Block to succeed: the Canadian orthopedic resident research experience

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Background: We assessed the current state of Canadian orthopedic resident research and the effect of protected block research time on the numbers of grants obtained, research projects completed, submissions for publication, publications and conference presentations.

Methods: We administered a 27-item cross-sectional survey containing quantitative and qualitative questions to postgraduate year (PGY)-3 to -5 residents in all 16 Canadian orthopedic training programs in the academic year of Jul. 1, 2005, to Jun. 30, 2006.

Results: There was an overall response rate of 45% (85/188) from residents in 15 of 16 orthopedic programs: 56% (48/85) of respondents took block research time of at least 1 month (mean 5 mo). The number of months taken was positively correlated with the number of grants obtained (r = 0.28, p = 0.011) and publications (r = 0.23, p = 0.031). Residents who took block time obtained more grants (Fisher exact test 3.54, p = 0.048) and publications (Fisher exact test 6.09, p = 0.012) than those who did not take block time. About 41% (35/85) of respondents said time was the biggest obstacle to research.

Conclusion: Providing protected block research time during residency allows Canadian orthopedic residents greater research success.

Contexte : Nous avons évalué l'état actuel de la recherche en orthopédie effectuée par des résidents et l'effet des périodes de temps réservées à la recherche sur le nombre de bourses obtenues, de projets de recherche menés à terme, de demandes de publication, de publications et de communications présentées à des conférences.

Méthodes : Dans le cadre d'une enquête transversale, nous avons administré un sondage en 27 points renfermant des questions d'ordre quantitatif et qualitatif à des étudiants de la troisième à la cinquième année de résidence au cours de l'année universitaire du 1er juillet 2005 au 30 juin 2006.

Résultats : Nous avons obtenu un taux de réponse globale de 45 % (85/188) de la part des résidents de 15 programmes d'orthopédie sur 16 : 56 % (48/85) des répondants ont déclaré avoir consacré à la recherche une période de temps d'une durée d'au moins 1 mois (moyenne 5 mois). Le nombre de mois consacrés à la recherche était en corrélation positive avec le nombre de subventions obtenues (r = 0,28, p = 0,011) et de publications (r = 0,23, p = 0,031). Les résidents qui ont bénéficié de périodes de temps réservées à la recherche ont obtenu un plus grand nombre de bourses (test exact de Fisher 3,54, p = 0,048) et ont publié davantage (test exact de Fisher 6,09, p = 0,012) que ceux qui n'en n'ont pas bénéficié. Environ 41 % (35/85) des répondants ont affirmé que le facteur temps était le plus gros obstacle à la recherche.

Conclusion : Offrir des périodes de temps réservées exclusivement à la recherche durant leur résidence permet aux résidents canadiens en orthopédie de mieux réussir en recherche.

Research has become an integral part of residency training across all specialties. In Canada, the CanMEDS initiative dictates the graduate to "contribute to the development, dissemination and translation of new knowledge and practices" as a "Scholar." In the United States, the Accreditation Council for Graduate Medical Education (ACGME) requires every training program to "establish and maintain an environment of inquiry and scholarship" and "an active research component must be included."

There have been a number of survey-based studies investigating the

resident research experience.[1–25] Characteristics of research curricula, research productivity and factors affecting productivity have been investigated.[1–24,26] These factors include mentorship,[3,5,7,14,15,18,25,26] presence of a classroom curriculum,[3,5,18,26] program director support,[5,13,23] a designated research director,[5,13,18,23] opportunity to present research,[5,14,18,26] journal clubs[5,16] and protected research time.[5,10,14,18–22,26] However, to our knowledge, reasonable expectations of research productivity during residency have never been reported. No studies have looked specifically at the Canadian orthopedic resident population, with the most published studies being American.[1–13,15–24,26] The only Canadian publications we found were about family medicine and anesthesia residencies.[14,20,25]

Residents as learners

Although programs are placing more emphasis on applicants to the specialty having prior research experience, most residents have limited experience and are expected to learn these skills during residency. Training for orthopedic research should follow the same educational principles as training to achieve clinical orthopedic expertise or master any other skill. This requires motivation and alertness, uninterrupted focus and repetitive practice with feedback.[27,28] Protected block research time, which was the focus of our study, would help residents obtain the educational environment to develop mastery in research.

Knowing that a set amount of time is available for research is encouraging for residents. Time away from clinical duties helps with alertness and provides an opportunity for uninterrupted focus on research. This time can also be dedicated for writing and meetings, and it facilitates practice and feedback on research. Furthermore, uninterrupted time is crucial for initial planning of a project and final manuscript submission.

