

Faculty Turnover and Resident In-Training Examination and Board Scores

John F. Kragh, Jr., MD, Justin Robbins, MD, and John A. Ward, PhD

Abstract

We tested the association between educator turnover and resident performance. A retrospective study analyzed an orthopaedic residency for 12 years. Orthopaedic In-Training Examination (OITE) scores for residents and American Board of Orthopaedic Surgery part 1 scores for graduates were analyzed with linear regression. Turnover was at first low, then rose, and finally dropped; OITE scores went the opposite direction. The OITE score nadir was just after the turnover apex, and the association was significant ($P = .008$). Turnover was not associated with board scores. Educators and policymakers should know that faculty turnover appears negatively associated with resident OITE performance.

Academic medicine is in flux for many reasons, including financial problems and resident duty hour changes. The educator has a central role in ensuring quality of adult education, and educator turnover has been reported to affect learning as well.¹⁻⁴ Most studies that address the effect of educator turnover and student performance are in child education, and few studies have addressed health care faculty turnover.⁵⁻⁷ The few education studies that have measured faculty turnover have described negative associations with learning in undergraduate medical or dental education populations, whereas we found no correlation studies specifically in resident education.⁵⁻⁷ For example, one study determined that employee turnover at a medical center annually cost \$17 to \$29 million (3.4%-5.8%) out of an operating budget of \$500 million.⁷ Definitive data supporting the claimed association between faculty turnover and learning appear lacking at the residency level. Authors have noted a negative association between faculty turnover and learning;

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their reports sometimes provide indirect evidence.^{5,7} Still unexplored, however, are the temporal association between the variables, the relative strength of the correlation, and which aspects of learning may or may not be affected. Such evidence may be important to education stakeholders (eg, residents, faculty, policymakers, patients).

In one residency, we based a study on resident Orthopaedic In-Training Examination (OITE) and American Board of Orthopaedic Surgery part 1 (ABOS1) scores. The purpose of this study was to determine the association between faculty turnover and test scores.

MATERIALS AND METHODS

Design

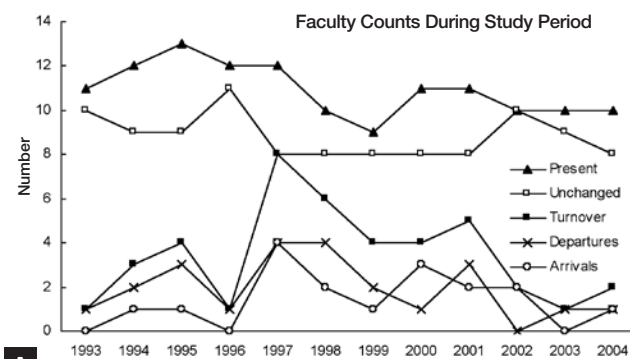
We used OITE and ABOS1 scores and records of faculty turnover to retrospectively examine 1993–2004 data in a residency. Our hypothesis was that resident scores are a direct function of faculty turnover. The institutional review board approved this study.

Residency Program

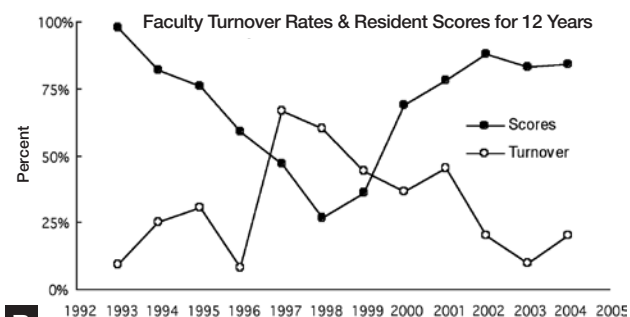
During the study period, mean number of residents per year was 4, for a mean annual total of 20 residents in the program, and the mean number of surgeons present was 10 (Figure 1A). All surgeons were full-time, except 1 who arrived in 2002 and was half-time. The program, which was never on probation, had 2 routine residency review committee (RRC) reviews during the study period. RRC findings included some subspecialty operative case counts that were low and research productivity that needed improvement, but curriculum quality was not cited during the study period. Quality of residents did not vary much, as evidenced by their strengths of application, medical school grades, and national board scores. There were no major changes to the curriculum. The residents did not take OITE preparation courses but did take board preparation courses. For the OITE, residents prepared both individually and in one large group.

