The Kansas IDeA Network of Biomedical Research Excellence (K-INBRE) was established in 2001 and is a network of 10 higher-education institutions in Kansas and northern Oklahoma. The program is funded by the Institutional Development Award (IDeA) program of the National Institutes of Health (NIH). As part of the program's goal to enhance the research infrastructure in Kansas, a training program was developed to encourage undergraduates to participate in biomedical research. From September 2002 to May 2012, the K-INBRE supported 731 students at 10 institutions. Although 16% of student participants in the program are still undergraduates, 323 of our students have gone into biomedical graduate school or medical school programs. Thirty-seven percent of all the completed students have matriculated into graduate programs and 19% of our completed students went to medical school. Moreover, 12% have gone into other health-related professions. One percent of our students who went into medical school programs are in highly prestigious MD/PhD programs. In the fall of 2011, we surveyed participants from the last 10 years about career choices and the impact of the K-INBRE program on those students. Two hundred twenty-four former and current students responded to the survey with a consensus of high impact of the K-INBRE program on student training, career choices, and perceptions about research.

INTRODUCTION

The Kansas IDeA Network of Biomedical Research Excellence (K-INBRE, originally designated the Kansas-Biomedical Research Infrastructure Network) program is a National Institutes of Health (NIH)-funded program to develop biomedical infrastructure and research in the state of Kansas (http://www.kumc.edu/kinbre/). The aim of the K-INBRE undergraduate program is to enhance the undergraduate educational experience by providing funding to undergraduate students, the next generation of biomedical scientists, to do research at the 10 participating institutions in the States of Kansas and Oklahoma. K-INBRE schools have wide-ranging missions. The lead university is the University of Kansas Medical Center (KU-MC), which has a comprehensive medical school and offers many doctoral programs leading to the PhD. The K-INBRE also has two predominantly undergraduate institutions that serve mainly minority students—Haskell Indian Nations University (HINU) and Langston University (LU). The breadth of missions among K-INBRE campuses requires that the K-INBRE have a flexible vision for how each institution achieves its mission as it fulfills the K-INBRE's goals. Therefore, the execution and design of activities on each campus are unique to each site because it is recognized that programs that are appropriate at one institution may not be appropriate at another. Nevertheless, the major focus for each institution's program is to introduce undergraduate students to biomedical research.

The K-INBRE has continuously monitored students' initial placement after graduation for the last 10 years. However, we wanted additional feedback about program perceptions and career choices and outcomes beyond the initial tracking after graduation. Programs such as this often lose touch with their participants after the students' initial postgraduation placement. Therefore, the survey was intended to provide additional feedback about student perceptions of the program and subsequent career outcomes and help us test the hypothesis that student enrollment in post-baccalaureate programs will be better if they participate in high-quality undergraduate research.
experiences compared with other undergraduates. This paper presents outcomes of K-INBRE participants since 2002 and the results of a survey sent to participants in the program through November 2011.

METHODS

K-INBRE overview

The goal of the K-INBRE undergraduate program is to introduce undergraduate students to biomedical research. Each campus is provided funding ($28,000) to enrich undergraduate participation in research. Activities considered for the program include: research scholarships for undergraduates, research mini-grants for faculty working with students, summer research programs for high school students, support for gatherings of K-INBRE participants to share information and experiences, and support to create informational/recruitment brochures to increase participation and awareness of the K-INBRE program. Other appropriate activities include: student travel support, sponsorship of symposia for student oral/poster presentations, support for the implementation of formal course credit for the research experience, funding for programs for undergraduate access to primary research literature on-line, support for programs to incorporate new technologies into existing classes to better prepare students for graduate research, funding for invited speaker travel, and mini-grants to help update equipment for undergraduate student research. The programs that had K-INBRE support, and which campuses participated in them, are summarized in Table 1. For this program, students are selected on each campus by the on-campus faculty. In general, at our K-INBRE institutions, faculty have very close interactions with the students. Criteria such as motivation, class standing (e.g., Fr. vs. Sr.), and a faculty member’s experience with the student are often included as selection criteria. Grades, previous research experience, letters of recommendation, enrollment in a research class, mini-grants outlining the project, and postgraduate interests are used for selection in various combinations.

In addition to individual campus programs, the K-INBRE also funds approximately 30 Summer/Semester scholars each year ($4,000/student), which are independent of the campus funding (http://www.kumc.edu/kinbre/summer_scholar_recipients.html). These applications are reviewed for project quality and student qualifications by the K-INBRE Incentives and Awards Committee. This committee is comprised of faculty from several K-INBRE campuses. The students supply transcripts, letters of recommendation, a biosketch, and a one-page research project outline. The mentor, who will supervise the student’s research, is also required to supply an NIH biosketch. The committee uses all of this information to select high-quality students and mentors into the program. The funding allows students to participate in research either during the summer, during the academic year, or both.