Research goal and questions

The primary goal of our study was to describe the current state of Canadian orthopedic resident research experience. We asked the following questions to meet this goal.

- What is the research productivity of residents?
- What structure and support exist for resident research?
- What are residents' expectations for research productivity?
- What is residents' level of satisfaction with research?
- Is there an association between research productivity and age, postgraduate year (PGY), amount of protected block research time, satisfaction with research and change in research interest during residency?
- Is there a difference in research productivity between residents who took protected block time for research and those who did not?
- Is research productivity affected by access to a research director, journal club and classroom teaching of research methods; possession of an advanced degree; or intention to become an academic surgeon?

METHODS

We administered a cross-sectional online survey of all PGY-3 to -5 Canadian orthopedic residents during the academic year of Jul. 1, 2005, to Jun. 30, 2006. The inclusion criteria were orthopedic residents in the third to fifth year of training in any of the 16 Canadian programs during the stated time period. We excluded PGY-1 to -2 residents mainly for 2 reasons. First, research takes time to complete and thus most junior residents would not have had the time to complete research projects. Second, by the third year, residents would have more comments to make about their research experience during residency.

The survey

English and French versions of the 27-item online questionnaire were available at www.orthoresidentresearch.org/survey (see Appendix 1 for the English version). The survey was structured with a combination of demographic, categorical, 5-point Likert-type scale and open text questions.

Educators and orthopedic surgeons reviewed the questionnaire and provided input. We then asked 12 PGY-1 and -2 orthopedic residents to pretest it to obtain face validity. We made subsequent changes to areas of concern and ambiguity.

Conducting the survey

We contacted the 13 English and 3 French orthopedic programs in Canada by email and telephone to determine the number of residents in PGY-3 to -5 of their respective programs and to request that programs email the link to the online questionnaire to these residents for completion. We contacted the residents 3 times by email from March to June 2006 for data collection. We made no other attempts to reach nonresponders.

Statistical analysis

Likert-type questions on the survey all used a 5-point scale (1 to 5), but we recoded responses differently for statistical interpretation. We recorded the responses to questions 21 to 25 as 0 to 4. We also summed the scores from these 5 questions to obtain a total score out of 20 for "overall satisfaction." We recorded the responses to question 26 as –2 to 2; a response of –2 represented substantially decreased interest in research, 0 represented no change and 2 represented substantially increased interest.

We performed a descriptive analysis (i.e., frequency, mean, median, mode, standard deviation) for all collected data. We also reported the journals in which residents'

research was published and the number of publications residents' had in each journal.

We performed a Pearson *r* correlation on age, PGY, 5 measures of productivity (i.e., number of research projects completed, grants obtained, projects submitted for publication, publications and conference presentations), satisfaction score from question 24, overall satisfaction score and change in research interest.

We used the χ^2 test to determine whether research grants, projects submitted for publication and publications were dependent on block time; access to a research director, journal club and classroom teaching of research methods; posession of an advanced degree; and intention to pursue an academic career. We performed a multivariate analysis of variance (MANOVA) to determine whether the number of research projects completed and the number of conference presentations were dependent on these same variables. We used Cohen *d* to calculate the effect size for each MANOVA measure (small effect size $d = 0.2$, medium effect size $d = 0.5$, large effect size $d = 0.8$).

We categorized and reported qualitative responses, including the most important factor affecting research.

Results

Response rate

Of the 188 PGY-3 to -5 Canadian orthopedic residents (69 in PGY-3, 58 in PGY-4 and 61 in PGY-5), a total of 85 residents completed the survey, giving an overall response rate of 45% (85/188). Responders included 55% (38/69) of all PGY-3, 40% (23/58) of all PGY-4 and 39% (24/61) of all PGY-5 residents. Residents from 15 of the 16 programs responded.

Demographics

The mean age of the 85 respondents was 31 (range 25 to 39) years. There were 71 male and 14 female residents. Seventeen individuals held an advanced degree (all master's degrees), and the mean length of time spent obtaining those degrees was 2 (standard deviation [SD] 0.6, range 1 to 3) years. Four residents obtained those degrees while completing their orthopedic residencies. Thirty-seven respondents (44%) intended on pursuing academic careers.