Faculty Turnover

In this study, the independent variable was faculty turnover. Time between tests was measured in academic years rather than calendar years to more clearly establish the relationship between turnover and changes in test scores. Yearly turnover rate (%) was the ratio of the sum of departed and new surgeons to the total number of surgeons present. Our program had reorganized from a division, what the hospital called a *service*, to a department during the study period, and we used the term *chairperson* for the senior academic orthopedist in

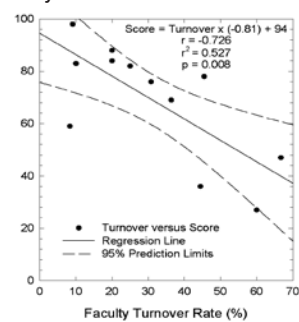


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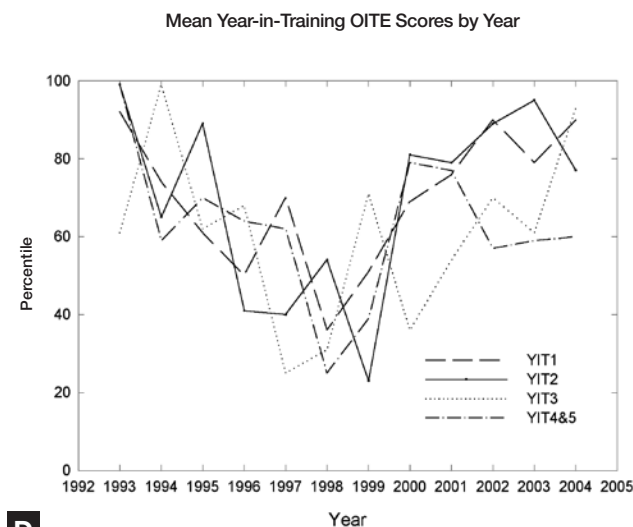


B

Faculty Turnover v. OITE Score for 12 Years



C



D

Figure 1. (A) The line plots of the number of faculty present, unchanged, departing, or arriving all appear flat and have ranges of 3 or 4. Turnover numbers in the line plot do not appear flat and show an increase followed by a decrease with a range of 7. The flatness of all variables except turnover numbers, which are not flat, indicates that turnover may be more likely to be associated with Orthopedic In-Training Examination (OITE) scores, which are also not flat. Although departing faculty may intuitively seem more important than arriving faculty, the data do not indicate any such effect. The costs of acquiring and training new faculty may be studied separate from the effectiveness of new faculty. (B) Expressing turnover as a percentage of a faculty group instead of as a count of individual faculty members appeared to match the opposite of the OITE score curve. This finding appeared to indicate that consideration of grouped data or interactions among faculty may be more important than consideration of individual faculty. The magnitude of changes is high and the timeliness of the association quick. (C) Linear regression showed that there was an apparent linear association between faculty turnover and mean program resident in-training examination scores. The 4 data points outside the 95% prediction limits were when the chairmen turned over, indicating that such turnover may increase the variability of scores compared with only total faculty turnover. (D) When resident scores were displayed by year-in-training (YIT) groups, the same association of scores was seen for each YIT mean group score, but the variance increased with stratification compared with the program mean. This is similar to a regression-to-the-mean phenomenon. Only YIT3 scores were significantly associated with educator turnover ($P = .026$), even though the study was not powered for YIT subgroup analysis. Graphically, all YIT scores have the same general pattern.

the program. We examined turnover of the chairperson to see if there were associations with resident test scores; chairpersons changed 4 times during the study period. We also examined turnover of residency directors; they changed 5 times during the study period. Four of the 5 director changes were also chairperson changes, as the 2 positions were filled by the same person until 2003. Quality and number of educators did not vary much with respect to fellowship training, interest in teaching, resident assessments of staff teaching, or rates of leaving the military on completion of service commitment.

Test Scores

The dependent variables were the means of our residents' OITE and ABOS1 scores, which were reported yearly by the test scorers. Scores were expressed as national percentiles. To see if there was a delayed association between faculty turnover and scores, we analyzed ABOS1 scores with turnover from 1 and 2 years before scores.