The K-INBRE also instituted the Star Trainee program in 2003. This program selects outstanding junior students who have already shown strong research potential to receive a $7,500 stipend during their senior year (http://www.kumc.edu/kinbre/star_trainee_recipients.html), and the faculty mentor’s lab receives $2,500 for supplies. Star Trainees also have $10,000 applied to their graduate stipend if they enroll in a graduate program in the State of Kansas. Applications are reviewed for project quality and student qualifications by the K-INBRE Incentives and Awards Committee using the same information that is used for summer/semester scholars.

From 2010–2012, the K-INBRE received additional scholarship money from the American Recovery and Restoration Act (ARRA). This program allowed students to receive funding for one year at a level of $5,000 per student. The same selection requirements used for the summer/semester scholars were used for the ARRA scholars and accounted for a 5% increase in the number of students who were funded by the K-INBRE (Table 2).

In addition to laboratory research, all K-INBRE students are asked to participate in at least six intra-campus K-INBRE scholar meetings per year to share student progress and learn from mentor experiences as part of the program. Campuses are provided with $200 per year for refreshments for these meetings from the K-INBRE Undergraduate Office. The K-INBRE also holds an annual, program-wide symposium to allow students to present research posters, with some of the students asked to present orally along with national and regional faculty speakers. The one-and-a-half day symposium has grown from an initial participation of 25 student abstracts with 75 faculty and student participants in January 2003, to 108 student abstracts and 255 faculty and student participants in January 2012 (http://www.kumc.edu/kinbre/symposium_schedule.html). Students are also encouraged to participate in individual campus research forums and national professional meetings.

To assess student outcomes, each campus coordinator recorded the number of students falling into the following categories: funded as summer/semester scholars, funded by regular K-INBRE campus funding, matriculated into graduate school, matriculated into medical school, matriculated into an MD/PhD program, pursued other medical professional programs, other outcomes, funded in the Star Trainee program, Star Trainee program participants who enter graduate school, and undergraduates currently in the program (Table 2).

K-INBRE student survey

The survey was administered using SurveyMonkey (http://www.surveymonkey.com/), and consisted of 20 questions inquiring about participation, research, outcomes, careers, program impact, social media, and the demographics of the students (Appendix 1). Most of the questions were multiple-choice with areas to add comments or expand on answers. Some of the questions were developed based on previous undergraduate assessments (11, 12) to
allow for comparative analyses. At the time of the survey, 659 students had participated in the K-INBRE over the approximate 10-year period at our 10 participating campuses. Contact information was available for 569 out of 659 current and former students as of October 2011. Surveys were sent out via SurveyMonkey to the e-mail addresses after two notifications indicating that the K-INBRE would be doing the assessment and the importance of the survey. The survey was open for approximately 2.5 months (October 17–December 31) with 11 follow-up e-mail reminders, including one from the campus coordinators at the schools that the students attended. In addition, as incentive for participation, we announced that respondents could elect to be eligible for a draw for an iPod. Forty-one of the e-mail addresses to which the survey was sent bounced back, leaving us with 528 possible survey responders. Two of the students opted out of the survey and future communication from K-INBRE. Two hundred twenty-four students responded to the survey, a 42% response rate (Table 3). This assessment was reviewed and assigned “exempt” status by the Human Subjects Institutional Review Board at KU-MC.

TABLE 1.
Activities supported by the K-INBRE at participating institutions a.