Research productivity measures

During their residencies, 48 respondents had taken at least 1 month of protected block research time compared with 37 who did not. Protected block time also included time taken to complete a master's degree during residency. The mean amount of protected time taken by the 48 residents was 5 (SD 7.3, mode 3, range 1 to 36) months. Residents completed a mean number of 2 projects (SD 1.3, mode 2, range 0 to 6). The mean number of research grants obtained per resident was 1 grant (SD 1.1, mode 0, range 0 to 6). The mean number of research projects submitted for publication per resident was 1 submission (SD 0.9, mode 0, range 0 to 5). The mean number of research projects accepted for publication per resident was 0 publications (SD 0.9, mode 0, range 0 to 5). The mean number of conference presentations per resident was 2 presentations (SD 2.1, mode 2, range 0 to 8). Residents had a combined total of 36 publications in 18 different journals. The *Canadian Journal of Surgery* published the most (7) papers.

Existing structure and support for resident research

About 73% (62/85) of respondents had access to a designated research director in their programs and 87% (74/85) had regular journal clubs (mode 12 times, range 0 to more than 40 times per year). About 56% (48/85) of respondents had classroom teaching of research methods.

Resident expectations for research

The mean minimum number of research projects that respondents felt a resident should complete was 2 (SD 1.1, mode 2, range 0 to 5). They also reported that the mean desirable number of publications to have by the end of residency was 2 (SD 1.0, mode 2, range 0 to 5). A mean of 3 (SD 2.4, mode 3, range 3 to 13) months of protected block research time was thought to be ideal. About 49% (42/85) of all respondents felt they had an adequate amount of time for research.

Resident satisfaction with research

The respondents' overall score for satisfaction with research was 8.3 out of 20. Broken down into the 5 questions (response scale of 0 to 4), the mean values of classroom research methods teaching (1, SD 0.8), completing a research project (2, SD 0.9), availability of research funding (2, SD 1.1) and satisfaction with research (1, SD 1.1) did not meet expectations. However, the value for ability to access a research preceptor in their departments (2, SD 1.0) did meet expectations. The mean change in respondents' interest in research was –0.2 (SD 1.2).

We found no statistically significant difference between the overall scores of residents with block time and those without ($F_{1,83} = 0.20$, $p = 0.43$). However, when asked about their satisfaction with research experience (question 24), the residents with block time were significantly more satisfied ($F_{1,83} = 5.77$, $p = 0.021$) than those without.

Correlations

We found a number of significant positive correlations

between PGY, amount of protected block time, productivity measures and satisfaction measures using Pearson *r* (Table 1).

Age was not correlated with any variables, but PGY correlated with the number of research projects completed ($r = 0.32$, $p = 0.003$), submitted ($r = 0.28$, $p = 0.011$), published ($r = 0.22$, $p = 0.046$) and presented at conferences ($r = 0.39$, $p < 0.001$). The 5 measures of productivity were positively correlated with one another.

To further understand what research satisfaction meant for residents, we sought correlations between productivity measures, satisfaction score (survey question 24), overall satisfaction score and change in research interest score.

The satisfaction score correlated with the number of grants obtained ($r = 0.24$, $p = 0.025$) and publications ($r = 0.21$, $p = 0.049$). The overall satisfaction score correlated with the number of projects completed ($r = 0.22$, $p = 0.043$) and grants obtained ($r = 0.22$, $p = 0.048$). Change in research interest correlated with the number of grants obtained ($r = 0.22$, $p = 0.039$), projects submitted for publication ($r = 0.22$, $p = 0.040$), satisfaction score ($r = 0.48$, $p < 0.001$) and overall satisfaction score ($r = 0.43$, $p < 0.001$).

Effect of block research time on productivity

Respondents who took at least 1 month of block research time were more likely to obtain a research grant (Fisher exact test 3.54, $p = 0.048$) and to have a publication (Fisher exact test 6.09, $p = 0.012$) (Table 2). There were no differences in the number of research projects completed ($F_{1,83} = 3.30$, p 0.06), conference presentations ($F_{1,83} = 1.76$, $p = 0.15$) or submissions for publication (Fisher exact test 2.47, $p = 0.09$) (Table 2, Table 3).

Effect of other factors on productivity

Results of our χ^2 tests and MANOVA showed that access to a designated research director or journal club did not have an effect on any productivity measures. Classroom teaching of research methods was associated with fewer research projects completed ($F_{1,83} = 5.73$, $p = 0.025$) (Table 2, Table 3). Possession of an advanced degree was associated with more publications (Fisher exact test 7.21, $p = 0.011$) and conference presentations ($F_{1,83} = 4.51$, $p = 0.034$) (Table 2, Table 3). Intention to pursue an academic career was associated with more publications (Fisher exact test 6.03, $p = 0.014$) and presentations ($F_{1,83} = 6.64$, $p = 0.012$) (Table 2, Table 3).