Analysis

Searching for trends, we graphed turnover and scores in each year. Linear regression analysis was performed to dem-

onstrate the relationship between turnover and scores, and Pearson product-moment correlation coefficients (r s) and P s were calculated. The r is positive when the association is proportional, is negative when the association is inversely proportional, and ranges from 0 (no association) to 1 (perfect association). The r^2 ranges from 0 to 1 and can be interpreted as the amount of score variance explained by variance in turnover rates. As r^2 of the mean scores shows less variability than individual scores do, we further analyzed by mean scores for resident year-in-training (YIT) groups and then by each individual resident score. We used Microsoft Office Professional 97 (Microsoft Inc, Redmond, Wash) for data management, SPSS version 11.5 (SPSS Inc, Chicago, Ill)

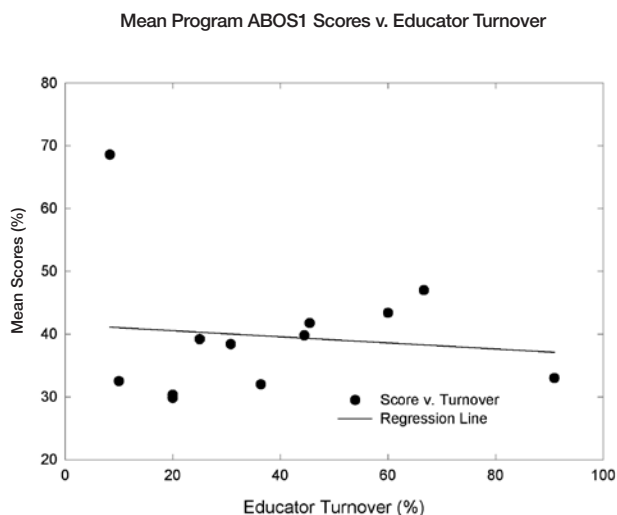


Figure 2. There was no apparent association between board scores and faculty turnover. The years between turnover and testing may allow other variables, such as graduation and moving, to make the board scores unresponsive to earlier turnover rate changes.

for statistical analysis, and Sigmaplot version 9 (Systat, Fall River, Mass) for linear regression.

RESULTS

Faculty turnover rates during the study period were at first low, then rose, and finally dropped (Figures 1B, 1C). Turnover rates ranged from 9% to 67%, a difference of 58 percentage points. Turnover rates rose 58% (9%-67%) and then dropped 57% (67%-10%) before leveling. The turnover graph looked like an inverted V with arms of similar length.

OITE scores were at first high, then dropped, and finally rose during the study period. OITE scores ranged from 27% to 98%, a difference of 71 percentage points. OITE scores dropped 71% (98%-27%) and then rose 61% (27%-88%) before leveling. The graph of these scores looked like a V with arms of similar length. The nadir of the OITE scores and the apex of the turnover rates were nearly simultaneous, with a slight lag for OITE scores relative to turnover rates. Periods of high OITE scores had low turnover rates, and periods of low scores had high turnover rates.

Results of the linear regression analysis of turnover and OITE scores showed the slope of the regression line to be -0.809 (Figure 1C). There was a significant, inversely proportional correlation between turnover rates and scores ($r = -.726$, $r^2 = .527$, $P = .008$). The r^2 indicated that approximately 53% of the score variance is explained by the variance in turnover rates, and these apply to mean program scores and turnover rates.

The chairperson turned over in 1996, 1998, 1999, and 2001. These 4 changes included the residency director turnover necessarily, as the 2 positions were united in these years. In 2003, the chairperson and residency director positions were separated, given to 2 surgeons, but the chairperson did not change. Only 4 of the study years had

the chairperson turnover, and only these same 4 years had OITE scores farthest from the regression line. All 4 and only these 4 years were outliers beyond the 95% prediction limits from the regression line. Thus, these findings indicated that chairperson turnover appeared to be associated with additional OITE score variability beyond the effects from overall faculty turnover rates. The association of chairperson turnover and increased OITE score variability was with the next test taken.