| Campus Activity                                                      | ESU | FHSU | HINU | KSU | KU-L | KU-MC | LU | PSU | WU | WSU |
|---------------------------------------------------------------------|-----|------|------|-----|------|------|----|-----|-----|-----|
| Research scholarships for undergraduates                           | ☒   | ☒   | ☒   | ☒   | ☒   | ☒   | ☒ | ☒   | ☒   | ☒   |
| Research mini-grants for faculty working with students             | ☒   | ☒   | ☒   | ☒   | ☒   | ☒   | ☒ | ☒   | ☒   | ☒   |
| Summer research program for high school students                   | ☒   | ☒   | ☒   | ☒   | ☒   | ☒   | ☒ | ☒   | ☒   | ☒   |
| Gatherings of K-INBRE participants to share information and experiences | ☒   | ☒   | ☒   | ☒   | ☒   | ☒   | ☒ | ☒   | ☒   | ☒   |
| Create informational/recruitment brochures to increase participation and awareness of the K-INBRE program | ☒   | ☒   | ☒   | ☒   | ☒   | ☒   | ☒ | ☒   | ☒   | ☒   |
| Support student travel to make presentations                       | ☒   | ☒   | ☒   | ☒   | ☒   | ☒   | ☒ | ☒   | ☒   | ☒   |
| Symposium for oral/poster presentations of student participants     | ☒   | ☒   | ☒   | ☒   | ☒   | ☒   | ☒ | ☒   | ☒   | ☒   |
| Implement a program to allow the undergraduate research experience to be a formal course and have a credit hour value attached to it | ☒   | ☒   | ☒   | ☒   | ☒   | ☒   | ☒ | ☒   | ☒   | ☒   |
| Implement a program that will increase undergraduate access to primary research literature online | ☒   | ☒   | ☒   | ☒   | ☒   | ☒   | ☒ | ☒   | ☒   | ☒   |
| Develop programs to incorporate new technologies into existing classes to better prepare students for graduate research | ☒   | ☒   | ☒   | ☒   | ☒   | ☒   | ☒ | ☒   | ☒   | ☒   |
| Invited speaker travel: An invited scientist can present a seminar and interact with students | ☒   | ☒   | ☒   | ☒   | ☒   | ☒   | ☒ | ☒   | ☒   | ☒   |
| Develop programs to develop interdepartmental projects to foster cooperation among faculty and develop interdepartmental projects involving undergraduates | ☒   | ☒   | ☒   | ☒   | ☒   | ☒   | ☒ | ☒   | ☒   | ☒   |
| Mini-grants to help update equipment for undergraduate student research | ☒   | ☒   | ☒   | ☒   | ☒   | ☒   | ☒ | ☒   | ☒   | ☒   |
| Methods used for student selection: grades, 1; previous research experience, 2; letters of recommendation, 3; enrollment in a research problems class, 4; grant/ mini-grant with mentor/not just an application; 5; postgraduate plans, 6. | 2,6 | 1,5 | 4 | 1,2,6 | 1,2,3,6 | N/A b | 1,4,6 | 5 | 1,5,6 | 1,3 |

aEmporia State Univ., ESU; Fort Hays State Univ., FHSU; Haskell Indian Nations Univ., HINU; Kansas State Univ., KSU; Kansas University-Lawrence, KU-L; Kansas University-Medical Center, KU-MC; Langston Univ., LU; Pittsburg State Univ., PSU; Washburn Univ., WU; Wichita State Univ., WSU.

bKU-MC does not have undergraduate students during the academic year. Summer interns are summer/semester scholars.
The K-INBRE 2011 student survey

There was a 42% response to the K-INBRE survey by students who had participated or were currently participating in the K-INBRE program based on successful e-mail notifications. Survey respondents represented all but one (HINU) of our K-INBRE campuses and the distribution of respondents was not statistically different ($p = 0.15$, $\chi^2$ test) from the distribution of student participants throughout the entire length of the program (Table 3). The absence of respondents from HINU reflects that HINU was the campus with the smallest number of students that participated in formal research (Table 3), and possibly the general hesitancy of Native Americans to participate in assessments (4).

The survey participants were fairly evenly distributed based on when they graduated (Baccalaureate degree) and when they started postgraduate studies (i.e. medical or graduate school) (Table 4). The “experience” of the survey participants exceeded that of the general K-INBRE student population based on the number of semesters that a student was funded by the K-INBRE (Table 5). There was a higher percentage of students who had more than two semesters of funding among the survey respondents (47%) compared with the overall statistics compiled by the K-INBRE from 2002–2012 (23%; $p = 0.03$, $\chi^2$ test). Perhaps more experienced students felt a greater obligation to respond to our inquiry or they were more motivated because they had a good experience in the program. Regardless, the number of students who participated for two semesters was the largest group for both our survey respondents and total K-INBRE participants from 2002–2012 (Table 5). The pattern was also true for students who participated one semester (second highest), four semesters (third highest), three semesters (fourth highest), and five semesters (fifth highest). Therefore, the survey included students with the complete range of possible laboratory experiences.