Qualitative opinions on research

When asked about the single most important factor impacting their research experience during residency, 41% (35/85) of residents responded that time constraints was most important, whereas 28% (24/85) reported that preceptor support was most important. Other notable responses included funding, organizational support, interest, program requirements and access to a designated research director.

In the comments section, residents again mentioned time constraints, lack of preceptor support and human resources as obstacles to research. Another obstacle mentioned was the expectation of higher-quality research without a corresponding increase in time or support. Others thought that program requirements for research were unreasonable, that doing one project per year was too onerous and that submission for publication should not be

Table 1. Correlation coefficients for postgraduate year, age, research productivity measures, satisfaction scores and change in research interest of 85 orthopedic residents who responded to a survey on research during residency in the academic year Jul. 1, 2005, to Jun. 30, 2006

	Characteristic, Pearson *r*										
Characteristic	PGY	Age, yr	Block time, mo.	No. projects completed	Grants	No. projects submitted	No. projects published	No. presentations	Satisfaction (Q.24)	Overall satisfaction score	Research interest
PGY	1	0.11	0.01	0.32*	0.2	0.28†	0.22†	0.39*	–0.19	–0.18	–0.07
Age, yr	0.11	1	–0.01	0.14	–0.18	–0.01	0.02	–0.09	–0.2	–0.14	–0.08
Block time, mo	0.01	–0.01	1	0.07	0.28†	0.21	0.23*	0.21	0.21	0.1	0.2
No. of projects completed	0.32*	0.14	0.74	1	0.23†	0.62†	0.55*	0.61*	0.17	0.22†	0.21
No. of grants	0.2	–0.18	0.28†	0.23†	1	0.40*	0.32*	0.42*	0.24†	0.22†	0.22†
No. of projects submitted	0.28†	–0.01	0.21	0.62*	0.40*	1	0.77*	0.57*	0.2	0.17	0.22†
No. of projects published	0.22†	0.02	0.23*	0.55*	0.32*	0.77†	1	0.51*	0.21†	0.19	0.13
No. of presentations	0.39†	–0.09	0.21	0.61*	0.42*	0.57*	0.51*	1	0.11	0.15	0.12
Satisfaction (Q.24)	–0.19	–0.2	0.21	0.17	0.24†	0.2	0.21†	0.11	1	0.81*	0.48*
Overall satisfaction score	–0.18	–0.14	0.1	0.22†	0.22†	0.17	0.19	0.15	0.81*	1	0.43*
Change in research interest	–0.07	–0.08	0.2	0.21	0.22†	0.22†	0.13	0.12	0.48*	0.43*	1

PGY = postgraduate year; Q = question.
*Correlation is significant at the 0.01 level.
†Correlation is significant at the 0.05 level.

mandatory. Residents made comments supporting quality over quantity of research in the learning setting. Some respondents also felt that completing a research project should be optional for residents who do not plan on academic practice.

Discussion

Response rate and sampling

Survey response rates from residents reported in the literature were between 59% and 80%.[6,7,17,18,22] Compared with those numbers, the 45% response rate in this study was low, but not unreasonable in regards to sampling bias because the population sampled was a homogeneous group. They were all residents in the same surgical specialty and country. In addition, 16.5% of our sample was female, which is representative of the total number of female orthopedic residents; 16.9% of all orthopedic residents are women according to the Canadian Post-MD Education Registry (CAPER, www.caper.ca) census for the same academic year. Respondents represented 15 of the 16 programs. Bias may have been introduced because 44% of respondents were in PGY-3 and those more interested in research may have been more likely to fill out the survey.

Our study differed from others in that it was administered online. It is difficult to conclude whether this had any effect on the response rate or sampling bias because every resident could be reached by email.

Research productivity measures

The most common amount of protected time taken was 1 to 3 months (41/48 or 85%), with 3 months being the most frequent (29/48 or 60%). This was most likely a reflection of program curricula that offer 3-month research rotations to residents. Three institutions consistently had residents reporting this amount of protected time and accounted for 23 of 29 responses: McMaster University (11/12), University of Western Ontario (5/6) and University of Ottawa (7/8).

Research activity among respondents seemed appropriate.