Analysis of resident scores by YIT showed that scores by year groups also had a significant association between year group mean scores and turnover (Figure 1D). All year groups had results concordant with the mean program scores. The r^2 values showed that more variability of mean scores was evident than when mean program scores were analyzed, and this is like a regression-to-the-mean phenomenon (YIT1, $r^2 = .233$, $P = .112$; YIT2, $r^2 = .265$, $P = .087$; YIT3, $r^2 = .405$, $P = .026$; YIT4&5, $r^2 = .191$, $P = .156$).

The board scores were level overall during the study period, with a narrower range and lesser variability than OITE scores. Results of the linear regression analysis of turnover and board scores showed the slope of the regression line to be -0 (Figure 2). There was no significant correlation between turnover rates and scores ($r = .094$, $r^2 = .008$, $P = .77$).

DISCUSSION

The main finding of the present study was a significant association between faculty turnover and resident OITE scores. This finding was an inversely proportional association, as expected. We found that, as turnover increased, OITE scores decreased, and as turnover decreased, scores increased. The periods of low and high turnover permitted comparative analysis, which confirmed yet delimited conventional understanding of education.

The association between faculty turnover and ABOS1 scores was not significant. Annual trends did not show associations, and linear regression appeared flat, with wide data variability. One message of the present study is that not only were faculty turnover rates inversely proportional to some aspects of learning (ie, OITE scores), but turnover was not associated with other aspects of learning (ie, ABOS1 scores). In our residency, after determining the effect that faculty turnover had on resident OITE scores, we felt that periods of high turnover or episodes of chairperson turnover deserve further study. The program appeared to be inadequately prepared for or buffered against such turnover rates or perhaps the causes of such turnover, and, now that we know the importance of turnover, countermeasures such as faculty retention efforts and incentives may be considered or used. Although low OITE scores have been associated with low ABOS1 scores,⁸ we had few such residents in this situation. Such findings of low OITE and low ABOS1 score associations focus on individual residents and emphasize the importance of resident selection but can also de-emphasize residency program traits, such as fac-

ulty characteristics. The boards may be less responsive to turnover because of the years between turnover and testing or because of other unmeasured variables, or there may not be an association.

The association of OITE scores and turnover may be a cause-and-effect relationship. The plausibility of this cause-and-effect possibility led to our hypothesis, which was evidenced in other, analogous populations. The association is strong, as indicated by the slope of the regression line and the statistical significance. The consistency of the association was evident during periods when the turnover went up and when it went down. The timing of the association was without delay. Turnover of the chairperson was associated immediately with increased variability of resident OITE scores each of the 4 times the chairperson changed. The gradient of the relationship showed a linear relationship throughout the observed ranges, and no threshold was evident wherein the relationship did

turnover entails one person stepping down and one stepping up, so the association of scores is with a dyad of the 2 changing. Comparing individual surgeons on their presence or absence, as we did in our previous study, is artificial in that the concurrent changes for 2 surgeons cannot be practically separable. In a larger sense, the interactions among faculty or the effects of the faculty as a whole instead of as the sum of its members are more evidenced than individual surgeon turnover both in the present study and our previous study. The whole may be greater than the sum of its parts in that the interaction or chemistry among the faculty is more easily seen in our present and previous researches than the effects of individuals. Surgeons may be naturally individualistic, but education research in orthopedic residencies may find consideration of faculties as entities more worthy of further study. Key faculty contributors appear to contribute through their interactions with other faculty

“...individual faculty members affect orthopedic OITE scores less than the faculty as a whole or less than the interactions among faculty members do.”

not hold. Nothing was incoherent, as no findings conflicted with current education knowledge. Given the conventional understanding of the effects that faculty turnover has on student performance in other education populations,¹⁻⁴ the empirically observed and significant covariation for both increased and decreased turnover rates in the present study and the appropriate timing between faculty turnover and OITE score changes are necessary and sufficient criteria for the association to be considered a possible cause-and-effect relationship in our residency during the study period. However, faculty turnover may not be a critical variable but may be an indicator of an underlying cause of turnover, such as an academic medical center in financial crisis. The residency studied is in a military medical center in which almost all faculty turnover occurred when military service obligations ended, and we identified no obvious variable that caused turnover to change. The OITE specifically was associated with turnover, but board scores were not, and for the preceding reasons the specificity of the cause-and-effect association appears limited to the OITE.