The gender of the survey respondents closely paralleled the gender distribution of student participants throughout the entire program’s life ($p = 0.54$, $\chi^2$ test) (Table 6). The higher percentage of female participants reflects the growing trend of more females receiving bachelor’s degrees than males (7) and the gender distribution of participating students reported by other undergraduate research programs (8, 11). The racial distribution of the survey respondents was 71% white, 8% black, 9% Asian, and <1% American Indian, Native Hawaiian, or Pacific Islander (Table 7). Five percent

### Table 2.

| Category                  | Number | Percentb |
|---------------------------|--------|----------|
| Campus scholars           | 369    | 50       |
| Summer/semester scholars  | 286    | 39       |
| ARRA scholars             | 33     | 5        |
| Star Trainees             | 43     | 6        |
| Totals                    | 731    | 100      |

### Table 3.

| Institutiona              | # Respondingb | %c | # in Programd |
|---------------------------|---------------|----|---------------|
| Emporia State             | 25            | 11 | 73            | 10            |
| Fort Hays State           | 5             | 2  | 56            | 8             |
| Haskell Indian Nations    | 0             | 0  | 23            | 3             |
| Kansas State              | 56            | 25 | 117           | 16            |
| Kansas-Lawrence           | 36            | 16 | 89            | 12            |
| Kansas-Med. Center        | 2             | <1 | 47            | 6             |
| Langston                  | 17            | 8  | 74            | 10            |
| Pittsburg State           | 29            | 13 | 73            | 10            |
| Washburn                  | 23            | 10 | 84            | 11            |
| Wichita State             | 31            | 14 | 95            | 13            |
| Total                     | 224           | 73 | 731           |               |

aInstitution that students attended during the academic year.  
b224 students responded out of 528 students who were e-mailed requests to participate in surveys based on deliverable e-mail addresses.  
cStudents in program 2002–2012.  
dNumbers do not total 100 due to rounding.
TABLE 4.
Distribution of survey respondents.

| Year | Baccalaureate Graduation | Entered Postgraduate School |
|------|--------------------------|-----------------------------|
| 2002 | 2                        | 0                           |
| 2003 | 5                        | 6                           |
| 2004 | 15                       | 8                           |
| 2005 | 13                       | 10                          |
| 2006 | 22                       | 13                          |
| 2007 | 12                       | 9                           |
| 2008 | 14                       | 13                          |
| 2009 | 25                       | 24                          |
| 2010 | 25                       | 16                          |
| 2011 | 24                       | 24                          |
| 2012 | 34                       | 0                           |
| 2013 | 23                       | 0                           |
| 2014 | 5                        | 0                           |

*Four respondents did not answer and one received a DVM without obtaining a Baccalaureate degree.

*Year respondent entered medical or graduate school, 39 answered N/A and 62 skipped the question.

TABLE 5.
Number of semesters of K-INBRE student participation.

| # Semesters | % of survey respondents | % of Participants 2002–2012 |
|-------------|-------------------------|-----------------------------|
| 1           | 25 (2)*                 | 34 (2)*                     |
| 2           | 28 (1)                  | 42 (1)                      |
| 3           | 17 (4)                  | 6 (4)                       |
| 4           | 19 (3)                  | 13 (3)                      |
| 5           | 5 (5)                   | 2 (5)                       |
| 6           | 2 (7)                   | 1 (6)                       |
| >6          | 4 (6)                   | 1 (6)                       |

*Number of semesters students were funded by K-INBRE to participate in research.

*Ranking of semesters of K-INBRE student participation highest to lowest.

of our survey respondents indicated that they were of Hispanic, Latino, or Spanish origin. This is consistent with the distribution of students in other undergraduate research surveys (8, 11) and approximates the general participation of students in our program from 2002–2012. However, because ethnic distribution was only informally tracked in our program until recently, we did not attempt to do a statistical analysis on this demographic.