Table 2. Results of χ^2 analysis of the research grants, projects submitted and published of 85 orthopedic residents who responded to a survey on research during residency in the academic year Jul. 1, 2005, to Jun. 30, 2006

Variable	Response; no. (%)		Fisher exact test	*p* value
	Yes	No		
Block time				
Research grant*	24 (50)	11 (30)	3.54	0.048
Projects submitted	29 (60)	16 (43)	2.47	0.09
Projects published*	18 (38)	5 (14)	6.09	0.012
Research director				
Research grant	27 (44)	8 (35)	0.53	0.32
Projects submitted	33 (53)	12 (52)	0.01	0.56
Projects published	17 (27)	6 (26)	0.02	0.57
Journal club				
Research grant	29 (39)	6 (55)	0.93	0.26
Projects submitted	39 (53)	6 (55)	0.01	0.58
Projects published	21 (28)	2 (18)	0.50	0.38
Classroom teaching				
Research grant	19 (40)	16 (41)	0.12	0.45
Projects submitted	22 (46)	23 (62)	2.24	0.10
Projects published	13 (27)	10 (27)	0	0.60
Advanced degree				
Research grant	9 (53)	26 (38)	1.21	0.20
Projects submitted	11 (65)	34 (50)	1.20	0.21
Projects published*	9 (53)	14 (21)	7.21	0.011
Intend to pursue academic career				
Research grant	19 (51)	16 (33)	2.80	0.07
Projects submitted	22 (60)	23 (48)	1.12	0.20
Projects published*	15 (41)	8 (17)	6.03	0.014

*Significant at $p < 0.05$.

Table 3. Results of multivariate analysis of variance of projects completed and conference presentations given for 85 orthopedic residents who responded to a survey on research during residency in the academic year Jul. 1, 2005, to Jun. 30, 2006

Variable	Response; mean (SD)		*p* value	Effect size, Cohen *d*
	Yes	No		
Block time	*n* = 48	*n* = 37		
Projects completed	2 (1.5)	2 (1.1)	0.07	0.4
Conference presentations	2 (1.6)	2 (1.1)	0.19	0.3
Wilks $\Lambda = 0.96$, $F_{2,82} = 1.67$, $p < 0.2$				
Research director	*n* = 62	*n* = 23		
Projects completed	2 (1.4)	2 (1.1)	0.32	0.3
Conference presentations	2 (1.4)	2 (1.5)	0.67	0.1
Wilks $\Lambda = 0.97$, $F_{2,82} = 1.31$, $p < 0.3$				
Journal club	*n* = 74	*n* = 11		
Projects completed	2 (1.3)	1 (1.2)	0.77	0.6
Conference presentations	2 (1.5)	1 (1.3)	0.20	0.4
Wilks $\Lambda = 0.96$, $F_{2,82} = 1.62$, $p < 0.2$				
Classroom teaching	*n* = 48	*n* = 37		
Projects completed*	2 (1.3)	2 (1.3)	0.019	0.5
Conference presentations	2 (1.3)	2 (1.6)	0.61	0.1
Wilks $\Lambda = 0.92$, $F_{2,82} = 3.57$, $p < 0.05$				
Advanced degree	*n* = 17	*n* = 68		
Projects completed	2 (1.5)	2 (1.3)	0.18	0.3
Conference presentations*	3 (1.6)	2 (1.4)	0.037	0.5
Wilks $\Lambda = 0.95$, $F_{2,82} = 2.23$, $p < 0.2$				
Intend to be academic	*n* = 37	*n* = 48		
Projects completed	2 (1.5)	2 (1.2)	0.66	0.4
Conference presentations*	2 (1.5)	2 (1.3)	0.012	0.6
Wilks $\Lambda = 0.92$, $F_{2,82} = 3.37$, $p < 0.05$				

SD = standard deviation.
*Significant at $p < 0.05$.

Completing an average of 2 projects and giving 2 presentations provided a resident with some experience conducting and disseminating research. However, the subsequent outcome of the experience was cause for concern. Only about one-third (64/172) of all projects completed was funded by a grant. Less than half (80/172) of the projects were eventually submitted for publication and then less than half (36/80) of these submissions were published giving an overall publication rate of 20% (36/172).

Existing structure and support for resident research

Three factors identified in the literature to have an influence on resident research were access to a designated research director, journal clubs and classroom teaching of research methods. It was necessary to identify these factors in this population before we could determine whether they had any effect on productivity measures. Most respondents had access to a research director (73%) and journal clubs (87%). Only about half (57%) of respondents had classroom teaching of research methods.

