Foundation funding was relatively low in 1999 and 2004 (5% to 7% of total funding) but increased substantially (336%) between 2004 and 2009, thus promoting foundations to the status of "major supporter" of COM research (15.8% of total funds, second only to the NIH). Also of relevance was the nonexistence of funding for clinical studies in 2004. It is not clear if this finding represents an actual absence of clinically funded research in 2004 or a reporting error on the 2004 survey.

Consistent with the 2 previous studies[8,9] on COM research funding, principal investigators with PhD degrees garnered the most research dollars and the highest number of awards. They averaged approximately $0.4 million per award, which is consistent with findings on principal investigators with PhD degrees employed by allopathic medical schools.[13] In contrast with previous reports on COM research funding, the greatest increase in funding activity

Table 6.
Correlation Coefficients for Colleges of Osteopathic Medicine That Completed the 2009 AACOM Survey (N=26)

Variable	Award Amounts	No. of Awards	Student Enrollment	School Age, y	No. of Faculty	Research Expenditures
No. of awards	0.85[a]	...	...	...	...	...
Student enrollment	0.24	0.15	...	...	...	...
School age (years)	0.24	0.32	0.46	...	...	...
No. of faculty	0.83[a]	0.82[a]	0.36	0.29	...	...
Research expenditures	0.86[a]	0.87[a]	0.04	0.09	0.83[a]	...
School type[b]	0.64[a]	0.68[a]	-0.13	-0.01	0.69[a]	0.72[a]

[a] $P<.001$.
[b] 0=private, 1=public.

Abbreviation: AACOM, American Association of Colleges of Osteopathic Medicine.

was not for PhDs but for individuals with dual degrees or MD degrees. For instance, the total amount of awards for PhD-DO principal investigators increased 909% between 2004 and 2009. This may reflect more involvement with research (and success) from an existing COM "pool" of dual-degree faculty, the addition of COM faculty having dual degrees along with their capacities to obtain research funding, or the attainment of additional terminal degrees by existing DO or MD COM faculty and consequently an enhanced ability to obtain research funds. Zinner and Campbell[13] found that increasing the involvement of faculty with medical degrees in research is a potential method of securing additional extramural research funding. This achievement may require COMs to allot faculty with medical degrees more time for research by reducing their hours allocated to patient care. It has been shown that faculty at medical schools without funding devote substantially more hours to patient care than do faculty at schools with funding (22.3 hours vs 9.8 hours).[13] Allied with this concept would be the provision of incentives (eg, tuition remission, sabbaticals) that encourage current medical faculty to hone their research skills. For example, there are several academic programs that build research skills that are often not addressed during medical training. Determining ways to involve more faculty with DO degrees in research is particularly relevant given that they received only 3 additional research awards in 2009 compared with 2004.

Table 7.
Multiple Linear Regression Results for Research Awards Reported as Active by Colleges of Osteopathic Medicine That Completed the 2009 AACOM Survey (N=26)

	P Values	
Variable	Model 1: Amount	Model 2: Number
Intercept	0.037	0.245
School type[a]	0.746	0.775
Research expenditures	0.007[b]	0.002[c]
No. of faculty	0.036[b]	0.125

[a] 0=private, 1=public.
[b] Statistically significant predictor of the total amount of awards. Model parameters: $F_{3,25}=27.1$, $P<.001$, $R^2=0.79$, SEE=1107.65.
[c] Statistically significant predictor of the total number of awards. Model parameters: $F_{3,25}=31.4$, $P<.001$, $R^2=0.81$, SEE=1.54.

Abbreviations: AACOM, American Association of Colleges of Osteopathic Medicine; SEE, standard error of the estimate.

The present study is the first to our knowledge to present detailed funding data for OMM research conducted at COMs. Although OMM research in 2009 amounted to only 2.4% of the total amount of awards received, there was a substantial increase in funding for OMM research (60%) between 2004 and 2009 (albeit only an increase of 6 total awards for a total of 27 awards or 1.4 awards per COM). This is indirect evidence that efforts to promote OMM research (eg, AOA research grants and development program) are making an impact at COMs similar to that observed at The Osteopathic Research Center and congruent with the suggestion that osteopathic physicians have an obligation to generate scientific evidence establishing the safety, efficacy, and effectiveness of alternative treatments for musculoskeletal conditions and spinal manipulation.[1,3,8] Moreover, an increase in OMM research may help to address the growing use of complementary and alternative therapies.[14] For OMM research to continue to expand, it will be necessary for COMs to secure more federal funding to build research infrastructure and programs to a level proportionate to the number of practicing osteopathic physicians.[2]

The present study also presents novel information regarding predictors of research funding at COMs. The variables used in the regression models explain a substantial portion of the variance in total award amounts (79%) and number of awards (81%) and provide guidance to COMs on how to increase research funding. First, research expenditures were found to be statistically significant predictors of the total amount and number of awards. This association was linear, thus indicating that similar, incremental increases in funding or awards can be achieved by COMs regardless of their current dollar investments in research. In other words, COMs with limited monetary resources or with philosophies favoring medical education could still increase research productivity by providing money for research. Similarly, The Osteopathic Research Center, the AOA's Council on Research, and the University of Rochester School of Medicine and Dentistry all reported substantial gains in research dollars relative to initial, smaller outlays of dollars for research support.[3,8,15] Simply speaking, investing dollars in research is important for obtaining funds to conduct research; however, the importance most likely resides with how the funds are used to support research and how efficient the process is for securing research funds. It has been suggested that providing coverage for basic university functions (eg, administrative tasks) and having a well-developed infrastructure for submitting and managing grants is essential for advancing research.[8,16] The importance of infrastructure was examined by Klein and colleagues,[17] who demonstrated that adding infrastructure raised grant applications 153% and total funds requested from $11.9 million to $41.8 million. It will be important to determine if there is an optimal and broadly applicable method for investing in research at COMs that produces the greatest effect on funding.

The regression analysis also showed that larger faculty sizes were significantly associated with more dollars in research funding independent of whether the COM was public or private. This finding supports the contention made by previous researchers that increasing faculty numbers beyond a certain critical mass needed for student education would allow faculty with greater research responsibilities to be more successful in securing extramural funding.[8,9] Moreover, this approach enhances research productivity without compromising educational objectives. It should be noted that faculty numbers used in this study did not include part-time or adjunct faculty. Use of such human resources has economic advantages and may represent an undocumented resource for promoting research.

Prozialeck[18] argued in a letter that COMs characterized as valuing and rewarding research create an institutional culture conducive to pursuing and obtaining research funds. Further, he states the research culture, not the number of faculty, is the primary factor influencing grant procurement by faculty. In contrast, this study found faculty size to be a statistically significant predictor of research funding even after considering COM type (private or public). Possibly different analytic approaches or the use of different data (ie, 2004 vs 2009) are reasons for these contradictory results. Nevertheless, the outcomes of the present study could be interpreted as supporting the contention that the research culture is an important factor to consider. More specifically, greater investments in research and reducing non–research-related workloads for researchers by hiring teaching faculty could substantially improve the research culture at COMs. Incentives for securing grants, a well-developed intramural funding program, protected time for research, and adequate start-up packages would enhance research-related morale, motivation, and culture. It may also be important to consider the dynamic interrelationships between research expenditures and monetary investments for additional teaching faculty. For example, a COM that employs more faculty members to cover teaching responsibilities may be in a better position to recruit and retain productive researchers who value reduced teaching workloads. Similarly, gains through research (eg, lab equipment) could improve teaching efficiency, thereby reducing teaching workloads. Therefore, we propose that expenditures for both research and teaching are associated with the research culture at COMs and thus the grant-seeking motivation of faculty.

The results of the present study should also be interpreted in the context of its limitations. First, the information presented was obtained using self-report surveys without published evidence regarding the surveys' reliability and validity. Therefore, certain biases and measurement error could cause erroneous reporting of data. Second, the data describe only dollar-supported research projects. It is possible that the full body of research occurring at COMs was not captured, as some faculty may be involved in research endeavors not requiring dollars. Third, because analyses were limited to data collected without the guidance of a theory-driven research hypothesis, certain key predictors of funding may have been overlooked. It will be important to examine individual, institutional (eg, philosophical views on research and teaching), and external (eg, culture of area where the COM is located) factors potentially related to funding.[19] Finally, the surveys were not designed to obtain information on all unique researchers associated with a funded research project. This will be necessary in the future if we want to construct a more comprehensive picture about COM research funding, such as the percentage of funding representing new, mid-career, and mature investigators and how this status relates to research productivity (eg, larger awards, multiple awards) in a COM environment.

Conclusion

Taken in the context of previous studies on COM research funding, the overall trend since AACOM began formally collecting funding data is a substantial rise in total research award amounts, from $16.6 million in 1989 to $216.6 million in 2009 (concurrent with research expenditure increases of $17 million). Further, the rate of increase has been exponential in some areas (eg, foundations, drug studies, faculty with dual PhD-DO degrees). Although this finding is encouraging, funding at COMs remains below what is typically observed at allopathic medical schools.[20,21] The possibility exists that COMs could branch out to other areas (eg, life sciences) that are experiencing rapid growth.[13] The American Recovery and Reinvestment Act of 2009 allocated new money for health services research to prioritize the study of health care practices in order to determine the best treatments, devices, and procedures for almost any ailment or disease. Further, academic-industry relationships may provide an important benefit in terms of funding and open new lines of research.[13] Although COMs have made great strides in the area of research funding, there is still room for growth.

References

1. Licciardone JC. Time for the osteopathic profession to take the lead in musculoskeletal research. *Osteo Med Prim Care*. 2009;3:3-6. http://www.om-pc.com/content/3/1/6. Accessed September 20, 2012.

2. Rose RC, Prozialeck WC. Productivity outcomes for recent grants and fellowships awarded by the American Osteopathic Association Bureau of Research. *J Am Osteopath Assoc*. 2003;103(9):435-440. http://www.jaoa.org/cgi/reprint/103/9/435. Accessed September 20, 2012.

3. Stoll ST, McCormick J, Degenhardt BF, Hahn MB. The National Osteopathic Research Center at the University of North Texas Health Science Center: inception, growth, and future. *Acad Med*. 2009;84(6):737-743.

4. Table 2: total NIH awards to each medical school in 2009. Blue Ridge Institute for Medical Research Web site. http://www.brimr.org/NIH_Awards/2009/NIH_Awards/2009/SchoolOfMedicine2009.xls. Accessed September 21, 2012.

5. AACOM Strategic Plan 2008-2013. American Association of Colleges of Osteopathic Medicine (AACOM) Web site. http://www.aacom.org/about/Pages/AACOMStrategicPlan.aspx. Accessed September 20, 2012.

6. Research grant and fellowship programs. American Osteopathic Association Web site. http://www.osteopathic.org/inside-aoa/development/quality/research-and-grants/Pages/research-grants-and-fellowships-program.aspx. Accessed September 20, 2012.

7. Commission on Osteopathic College Accreditation. *Handbook*. Chicago, IL: American Osteopathic Association; May 2011. http://www.osteopathic.org/inside-aoa/accreditation/predoctoral%20accreditation/Documents/coca-handbook.pdf. Accessed September 20, 2012.

8. Clearfield MB, Smith-Barbaro P, Guillory VJ, et al. Research funding at colleges of osteopathic medicine: 15 years of growth. *J Am Osteopath Assoc*. 2007;107(11):469-478. http://www.jaoa.org/content/107/11/469.full. Accessed September 20, 2012.

9. Guillory VJ, Sharp G. Research at US colleges of osteopathic medicine: a decade of growth. *J Am Osteopath Assoc*. 2003;103(4):176-181. http://www.jaoa.org/cgi/reprint/103/4/176. Accessed September 20, 2012.

10. Levitan T. *A Report on a Survey of Osteopathic Medical School Growth: Analysis of the Fall 2009 Survey*. Chevy Chase, MD: American Association of Colleges of Osteopathic Medicine; 2009. http://www.aacom.org/resources/bookstore/Documents/GrowthRpt2009.pdf. Accessed September 20, 2012.

11. Consumer Price Index frequently asked questions. US Bureau of Labor Statistics. http://www.bls.gov/cpi/cpifaq.htm#Question_1. Accessed September 21, 2012.

12. Crown WH. Violations of regression assumptions. In: *Statistical Models for the Social and Behavioral Sciences: Multiple Regression and Limited-Dependent Variable Models*. Westport, CT: Praeger Publishers; 1998:71-98.

13. Zinner DE, Campbell EG. Life-science research within US academic medical centers. *JAMA*. 2009;302(9):969-976.

14. Barnes PM, Bloom B, Nahin RL. Complementary and alternative medicine use among adults and children: United States, 2007. *Natl Health Stat Report*. 2008;(12):1-23.

15. Dorsey ER, Van Wuyckhuyse BC, Beck CA, Passalacqua WP, Guzick DS. The economics of new faculty hires in basic sciences. *Acad Med*. 2009;84(1):26-31.

16. Wayne PM, Pensack LM, Connors EM, et al. Increasing research capacity at the New England School of Acupuncture: building grants management infrastructure. *Altern Ther Health Med*. 2008;14(1):56-64.

17. Klein KP, Foley KL, Legault C, Manuel J, Shumaker SA. Creation of a grant support service within a Women's Health Center of Excellence: experiences and lessons learned. *J Womens Health (Larchmt)*. 2006;15(2):127-134.

18. Prozialeck WC. Culture drives research funding [letter]. *J Am Osteopath Assoc*. 2008;108(7):353.

19. Hendrix D. An analysis of bibliometric indicators, National Institutes of Health funding and faculty size at Association of American Medical College medical schools, 1997-2007 [published correction appears in *J Med Libr Assoc*. 2009;97(2):74]. *J Med Libr Assoc*. 2008;96(4):324-334.

20. Campos-Outcalt D, Senf J. Family medicine research funding. *Fam Med*. 1999;31(10):709-712.

21. Young RA, DeHaven MJ, Passmore C, Baumer JG, Smith KV. Research funding and mentoring in family medicine residencies. *Fam Med*. 2007;39(6):410-416.