The strengths of the present study include its 12-year duration and its novel application of linear regression to analyze orthopedic faculty turnover versus resident test scores. This study of orthopedic surgical residency confirmed the findings of previous studies in other educational populations—that faculty turnover affected student performance.¹⁻⁴ Previously with our residency, we studied the association of individual surgeons and OITE scores by subspecialties and found that there were few strong associations with individual surgeon-educators.⁹ However, the effect of interactions among faculty members on OITE scores was obvious in that study, whereas individual faculty associations with OITE scores were not. Chairperson

members, and in our previous study of our residency such effects can be either positive or negative in their effect on OITE scores.⁹ As evidenced in the present study, faculty turnover of individuals such as the chairperson, despite being a key faculty member, affected only the variability of OITE scores (a minor effect), whereas turnover rates of the faculty as a whole appeared to affect mean OITE scores (a major effect). All these findings appear to converge on the point that individual faculty members affect orthopedic OITE scores less than the faculty as a whole or less than the interactions among faculty members do.

Before concluding our study, we sensed that faculty turnover may be associated with education performance, but, until we developed the measures here, we did not measure faculty turnover over several years. Plotting turnover yearly added a broad and valuable perspective because the trends became clear. Our sense of the importance of educator turnover was validated by other military residencies that had periods of high turnover.

The present study has several weaknesses. The design was retrospective, not prospective, and observational, not an experiment wherein something could be proved. The study lacked controls. Test scores are a suboptimal surrogate endpoint for resident performance. Educational quality is complex and determined by many variables not studied here, and, as evidenced by the r^2 of .527, only about half of the mean OITE score variability is attributable to faculty turnover variability, which indicates that other variables were evident in our residency during the study period. Such variables worthy of consideration may include resident rotations and case mix volume. The scope of the present study was limited to faculty turnover and resident OITE and ABOS1 scores in a single residency program,

and application of the finding beyond that scope should be made with caution. In our program, there were wide ranges of both turnover and OITE scores, and such wide ranges lend themselves well to analysis by linear regression. We also saw covariation as both faculty turnover rates rose and fell by large amounts. However, in other programs in which score or turnover ranges may be narrow for any reason, or turnover only increases or decreases during a time period, researchers will have difficulty finding a similar association. For example, if a program has flat scores or turnover throughout a time of interest, then no clear determination of the association may be made, as the data points are in a narrow cluster, and data spread is needed for significant associations with linear regression. The finding of the present study needs to be checked in several programs before it can be generalized with confidence. ABOS1 scores may not be associated with faculty turnover, as there are more years between turnover and scores, and those years include several major life events, such as residency graduation, job changes, and moving families to new homes. We suspect that with further research the association of faculty turnover and OITE scores, which appeared linear here, may show a floor effect in that, below a threshold, lower turnover may not correlate linearly with lower scores. Perhaps the period of study was extreme for turnover, and less extreme periods with lesser turnover rates may show a weaker association with scores because of regression toward the mean. However, the turnover rates in the present study are typical in military graduate education faculties and the military in general. There was some predictability of turnover that allowed planning of faculty management.

CONCLUSIONS

The present study found a strong and timely association between faculty turnover and resident in-training examination scores in an orthopedic residency. The evidenced association, its magnitude, its timeliness, and therefore its importance, may help academic orthopedists to use educational metrics and evidence-based education to better assess and manage residencies. Residency directors and department chiefs may want now to measure and track turnover in order to study and manage staff turnover. Resident candidates interviewing for positions may wish now to ask residency directors what the recent turnover rates were and what turnover rates are

expected in the program. Candidates may want to ask if the chairperson is expected to have faculty turnover or to step down during the candidate's resident time. Academicians, orthopedic residency applicants, and policymakers now have specific evidence and structural knowledge of the effect that faculty turnover has on orthopedic resident education. The findings herein may stimulate further exploration of evidence-based education. A prospective study of multiple residencies would be valuable in checking the generalizability of our study findings.

AUTHORS' DISCLOSURE STATEMENT AND ACKNOWLEDGMENTS

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The opinions and assertions contained in this article are the private views of the authors and are not to be construed as official or reflecting the views of the US Department of Defense or US Government.

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