Resident expectations for research

The information that we gathered revealed what Canadian orthopedic residents expect from their research and also what programs can expect from their residents. The respondents desired most to complete 1 to 2 projects (63/85 or 74%) and to publish 1 to 2 papers (65/85 or 76%) during their residencies. In reality, most completed 0 to 3 projects (73/85 or 86%) but published 0 papers (62/85 or 73%). The number of resident research projects completed matched their expectations, but their production in terms of publications did not. Furthermore, half of all respondents felt that their research time was inadequate; most felt that having up to 3 months of protected time would be ideal (61/85 or 72%).

Resident satisfaction with research

Results from the satisfaction measures portion of the survey provided some insight. With a score of 2 indicating "meets expectations," 4 of the 5 individual scores had a mean score of less than 2. Only the ability to access a preceptor had a mean greater than 2 (2.29). Respondents also felt their interest in research had slightly decreased and at best remained the same with a mean score of –0.22, with 0 indicating "no change"). Considering all of the above, most respondents felt that their research experience barely met their expectations.

Correlations

After determining the current demographics, productivity, existing structures and support and satisfaction levels, we sought correlations between any of these factors using Pearson *r* (Table 1).

It was not surprising that PGY correlated with 4 of the 5 productivity measures because residents in later years would have had more time to complete research than those in early years. Similarly, months of protected research time correlated positively with grants and publications. This was the first indication that protected block research time affected productivity components that required the most focused time: writing for grants and publications.

The 5 productivity measures positively correlated with one another, suggesting that respondents who were more active were also more productive. Production led to more satisfied residents as well. Respondents with higher satisfaction scores and change of research interest were also more productive, with obtaining grants being the consistent correlate.

Effect of protected block time on productivity

Block research time had a positive impact on the number of grants obtained and publication, which further supports observations reported in the literature. Segal and colleagues[19] showed that orthopedic residents who took a research year published significantly more papers during their residencies. In internal medicine, even a well-structured 2-week research rotation resulted in substantially more resident research projects.[9]

Comparing publication rates, respondents who did not have block research time published at a rate of 8% (5/64), whereas respondents who did published at a rate of 29% (31/108). This rate was 3.7 times higher than that of residents without block research time and showed that most publications came from those who did have block time.

Effect of other factors on productivity

Although access to a research director was reported to be significant in the literature,[5,13,18,23] this did not affect productivity in our study. The role and involvement of each program's research director was likely highly variable, so our result was not surprising. The frequency of journal clubs was highly variable among programs. Contrary to the literature,[5,16] access to a journal club did not affect productivity measures.

Classroom teaching of research methods resulted in significantly fewer projects completed but did not affect other measures; this result was surprising. Knowledge of the fundamental principles of research is necessary in order to conduct research. Classroom teaching would be an effective way to ensure residents have this basic knowledge. Literature reviews suggested that classroom teaching of research methods should help, not hinder, productivity.[2,5,18,26] Although basic knowledge is a prerequisite to developing cognitive skills, it does not guarantee knowledge application.

Successful research skills can only be developed through the application of knowledge in practice.

Respondents with an advanced degree had more publications and gave more conference presentations during their residencies. This was not surprising as they were more experienced with the research process and therefore were further along the learning curve. Three of the 4 respondents who obtained master's degrees during residency had publications at the time of the survey and all of them had given conference presentations. This was likely owing to the protected time they had for research.

Residents who intended to pursue academic careers were also more successful in publishing and gave more conference presentations. Those who are more interested in academia should have some improved productivity in research, but support (such as protected block research time) is crucial for publishable results.

Qualitative opinions on research

Many respondents felt that having good preceptor support was the single most important factor impacting their research experience; the literature supports this finding.[3,5,7,14,15,18,25,26] However, most respondents in our study felt that time constraints was the most important factor. Similar studies conducted among general surgery, anesthesiology and pediatric residents reported the lack of protected time as the biggest barrier to conducting research.[4,9,20] Once expertise in research skills is achieved, it may be easier for the orthopedic researcher to pursue and complete research without protected time. In most cases, residents are novices and require more uninterrupted time.

Respondents who were concerned about the quality of their research experience favoured completing fewer projects and working on a project from start to finish rather than "parachuting" into projects already underway. Programs that require 1 project per year made this difficult to achieve.

