

A conversation with Elizabeth A. Stuart

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Abstract Elizabeth A. Stuart is a Professor in the Departments of Mental Health, Biostatistics, and Health Policy and Management at the Johns Hopkins Bloomberg School of Public Health, and Associate Dean for Education at the school. She is a renowned expert in the area of causal inference, including propensity score methods for observational data and the generalizability of randomized trial results, and is also a Fellow of the American Statistical Association. Prior to her appointment to the faculty at Johns Hopkins, Professor Stuart received her Ph.D. in statistics from Harvard University and a bachelor's degree in mathematics from Smith College. In 2015, Professor Stuart was recognized at the International Conference on Health Policy Statistics with the Mid-Career Award from the Health Policy Statistics Section of the American Statistical Association.

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1 Early years

Elizabeth “Liz” Stuart was born in Kogarah, New South Wales, Australia in 1975. Her parents, Richard and Ruth, were Americans living in Australia. Liz’s birth, 3 months premature, occurred 3 years after their move to Australia. When she was 2 years old, her family moved back to the United States and settled in Laconia, New Hampshire (Fig. 1).

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Fig. 1 Elizabeth Stuart, born 3 months premature, held by mother Ruth Stuart (*top left*) and approximately 6 months old (*top right*). Father Richard Stuart, Elizabeth Stuart, and Ruth Stuart (*bottom*)

2 Education

What subjects did you favor in your early education?

I definitely gravitated towards math during elementary and middle school. I do remember doing a special program in computer programming in elementary school; I have vivid memories of programming turtle logic where we would move the little turtle on the screen.

Were there notable events in college that contributed to your career path?

I attended Smith College and they have a program called Stride, which was a way to get undergrads involved in research very early on. I participated in Stride for my first and

second years at Smith where I worked with math professor David Cohen. My research focused on differential equations and models of disease transmission. That was effectively my first exposure to applied math. I would say that is what helped me start thinking more about research and how to take my mathematical interest and turn that into something more relevant for public health and policy.

How did you go from that experience to applying to graduate school?

I graduated from Smith College in 1997 and did not go to graduate school right away. I didn't have a clear path when I was leaving college. I knew I wanted to do something mathematical and help make the world a better place, which sounds cliché, but was true. I just didn't know how to do that or what that might look like. Most of my friends in college were not math majors, they were studying history and English and I was the lone mathematician. One of my friends came to me from the career development office and she said, "Liz, I found the perfect job for you. It's a place called Mathematica." I looked into it and Mathematica actually was a wonderful fit as a public policy research firm. So I applied and stayed for 2 years after my undergraduate education.

My role there essentially involved doing a lot of statistical programming. Mathematica was where I was first exposed to this idea that you can do statistics (I just didn't know it was statistics at the time) and be working to help improve public health and public policy. So, I stumbled into it, but it ended up being a really good fit. I hadn't taken any statistics classes during undergrad; I was a math major and chemistry minor taking theoretical math classes and also some computer science. At the time, the Smith math program only offered one or two statistics classes, and I didn't even take those. I didn't even know statistics existed until I went to Mathematica.

I was at Mathematica in a research assistant/programmer position, a job a lot of people would stay at for 2 years and then go off to graduate school. That's what I did too. I looked around at different types of graduate programs: applied math, statistics, biostatistics, even demography. Basically, I was looking for a place where I could do something that was well grounded in math but contributing to a greater good and applying it to a public policy area. I converged on statistics Ph.D. programs and decided to go to



Fig. 2 Elizabeth Stuart with husband Brian Doyle at her Ph.D. graduation in 2004

Harvard. This was partly because of Mathematica's connection to Harvard's Department of Statistics, including to Don Rubin. I knew that he was doing the sort of work that might help me continue to work in the policy area. I enrolled in 1999 and worked with Don, graduating in 2004 (Fig. 2).

What was your graduate education like at Harvard?

I had a great experience. Harvard's statistics Ph.D. program is small, although we had the biggest cohort that had ever happened (at least up to that point) my first year, which was eight people. I entered with seven other people and we came from a variety of backgrounds, from all across the world and we had different types of interests. The nice thing is that we had this cohesive feeling of a cohort and I have many fond memories. Well, as fond as they can be when you're sitting in the statistics department library working on problem sets together, much of the time with my classmates Shane Jensen and Sam Cook in particular.

Since I did not take any statistics classes before I started my statistics Ph.D. program, I had a lot of catching up to do. I had never heard of maximum likelihood estimation and didn't even really know regression. I had run regressions at Mathematica but I did not know any of the theory underlying them. My classmates helped me through my coursework the first couple years, and when we would get harder assignments they would bring me up to speed.

The department is a small community, so all the faculty knew all the students and all the students knew each other, which was a really nice environment. One thing that was especially useful was that, after you passed your qualifying exams, the department required you to present on your research for 20 min twice a year. All the faculty and students would come, and it was stressful but it was also just so incredibly beneficial. You were, in a way, forced to make progress to have something to report on, but maybe even more useful was learning what the other students were doing. I think that helped contribute to a culture where you could focus on your own stuff but then learn little pieces about lots of other really important topics.

I am interested in your role models and mentors during your time at Harvard.

I knew it was likely I would be working with Don Rubin given our intersecting interests, and quickly converged on a dissertation focused on causal inference. Thus Don was a key role model. He was very influential in my thinking about the world, statistics, and how to apply statistics in the world. We have had many conversations on wide-ranging topics where I have learned a huge amount from him. I continue to consider him an important statistical role model to this day.

Alan Zaslavsky, who was on my dissertation committee, was similarly a role model both then and now. Beyond being amazingly smart with knowledge spanning a variety of topics, he also has an innate desire for social good. He made me question how we can operate in our lives, both our statistical lives and our personal lives, in a way that improves society. Alan came to my wedding in 2001 and is such a kind and generous person. I didn't work as closely with him as I did with Don, but I saw him as a role model in terms of finding a balance of really rigorous statistics applied to social good.

Gary King, in the Department of Government, was my third advisor in graduate school. He was one of those people involved in a large number of really interesting projects, and he helped me think about how to apply statistics to topics in government and political science. Maybe because of that, Gary also taught me a lot about how to disseminate statistical methods, help non-statisticians learn how to use methods in correct ways, and help make it easy for non-statisticians to do that.

3 Career

Talk about your career path after you finished your Ph.D.

When I was leaving graduate school I remained motivated by this desire to do applied statistics. I looked around at a variety of jobs where I knew applied work would be valued—both in academia and outside academia. I came back to Mathematica because of my incredibly positive earlier experience. I knew it was a great organization, had fantastic people, a mission statement I agreed with, and high quality work. I knew it would be a place where I would be happy. I was so fortunate that they are located in Washington, D.C., which was where my husband was already working very happily at his job. We considered moving and looked at positions across the country. But in the end, I was really excited about going back to Mathematica and I happily moved to D.C. During my post-Ph.D. time at Mathematica, I worked on interesting large-scale randomized experiments of public policy interventions. This included projects like Upward Bound, which is a program for disadvantaged high school students, and a reading program called Power For Kids.

At one point while at Mathematica, I gave a talk at Hopkins in the Department of Biostatistics and some people from the Department of Mental Health were there. They encouraged me to apply for their job opening. It never would have occurred to me to apply for a job in a Department of Mental Health; had I been doing a full-fledged job search, it would not have been part of my process to consider that job because I had absolutely no qualifications in mental health. But, as it turned out, they were looking for someone who could serve as a bridge between the Department of Mental Health and the Department of Biostatistics. They did a lot of school-based preventive interventions to try and improve the conditions of inner city kids and help improve behavior and later outcomes. Thus, they were really excited because I had knowledge and expertise about methods related to those topics, including randomized trials and statistical issues in education research, such as clustering of students within classrooms.

So I applied and got the job! It's been a great fit in the 10 years since then. It was a tough decision to leave Mathematica—I was happy at Mathematica, doing interesting work, and working with great people, but I ultimately decided it was worth a shot to try an academic career. I missed teaching, interacting with students, and having dedicated time and space to do my own methodological work.

What has it been like being primarily appointed in a non-statistics department as a statistician? At the time you joined the Department of Mental Health you were the only statistician.

For me, it has worked out well. I had been cautioned against joint appointments, but there are different kinds of joint appointments. My joint appointment is one where I am primarily in the Department of Mental Health, my “boss” is the Department of Mental Health chair, and my promotions were handled by the Department of Mental Health. I am not split in half across departments like some other joint appointments where you effectively have two “bosses.” That can be challenging.

Thus, the expectations for my position are fairly clear that I have one job: in the Department of Mental Health. The Department of Biostatistics is there in essentially a supporting role; they support me and I support them too. I teach courses in the Department of Biostatistics, which the Department of Mental Health appreciates and credits toward my



Fig. 3 Elizabeth Stuart, Dani Fallin, and Janet DiPietro from Johns Hopkins Bloomberg School of Public Health

teaching obligations. The environment is very supportive and collaborative and it has been easy to have the two departments work together to figure out how to make things work well for me, in part due to great leadership (Fig. 3).

So, my joint appointment has worked out as someone who wants to do applied statistical work, and, in fact, I now have a 3rd departmental appointment, in the Department of Health Policy and Management. I can write the sorts of papers I want, which are a mix of methodological development and tutorials disseminating statistical methods, which are highly valued. I can work on interesting problems and develop really close collaborations. I also want to fully give credit that the Department of Biostatistics has been welcoming since the day I arrived. I participate in faculty meetings and have office space there. I would have been nervous going to a Department of Mental Health if I didn't know that there was this very strong Department of Biostatistics two buildings over. They really have made me feel like a part of their community even if my primary appointment isn't in their department.

What resources or opportunities do you think were key to your success as an early career faculty member?

At Hopkins people are left to their own devices—in a good way. It's a vibrant environment, and there are a lot of smart people around with a lot of ideas. You are given the time to figure out where your passions and interests will take you. In the first few years especially, the teaching load is quite light, and that gives you a lot of time for research. You can quite easily find topics that are interesting to you methodologically, but are also important. This stimulating environment that prioritizes high quality research also has systems in place to help that, and many potential collaborators to contribute to and advance your ideas.

One thing that I personally have benefited from is networking and connections with people from other institutions. I go to a lot of conferences and have accepted maybe too many speaking invitations, but I think making those connections with people around the country who are interested in similar areas is important. I have grants now with people I have gotten to know mostly from seeing them at conferences. We had similar research interests and that has developed into NIH funded projects together.

I also don't think I realized how valuable I would find my early career colleagues both locally and at other institutions. It is absolutely critical for talking through career issues, like making decisions about where to submit papers and give talks, but also just to get a sense for what other departments are like. That's how you can find out what is reasonable or not reasonable, and maybe also appreciate the resources you might be taking for granted!

Who are your most significant mentors now?

I have been fortunate to have some really great support at Hopkins. When I arrived, Scott Zeger was chair in biostatistics and Bill Eaton was chair in mental health. Now Karen Bandeen-Roche is chair in biostatistics and Dani Fallin is chair in mental health. All four of them have been very supportive, and especially now as I am looking ahead, I still look to people like Scott, Karen, and Dani for career advice.

What two papers do you think others would say are your most notable? How did the ideas for those papers come about?

My most notable paper, the paper that people come up to me and say, "I love this paper of yours," is my 2010 paper in *Statistical Science* Stuart (2010). It is a literature review on propensity score matching methods. What cracks me up about that paper is that it was the "throw away" paper of my dissertation. I had two very clear papers. The first was a theoretical paper on conditions under which propensity score methods work. The second was an applied education example. We developed this interesting matching algorithm to deal with the fact that there are different locations and you need to balance both child characteristics and location (school) characteristics. So, I had those two papers and I needed a third paper. I decided to do a literature review. I think it was a well done literature review and there was a value in providing that overview. There hadn't been a cohesive comprehensive paper that tied together what was known up to that point in time so it really fit a need and has been well-received.

The other one that people also bring to my attention a lot is a 2011 paper in *JRSS-A* on methods to assess and enhance the generalizability of randomized trial results Stuart et al. (2011). In graduate school I did work on non-experimental studies, and understood very deeply how they work and what is both good and bad about a non-experimental study. At Mathematics, I got hands-on experience with randomized experiments in the real world and helped dig through the pros and cons of randomized experiments. That led to this research area of mine about how well we can generalize the results from randomized trials to target populations, accounting for the fact that often the people that participate in trials are not representative of the populations that we might really end up caring about for policy decisions.

What do you think is your most important paper? How did that paper develop?

For me, my favorite paper of my own is one with Kosuke Imai and Gary King from 2008 Imai et al. (2008). I like it because it provides an overarching framework for tradeoffs in causal inference and different study designs. Randomized trials provide internal validity. However, large scale non-experimental studies might actually be better for external validity. We provide a way to think about these tradeoffs, and if you're interested in population average treatment effects, point out that a small randomized trial may in fact be less helpful than a large-scale well done non-experimental study. That statement is fairly

controversial. A lot of people immediately say a trial is always better than a non-experimental study, but that's partly why I like that paper, because we were trying to push on that a little bit. And help people think beyond what their first intuition might be.

Your award at ICHPS honored mid-career achievements. What does mid-career mean to you and what do you see when you look forward in your career?

The nice thing for me is that I am mid-career, but I have also just been promoted to full professor, so I can look ahead without thinking about what I need to do to get promoted. I suppose mid-career in my mind would be around that horizon of promotion to full professor, for those in academia. Depending on what side of that you are on, it has slightly different meanings. Before that promotion, it's a time when you establish yourself in some ways and develop in others, building a body of research and a reputation. But now I can pause and think about where I want to go from here. You think about what you have been doing along the way, and whether, for the next 15 years, do you want to continue doing the same things or move in another direction. This could mean different research areas but also could be towards administration or teaching. In my case, I have decided to take on a part-time Associate Dean for Education role, which will enable me to maintain my teaching and research priorities, while also having the opportunity to help the School of Public Health think more strategically about teaching, be innovative in our teaching, and use data to better inform the educational enterprise.

4 The field of statistics

What do you think the data science revolution means for statistics?

I think the data science revolution is wonderful for statistics. However, we do need to remind people that statistics is a fundamental part of it since we aren't always included in those conversations. Even if they are doing statistics, the word just isn't used. It is really exciting to start seeing more discussion of data and how do we use data. All these different ways we can answer important questions using existing administrative data or new streams of data like Facebook feeds. There are opportunities to do statistics or data science in non-traditional jobs and non-academic jobs. I personally have very much enjoyed an academic career and I think there are a lot of benefits to it that will continue to be appreciated moving forward. My hope is that the new data science wave will increase the number of people working in statistics, some who will choose a non-academic path and others who will choose to stay in academia. If the excitement over data science and big data increases the pool of people learning statistics it will be win-win for the field and give statisticians more opportunities and more choices in their careers.

How have you seen statistics education evolve since you received your degree?

In general, I think there is a movement towards more applied experiences and attention to programming, including the nuts and bolts of data management and analysis. Not that people are spending time learning boring things, but just an appreciation that in order to do good statistical work, we have to learn how to transform data properly and then analyze it appropriately. In practice, we are not handed a nice clean matrix with no missing values.

The data are messy. That said, topics like missing data, survey design, and data analysis are not taught in a lot of places, and we should consider including them.

What statistical area related to your work do you think is the most debated?

Since I operate primarily in a more applied area, I am going to answer this with that angle. As someone who works in causal inference, I see firsthand very frequently the non-experimental study versus the experiment debate. There are some people who have it in their heads that a randomized experiment is always better than a non-experimental study, and that a non-experimental study is useless, always give misleading answers. That's a debate I follow closely and I think it is one that is not going away. One of my main interests is answering: "How do we help people understand the pros and cons of a given design for a particular research question?" We are never going to be able to have a rank ordering that says this type of study is always better than that type of study. It's going to be tailored more for the research question we want to answer and I hope to help people understand that.

5 Outside the academy

Do you have any advice about balancing work and family?

This is a matter dear to my heart. I have a husband and two small children; they are now five and seven (Fig. 4). Sheryl Sandberg recently wrote an essay about the importance of having a good partner. I would reinforce that message. What has made my work-life balance possible is having a partner who can pick up the kids if needed, or can stay home with them when they are sick. If I need to travel, he more than understands, since he understands that conferences and seminars are part of my job. He doesn't make me feel guilty and he is very supportive. Also, my parents have been very generous, and will come down and stay with him and the kids if I am gone for a longer period of time since he has his own demanding full-time job.



Fig. 4 Elizabeth Stuart with husband Brian Doyle and children Clara and Paul

Living in a supportive community has also been so helpful. We have neighbors and friends who I can call if I hit traffic, and they may be able to pick up my kids or take them to a birthday party. Having a community of understanding people who you can rely on, including family, friends, neighbors, and coworkers, is really important.

I think two key benefits of academic jobs (and some non-academic jobs) are that they are very flexible, and I love the fact that I am essentially my own boss. I have work I need to do, but if I want to spend Friday morning going on a field trip with my kids, no one is waiting for me to punch a time card or checking to see if I am in my office. I can make up the time that evening or on the weekend. Basically, I can arrange my schedule in a way that works for me in a very flexible way, which helps work-life balance.

What are your favorite activities outside of academia?

Currently, I am highly involved in my kids' school and education, and serve as co-President of the PTA there. I find it very rewarding and am happy to be involved with their school in a deep way (and it is particularly interesting to me since I do some education research). That said, I won't be devastated when my co-President term is up! I look forward to having more time to go back to some of the other things I like to do, like running and cooking. With two small kids my weekends are frequently taken up by birthday parties, soccer, and French classes, but I also try to fit in some runs and time with friends.

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Compliance with ethical standards

Conflict of interest The interviewer and interviewee declare that they have no conflicts of interest.

Ethical approval This article does not contain any studies with animals or human participants.

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