To evaluate the K-INBRE impact, we asked a series of questions about working independently and formulating ideas, being motivated, learning, analyzing and interpreting data, understanding the scientific process, overcoming obstacles, and increasing one’s self-confidence (Table 8). Average scores for K-INBRE participants were high, ranging from 4.14–4.52 (Table 8). These scores equaled or exceeded the mean scores for similar assessments of non-K-INBRE-funded undergraduates doing research reported in 2004, 2007 (11, 12), and 2010 (8). For example, when asked if the K-INBRE “improved my understanding of how knowledge is constructed and how scientists work on real problems,” the average K-INBRE score was 4.52/5.00 (Table 8). In the analysis of Surveys of Undergraduate Research Experiences (SURE) (11, 12), which included students from many different kinds of colleges and universities across the United States, similar inquiries about growth experienced by students funded by the Howard Hughes Medical Institute (HHMI) or by students “who changed to graduate education in science” (GES students) scored 4.10/5.00 and 4.20/5.00, respectively. When asked if the K-INBRE “improved my ability to integrate theory and practice,” the average K-INBRE score was 4.32/5.00. In the SURE assessment, a similar question scored 3.85/5.00 for HHMI-funded students and 4.13/5.00 for GES students (11). When asked if the K-INBRE “gave me tolerance for obstacles faced in the research process,” the average K-INBRE
score was 4.46/5.00. In the SURE assessment, the same question scored 4.10/5.00 for HHMI-funded students and 4.18/5.00 for GES students. We also compared K-INBRE student “tolerance for obstacles” to that of students in the undergraduate research program at Emory University (8). The average K-INBRE scores exceeded the scores of the Emory University students (4.00/5.00) (8). Moreover, when K-INBRE students were asked to rank the statement, “It increased my self-confidence,” the response averaged 4.14/5.00 (Table 8). In the SURE assessment, a similar question scored 3.59/5.00 for HHMI-funded students and 4.03/5.00 for GES student respondents (11). “Self confidence” scores for all students reported in both the 2004 and 2007 SURE analyses were 3.50/5.00 (11, 12) and 3.7 at Emory (8). Therefore, in all the assessments summarized in Table 8, the students scored the K-INBRE program equal to or higher than students participating in research experiences assessed in the SURE or at Emory University. The sample size of the K-INBRE assessment was smaller than the SURE assessment (224 vs. 1135) (11, 12) or the undergraduate assessment done at Emory University (822). However, since the K-INBRE survey respondents appeared to reflect the general experience, demography, and campus distribution of the total K-INBRE student participation pool, it is likely that similar data would be obtained with a larger sample size. However, it is possible that whatever motivated students to respond to the survey may have also affected their opinion. Therefore, some caution is required in making that extrapolation. It is important to note that the K-INBRE survey also included students who worked on research during the academic year, so the student populations may not always be directly comparable to the SURE survey (11), which only analyzed students in summer research programs.

One recurring theme among the student comments was how the K-INBRE program provided experience and confidence (Appendix 2). For example, one student indicated, “It gave me the confidence to pursue an independent graduate studies program, the Master’s International Program through the Peace Corps . . . without my K-INBRE experience, I would not have had the confidence to participate in this program” (Appendix 1, Comment 14). Another student added, “K-INBRE gave me a chance to explore science and help me decide that I wanted to be a scientist” (Appendix 2, Comment 26). One additional response was, “. . . it gave me confidence that I never had, it let me believe that ordinary people like me can make scientific discoveries. If it is not for this program, I would never believe I could give a talk in front of a hundred people” (Appendix 1, Comment 70).

We assessed the types of scientific presentations made by K-INBRE survey respondents (Table 9). Over 70% of K-INBRE students were able to present a poster off campus or at a conference or professional meeting. Over 27% were authors on a manuscript intended for publication in a professional journal (Table 9). Lopatto reported that 27.9% of

| Questiona | Responseb |
|-----------|-----------|
| It helped me to better think and work independently and formulate my own ideas. | 4.35 |
| It helped me become more intrinsically motivated to learn. | 4.22 |
| It made me a more active learner. | 4.32 |
| It helped improve my skills in the analysis of data and interpretation of results. | 4.46 |
| It gave me tolerance for obstacles faced in the research process. | 4.46 |
| It improved my understanding of how knowledge is constructed and how scientists work on real problems. | 4.52 |
| It improved my ability to integrate theory and practice. | 4.32 |
| It increased my self confidence. | 4.14 |
| It increased my ability to work in a team. | 3.92 |
| It increased my potential to be a teacher of science. | 3.93 |

Table 8.

| Presentation Typea | % Response |
|--------------------|------------|
| An academic paper presented by your mentor or other senior member in the lab | 32.7 |
| A poster presentation on campus | 67.7 |
| A poster presentation off campus at a conference or professional meeting | 70.5 |
| A talk on campus | 45.5 |
| A talk off campus at a conference or professional meeting | 20.9 |
| A manuscript intended for publication in a professional journal (one or more) | 27.3 |
| A website or Internet presentation | 2.3 |
| None of the above | 3.6 |
| Other | 5.0 |

Table 9.

a220 out of 224 students responded to these questions.

bStudents could Strongly Agree (5), Agree (4), Neither Agree Nor Disagree (3), Disagree (2) or Strongly Disagree (1). Answers were weighted as indicated.
undergraduates participating in research presented posters at conferences or professional meetings, and that 19.7% were authors on a manuscript intended for a professional journal (10). Nearly 21% of the K-INBRE students surveyed were able to give a talk off campus at a conference or professional meeting. Lopatto reported that 12.9% of the students surveyed in his assessments gave a talk or colloquium at a conference or professional meeting (10). Almost 68% of K-INBRE students surveyed were able to make a poster presentation on campus (Table 9). Therefore, K-INBRE students had excellent opportunities to develop communication skills and had opportunities to present their research at levels comparable to, or better than, those seen in other undergraduate research programs. We attribute part of this outstanding participation metric to the annual K-INBRE symposium. Indeed, some of our survey respondents even commented on the annual symposium. One said, “….Perhaps the most important impact is attending the general meeting each January and realizing that I am part of a very large and very intelligent community of people who are interested in the same things as I am and who are willing to collaborate and share ideas and information. Coming from a small institution, it is not always possible to look around and realize my peers are there. These meetings motivate me . . .” (Appendix 2, Comment 125).

The K-INBRE survey inquired about students’ impressions of their research experience (Table 10), whether they would recommend the program to future students (Table 11), and whether they thought the K-INBRE program should be continued (Table 12). Over 90% of the K-INBRE students indicated that they had a positive experience and that they learned a lot and would do it again, with over 27% of those students indicating that their research project was “fantastic” (Table 10). The overall student impression was 4.16/5.00, and over 98% of the students surveyed agreed with the statement, “The K-INBRE made a big impact on my life and I recommend that other students participate in the program” (Table 11). One hundred percent of the students agreed or strongly agreed that “The K-INBRE program is an important program for student development and should be continued in Kansas” (Table 12). The positive K-INBRE impact is consistent with the general positive influence undergraduate research has on student academic development (10), especially for students at PUIs (16). This is also consistent with the finding that over 90% of K-INBRE survey respondents agreed or strongly agreed that the participation in the K-INBRE program helped in the student’s career choice (Table 13). Even when students indicated that research was not a career outcome, they felt that the K-INBRE research program provided a positive learning experience. For example, one student commented, “I realized that a life in research didn’t fit my personality or goals. I learned a little more about science, how to contribute to science, how to interpret/read literature, how to formulate experiments, how to get frustrated, how to gain resilience . . . .” (Appendix 2, Comment 165).

### Table 10.

Students’ overall impressions of their research experience.

| When you reflect on your research project as a learning experience, you feel that²: | Number | Percent |
|-------------------------------|--------|---------|
| My research project was fantastic (5) | 60     | 27.3    |
| I had a good time, learned a lot, and would do it again (4) | 140    | 63.6    |
| I feel neutral about it—there were both good and bad things (3) | 17     | 7.7     |
| It was better than working somewhere else, but I don’t think I learned a lot (2) | 2      | 0.9     |
| Time in the lab was a waste—I didn’t learn much (1) | 1      | 0.5     |
| **Overall score¹** | **4.16/5.00** |

¹220 out of 224 students responded to this question.
²Answers were weighted as indicated in parentheses.

### Table 11.

Participant recommendations to future students.

| The K-INBRE made a big impact on my life and I recommend that other students participate in the program¹ | Number | Percent |
|-------------------------------------------------|--------|---------|
| Strongly agree (4) | 120 | 58.0 |
| Agree (3) | 83 | 40.1 |
| Disagree (2) | 3 | 1.4 |
| Strongly disagree (1) | 1 | 0.5 |
| **Overall score¹** | **3.56/4.00** |

¹207 out of 224 students responded to this question.
²Answers were weighted as indicated in parentheses.

### Table 12.

Participant recommendations about program continuation.

| The K-INBRE program is an important program for student development and should be continued in Kansas¹ | Number | Percent |
|-----------------------------------------------------------------------------------------------------------------|--------|---------|
| Strongly agree (4) | 170 | 82.1 |
| Agree (3) | 37 | 17.9 |
| Disagree (2) | 0 | 0 |
| Strongly disagree (1) | 0 | 0 |
| **Overall score¹** | **3.82/4.00** |

¹207 out of 224 students responded to this question.
²Answers were weighted as indicated in parentheses.
We also assessed K-INBRE participants’ experience with the K-INBRE’s electronic presence. Only one-third of the survey respondents had visited the K-INBRE website in the last year and less than 20% were friends of K-INBRE on Facebook or had visited the K-INBRE Facebook page (Table 14).

**Assessment of K-INBRE outcomes**

As part of the K-INBRE survey we assessed the career choices of survey respondents (Table 15). Almost 40% of former K-INBRE participants who graduated went on to attend graduate school. Eight percent of the respondents attended MD/PhD programs, and another 11% entered other medical professional programs. Therefore, over 85% of our former participants who responded to the survey entered some type of postgraduate educational experience (Table 15). The K-INBRE supported 723 students at our 10 participating institutions from 2002 to 2012, including our Star Trainees, ARRA scholars, and our Summer/Semester scholars (Table 2). Thirty-eight percent of our students entered into graduate programs (including MD/PhD programs). Twenty percent of our students went to medical school (including MD/PhD programs) and 12% went into other biomedical professions (Table 2). These numbers closely parallel the career choices of the survey respondents, although a higher percentage of MD/PhD students responded to the survey compared with our overall student population (8% vs. 1%; Tables 2 and 15). Our Star Trainee program is one that allows promising undergraduate students to get extensive science and laboratory training as undergraduates, and by helping support them their first year in graduate school we make them attractive graduate student candidates. Forty-three Star Trainees have participated in the program since its inception in 2003, and 81% of those who completed their undergraduate degrees went into graduate programs (Table 2).

According to the National Center for Education Statistics, which has published several long-term cohort studies of individuals who received their bachelor’s degrees, in the 1992–1993 cohort, 29.8% enrolled in graduate school by 1997 (13). Twenty-four percent of those students were enrolled in the life or physical sciences (13). Importantly, of the 29.8%, only about half (49% of the 29.8% = 14.6%) were enrolled within 1 year of graduation (13), which is the temporal metric the K-INBRE has been using as an outcome. Therefore, the K-INBRE overall post graduate success of 69% entering some kind of graduate, medical, or professional program is two to four times higher than the national average for the 1992 cohort, depending on which population is used as a comparison (total in four years that go on to post-baccalaureate degrees or within one year after graduation, respectively).

In similar types of analyses, in the summary of 1999–2000 Bachelor’s Degree Recipients (3), 22% went to graduate school or professional school. Of those who

| TABLE 13. K-INBRE influence on career choice. |
| --- |
| Participation in the K-INBRE program helped you in your career choice<sup>a</sup> | Number | Percent |
| Strongly agree (4) | 95 | 43.6 |
| Agree (3) | 102 | 46.8 |
| Disagree (2) | 21 | 9.6 |
| Strongly disagree (1) | 0 | 0 |
| Overall score<sup>b</sup> | 3.34/4.00 |

<sup>a</sup>218 out of 224 students responded to this question.

<sup>b</sup>Answers were weighted as indicated in parentheses.

| TABLE 14. Survey respondents’ experience with K-INBRE electronic presence. |
| --- |
| Question<sup>a</sup> | % Response |
| Have you visited the K-INBRE website at www.kumc.edu/kinbre in the last year? | 33.0 67.0 |
| Have you visited the K-INBRE Facebook page at www.facebook.com/KansasINBRE in the last year? | 16.5 83.5 |
| Are you a friend of K-INBRE on Facebook? | 19.9 80.1 |

<sup>a</sup>206 out of 224 students responded to these questions.

| TABLE 15. Career choices by survey respondents. |
| --- |
| Career Choice Following Graduation | % of Graduates<sup>b</sup> |
| Attended medical (MD/DO) school | 21.6 27.8 |
| Attended graduate school | 30.7 39.6 |
| Attended MD/PhD program | 6.2 8.0 |
| Attended other medical professional program | 8.7 11.2 |
| Took a job in a biomedical field | 5.0 6.4 |
| Took a job in a nonbiomedical science field | 4.6 5.9 |
| Took a job in a non science field | <1 1.1 |
| Still an undergraduate in training | 22.4 N/A |

<sup>a</sup>218 out of 224 students responded to this question.

<sup>b</sup>Distribution of career choices of graduates. N/A, not applicable.
graduated with degrees in life science, 38.1% went on to graduate or professional school. Of those with degrees in a health field, 24.2% went on to graduate or professional school. Similarly, in the 2008–09 Baccalaureate and Beyond Longitudinal Study (7), based on post-baccalaureate enrollment data (Table 2-18), 42.4% of students receive master’s degrees, doctoral degrees, or at least one professional degree. Therefore, the K-INBRE overall postgraduate success of 69% entering some kind of postgraduate, medical, or professional program ranges from 1.7 to 3.1 times higher than these national estimates depending on which cohort group is used as a comparison (Fig. 1).

According to the National Science Foundation (NSF), the number of science bachelor’s degrees awarded in 2008 was 426,260 in the USA (14; Table 2-18). There were 99,501 first-time, full-time graduate students in those same fields in 2009 (14; Table 2-23). Therefore, based on the statistics of the NSF, approximately 23.3% of the graduates in Agricultural, Biological, and Physical sciences went to graduate school. According to the Council of Graduate Schools, 30.2% of the applications to biological and agricultural sciences were accepted in the USA (2). The 2009 College Senior Survey (CSS) indicates that 28.9% of 2009 college graduates will attend graduate-professional school (5). Therefore, the K-INBRE success in graduate school placement (3) exceeds these national statistics by over two times (Fig. 1).

In assessing students in the K-INBRE who go on to medical school, according to the Association of American Medical Colleges, 19,230 people were accepted into medical school in the United States in 2011 (1). Therefore, the percentage of science baccalaureate recipients who went to medical school in 2011, based on NSF 2009 science bachelor’s degrees (434,835) (14; Table 2-18), is just under 5% (19,230/434,835 = 0.044). According to the CSS, 6% of students go to medical or dental school (5). Therefore, the K-INBRE success in graduate school placement (3) exceeds these national statistics by over two times (Fig. 1).

According to the National Center for Education Statistics (NCES) Bachelor’s Degree Recipients 1 Year Later 1992–1993 cohort (13), the NCES 1999–2000 cohort (3), the NCES Baccalaureate and Beyond Longitudinal Study 2008–2009 cohort (7), National Science Foundation Statistics (14), the Council of Graduate Schools (CGS) survey 200–2010 (2), and the 2009 College Senior Survey (5). See text for details.

The K-INBRE's strong survey scores in helping students work independently (4.35/5.00), making them more active learners (4.32/5.00), improving their ability to integrate theory and practice (4.32/5.00), and increasing their ability to work in a team (3.92/5.00) all indicate that there must be strong mentorship in the program and that they are active participants in the research process. Students gain more from a research experience if they are involved in assessment and literature review, and not just collecting data (9). Over 27% of our K-INBRE survey respondents indicated that they were co-authors on a manuscript intended for publication in a professional journal (Table 9), and a recurring theme among the student comments (Appendix 2) was about the available mentoring and how it influenced them. Comments ranged from, “I was able to work with a great instructor” (Appendix 2, Comment 45), to “I have also been given the chance to engage with fellow research partners and learn from an influential mentor. Our interactions have inspired teamwork within the laboratory and a fresh enthusiasm for learning” (Appendix 2, Comment 55), and also included “K-INBRE piqued my interest in biomedical laboratories is not the only thing that makes for a successful program. According to the Chronicle of Higher Education’s report on undergraduate research, “undergraduates learn and grow significantly from their research experiences, but require a strong mentor relationship to do so” (6). A long-term study, conducted at Indiana University, indicates that undergraduates do better when their mentors make it clear how important the student projects are (9). The K-INBRE's strong survey scores in helping students work independently (4.35/5.00), making them more active learners (4.32/5.00), improving their ability to integrate theory and practice (4.32/5.00), and increasing their ability to work in a team (3.92/5.00) all indicate that there must be strong mentorship in the program and that they are active participants in the research process. Students gain more from a research experience if they are involved in assessment and literature review, and not just collecting data (9).
research, which ultimately drove me to attend graduate school. I actually pursued graduate studies with my K-INBRE mentor, since I had such a fantastic research experience as an undergraduate” (Appendix 2, Comment 132). Indeed, bad mentoring did lead to a bad student experience in our program as well. One student was angry with the mentor because “I was denied the opportunity to see the project through from conception through synthesis of the final product)” (Appendix 2, Comment 152).

In conclusion, for participants in the K-INBRE program, the percentage of students who go on to post-baccalaureate programs (e.g., medical, graduate, or professional) equals (using some conservative estimates), or exceeds (using several different measures), national estimates (Fig. 1). Perhaps the flexibility of our individual campus faculty to select some students on less objective measures (i.e. motivation, faculty student interactions) along with more traditional selection processes (i.e. summer/semester scholar selection) allows us to identify strong students who fit “traditional” norms as well as ones who do not. Based on the information collected from our survey, the K-INBRE program is a positive experience for most of the participants (Appendix 2). Additionally, most students continued to pursue careers in the biomedical field beyond their undergraduate education. Indeed, we discovered that 47% of the students who responded to the survey who initially took jobs eventually went to graduate or medical school. In total, these data suggest that the student undergraduate training program is meeting the goals and objectives of the Kansas INBRE. The survey was limited by the ability to contact all past participants and reinforced the need to find ways to keep better contact with our students. We did not have contact information for everyone who had participated in the program because it has been difficult to keep information updated when people move and change jobs. We had hoped that our use of social media (e.g., Facebook) would help link us to former students. The data suggest that additional efforts will be needed by the K-INBRE program to improve this communication medium.

SUPPLEMENTAL MATERIALS

Appendix 1: K-INBRE scholar survey
Appendix 2: Written comments by respondents to the K-INBRE scholar survey

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