Limited human resources and infrastructure were other notable factors affecting research and are likely to apply to more than resident-level research. Increasing resources might not be realistic for all programs, but providing protected block time is feasible and would allow trainees to maximize their use of available resources.

CONCLUSION

We have attempted to characterize the current state of Canadian orthopedic resident research experience with an emphasis on the effect of protected block research time. With an ever-increasing demand for orthopedic research, respondents indicated that current research training barely meets their needs. Research activity seemed appropriate but publications and satisfaction were not meeting residents' expectations, and lack of time was identified as a major barrier.

One recommended solution is for residency programs to provide protected block research time. Residents with protected time were more productive, obtained more grants, published more papers and were more satisfied with their experience. If residency programs provide blocks of time (rotations) for teaching clinical expertise, they should adhere to the same educational principle for research training.

The purpose of our study was not to be prescriptive about how much time to provide, and Bernstein and colleagues[2] agree there is no one optimal length of block research time that works for every program. An approach we can recommend is to provide 2 blocks of protected research time during residency. The first block would be used to write grant proposals and plan data collection. The second block would be used for data analysis and, most importantly, manuscript submission for publication. Regardless, the standardization of providing protected block research time during residency will provide Canadian orthopedic residents with greater opportunities for success in research.

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References

1. Alguire PC, Anderson WA, Albrecht RR, et al. Resident research in internal medicine training programs. *Ann Intern Med* 1996;124:321-8.

2. Bernstein J, Ahn J, Iannotti J, et al. The required research rotation in residency. *Clin Orthop Relat Res* 2006;449:95-9.

3. Blake DJ, Lezotte DC, Yablon S, et al. Structured research training in residency training programs. The impact on the level of resident research activity. *Am J Phys Med Rehabil* 1994;73:245-50.

4. Cull WL, Yudkowsky BK, Schonfielf DJ, et al. Research exposure during pediatric residency: influence on career expectations. *J Pediatr* 2003;143:564-9.

5. DeHaven MJ, Wilson GR, O'Connor-Kettlestrings P. Creating a research culture: what we can learn from residencies that are successful in research. *Fam Med* 1998;30:501-7.

6. Dunn JC, Lai EC, Brooks CM, et al. The outcome of research training during surgical residency. *J Pediatr Surg* 1998;33:362-4.

7. Giveon S, Kahan E, Kitai E. Factors associated with family physicians' involvement in research in Israel. *Acad Med* 1997;72:388-90.

8. Hillman BJ, Witzke DB, Fajardo LLL, et al. Research and research training in academic radiology departments. A survey of department chairmen. *Invest Radiol* 1990;25:587-90.

9. Kanna B, Deng C, Erickson S, et al. The research rotation: competency-based structured and novel approach to research training of internal medicine residents. *BMC Med Educ* 2006;6:52.

10. Lessin MS, Klein MD. Does research during general-surgery residency correlate with academic pursuits after pediatric-surgery residency? *J Pediatr Surg* 1995;30:1310-3.

11. Levine RB, Hebert RS, Wright SM. Resident research and scholarly activity in internal medicine residency training programs. *J Gen Intern Med* 2005;20:155-9.

12. Levitt MA, Terregino CA, Lopez BL, et al. A national profile of resident research programs in emergency medicine. *Acad Emerg Med* 1999;6:348-51.

13. Levitt MA, Terregino CA, Lopez BL, et al. Factors affecting research directors' and residents' research experience and productivity in emergency medicine training programs. *Acad Emerg Med* 1999;6:356-9.

14. Mills OF, Zyzanski SJ, Flocke S. Factors associated with research productivity in family practice residencies. *Fam Med* 1995;27:188-93.

15. Morrison JC, Meeks GR, Martin JN, et al. Resident research projects — frequency of presentation and publication in a national forum. *Am J Obstet Gynecol* 1994;170:777-81.

16. Potti A, Mariani P, Saeed M, et al. Residents as researchers: expectations, requirements, and productivity. *Am J Med* 2003;115:510-4.

17. Rivera JA, Levine RB, Wright SM. Brief report: completing a scholarly project during residency training. Perspectives of residents who have been successful. *J Gen Intern Med* 2005;20:366-9.

18. Schultz HJ. Research during internal medicine residency training: meeting the challenge of the residency review committee. *Ann Intern Med* 1996;124:340-2.

19. Segal LS, Black KP, Schwentker EP, et al. An elective research year in orthopaedic residency: How does one measure its outcome and define its success? *Clin Orthop Relat Res* 2006;449:89-94.

20. Silcox LC, Ashbury TL, VanDenKerhof EG, et al. Residents' and program directors' attitudes toward research during anesthesiology training: a Canadian perspective. *Anesth Analg* 2006;102:859-64.

21. Souba WW, Tanabe KK, Gadd MA, et al. Attitudes and opinions toward surgical research. A survey of surgical residents and their chairpersons. *Ann Surg* 1996;223:377-83.

22. Stewart RD, Doyle J, Lollis SS, et al. Surgical resident research in New England. *Arch Surg* 2000;135:439-44.

23. Terregino CA, Levitt MA, Lopez BL, et al. A national profile of resident research experience. *Acad Emerg Med* 1999;6:351-6.

24. Thakur A, Thakur V, Fonkalsrud EW, et al. The outcome of research training during surgical residency. *J Surg Res* 2000;90:10-2.

25. Grzybowski S, Thommasen HV, Mills J, et al. Review of University of British Columbia family practice resident research projects 1990-1997. *Fam Med* 1999;31:353-7.

26. Hebert RS, Levine RB, Smith CG, et al. A systematic review of resident research curricula. *Acad Med* 2003;78:61-8.

27. Ericsson KA. The acquisition of expert performance: an introduction to some of the issues. In: *The road to excellence: the acquisition of expert performance in the arts and sciences, sports, and games*. Mahwah (NJ): Lawrence Erlbaum; 1996. p. 1-50.

28. Marteniuk RG. *Information processing in motor skills*. New York (NY): Holt, Reinhart and Winston; 1976. p. 189-231.

Appendix 1. Online questionnaire sent to Canadian orthopedic residents during the academic year of Jul. 1, 2005 to Jun. 30, 2006

1.	Training institution	_____
2.	PGY	_____
3.	Age	_____
4.	Gender	❑ M ❑ F
5.	Advanced degree (MEd, MSc or PhD)	❑ Y ❑ N
6.	If answered "Y" to 5:	
	6a. Degree attained during residency	❑ Y ❑ N
	6b. Type of degree	❑ MSc ❑ MEd ❑ PhD
	6c. Length of time spent for degree (e.g. 1 yr, 2 yr)	_____
7.	Did you take **BLOCK** research time of at least 1 month during your residency?	❑ Y ❑ N
8.	If yes, how much time (in months)	_____
9.	The **MINIMUM** number of research projects a resident **SHOULD** complete during an orthopedic residency	0 1 2 3 4 5 6 7 8 9 10 >10
10.	Number of research projects you completed to date	_____
11.	A **DESIRABLE** number of publications to have by the end of an orthopedic residency	0 1 2 3 4 5 6 7 8 9 10 >10
12.	Number of research grants obtained to date	_____
13.	Number of your research projects **SUBMITTED** for publication to date	_____
14.	Number of your research projects **ACCEPTED** for publication to date	_____
14b.	In which journals and how many publications? (If more room is required, please continue in comments box.)	Journal name # of Publications e.g. JBJS 1 e.g. CMAJ 2 _____ _____ _____ _____ _____ _____ _____ _____ _____ _____
15.	Number of your research projects presented at a meetings/conferences to date	_____
16.	Is the amount of research time during your residency adequate?	❑ Y ❑ N
16b.	How many months of protected block research time is ideal (in months)?	0 1 2 3 4 5 6 7 8 9 10 11 12 >12
17.	Is there a designated research director in your program?	❑ Y ❑ N
18.	Is there journal club in your program?	❑ Y ❑ N
	How often? (e,g, once/month)	_____
19.	Is there classroom teaching of research methods in your program?	❑ Y ❑ N
20.	Do you intend to pursue an academic career after residency?	❑ Y ❑ N

		EXPECTATIONS				
		fails to meet	marginally meets	meets	fully meets	exceeds
21.	How would you rate the value of classroom teaching of research methods to your research experience?	1	2	3	4	5
22.	How would you rate the value of carrying out a research project to your research experience during residency?	1	2	3	4	5
23.	Rate your ability to access a research preceptor in your department	1	2	3	4	5
24.	How satisfying has your research experience been so far during residency?	1	2	3	4	5
25.	Availability of funding for research during residency	1	2	3	4	5
26.	How has your interest in research changed since the beginning of your residency?	decreased significantly	decreased slightly	same	increased slightly	increased significantly
		1	2	3	4	5

27. What is the single most important factor impacting on your research experience during residency? _____

Comments: