



Review of Wellcome Trust PhD Research Training

Career Paths
of a 1988–1990
Prize Student Cohort



The Wellcome Trust

Acknowledgements

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Copies of this report can be obtained on request from the Trust's Marketing Department (Tel: 020 7611 8651; Fax: 020 7611 8545; E-mail: marketing@wellcome.ac.uk) or from the Trust's website (www.wellcome.ac.uk/publications). Correspondence concerning scientific or academic issues arising from the report should be addressed to Dr P M Chisholm, Scientific Programme Manager, Career Development Section, Wellcome Trust, 183 Euston Road London NW1 2BE.

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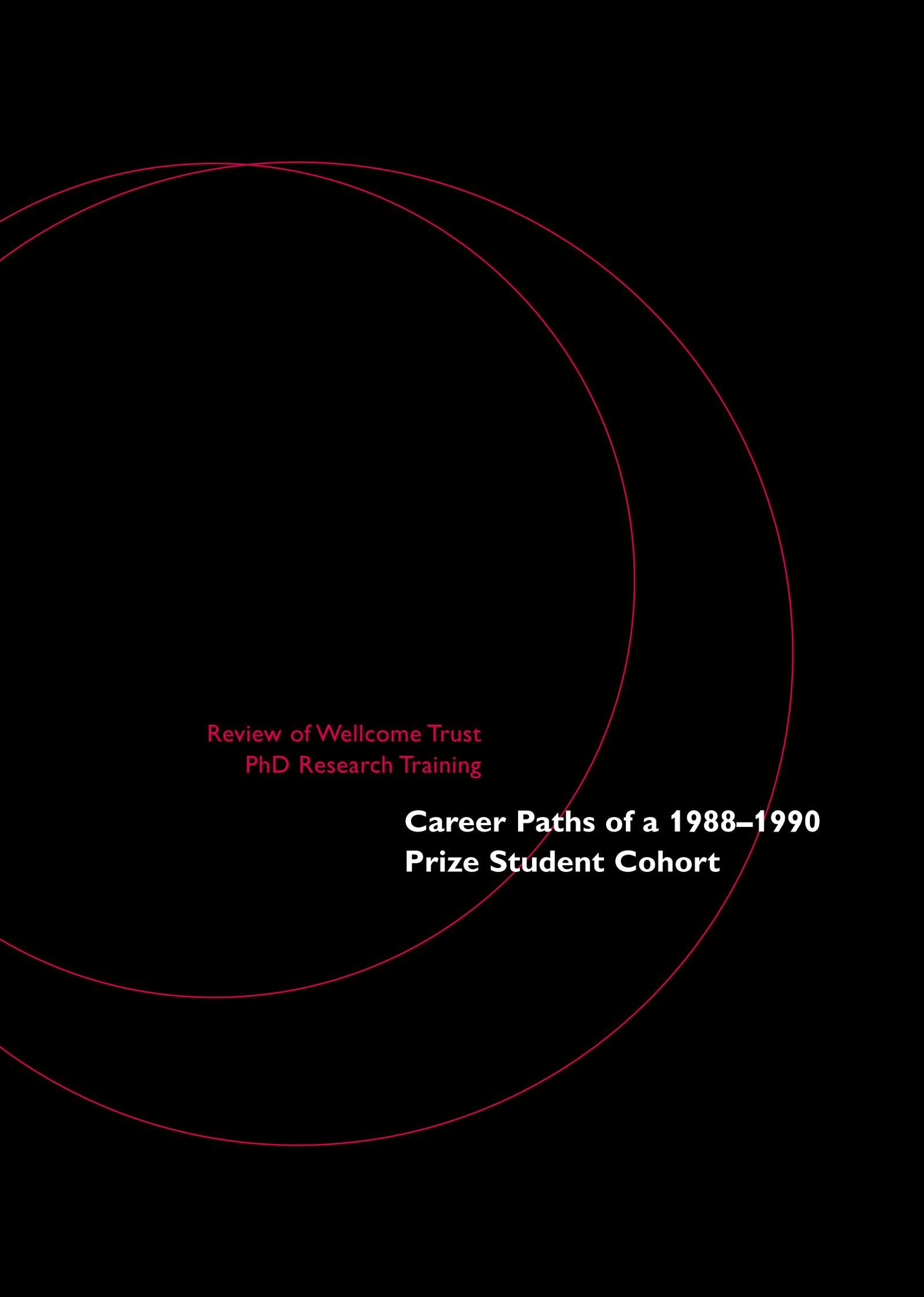
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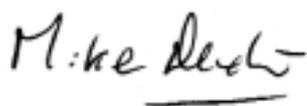
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Preface

The Wellcome Trust has a portfolio of personal award schemes which support individuals from the earliest stage of a research career to professorial level. The Trust recognizes the crucial importance of the type and quality of first postgraduate research training, the PhD, in providing students with an excellent grounding in the intellectual basis of scientific research endeavour as well as with the practical research skills which will equip them for a career in research. The Trust has provided formal PhD studentship schemes since 1986 and since then has maintained a diverse range of studentship awards. However, there are generic features common to all its studentships which ensure that Trust-funded students receive adequate personal financial support and are placed in excellent well-funded research laboratories where they receive high-quality research training and scientific and academic mentoring.

The Trust attaches considerable importance to assessing the outcome of its various personal support schemes and in monitoring the subsequent careers of the individuals it funds through them. This report on the careers of a cohort of past Trust-funded PhD students and its companion report on the opinions of current Trust-funded PhD students are the first parts in a series which will comprise a comprehensive review of Trust PhD research training. This report describes the research career outcomes of a group of Trust students who held Prize Studentships between 1988 and 1993 and provides important base-line information against which more recent as well as future Trust-funded students can be compared. The student perspective report presents the results of an opinion survey of current Trust students on many aspects of their PhD experience and is therefore a contemporary snapshot of life for some of today's postgraduate research students.

The two reports have provided important information for the Trust which will inform its internal policy-making processes, but it is hoped that their findings will also be of interest to a wider academic audience.



Dr T Michael Dexter FRS
Director, The Wellcome Trust
March 2000

Executive summary

All members of a cohort of Wellcome Trust-funded PhD students who received Prize Studentships between 1988 and 1990, allocated through a quota system to selected UK universities, were traced in spring 1999, and provided information on completion of their PhD and on their research careers since graduation. In addition, the research publication output of members of the cohort was measured from information provided from the Science Citation Index (SCI).

Key findings

- Some 92 per cent (125 out of 136) of the members of the cohort completed a PhD, almost all (81 per cent) within four years of the start of their three-year Trust studentship. Seven women and four men from a total of 58 women and 78 men resigned their studentship awards, all at a relatively early stage. No student failed at thesis examination or was asked to resubmit the thesis.
- The PhD research project resulted in contributions to an average of 2.9 original research publications in the scientific research literature (SCI), with 61 per cent of students contributing to between one and four original research articles. The great majority of these papers were published in the final year of the studentship or in the subsequent two years. A greater proportion of women than men (26 per cent compared to 12 per cent) did not publish from their PhD and the average number of publications resulting from their PhD projects was slightly lower (2.7 compared to 3.0).
- A substantial majority of the cohort (81 per cent) took a first postdoctoral position in academic research, although the proportion which remained fell to just under half (46 per cent) at the time of the survey. A significant proportion (18 per cent) is currently employed in the pharmaceutical or biotechnology industries. The majority (73 per cent) of those who left academic research are still working in science, medicine or health-related fields. More women than men left academic research, usually within the first three years. None of the cohort has been involuntarily out of work for any significant period of time.
- Substantial numbers of those who have remained in academic research (33 of 58) obtained postdoctoral academic research experience outside the UK – and, at the time of the survey, almost half (45 per cent) had returned to the UK. A significant number of those who remain in academic research in the UK today (27 of 40) have obtained research group leader status or command long-term research grant funding.
- For those who took a first position in academic research in the UK, over half (38 of 70) were supported by the Trust, either as research fellows or as postdoctoral research assistants. Of those individuals who are still Trust-funded (nine of 38) half hold Trust career awards or have obtained permanent academic appointments which have a predominant research component.
- On average, those individuals who held Trust Prize Fellowships immediately following completion of their PhD (31 of 125) doubled their research publication output during the period of their fellowship. This suggests that, by providing research continuity, these fellowships gave students a significant advantage at the start of their academic research careers.
- The cohort as a whole has contributed to 982 research publications (SCI) to date. The most prolific 10 per cent of the cohort has contributed 35 per cent of the total research publication output for the cohort. Of those who have remained in academic research, the women have had a substantially lower average publication output than the men (6.7 compared to 12.2 papers) over the five- to eight-year period since the end of their studentship.



one

Introduction

Introduction

This study traced the career paths of a cohort of 136 Wellcome Trust-funded PhD students who received Prize Studentships between 1988 and 1990. Detailed information was collected on thesis submission and examination dates, subsequent career positions and academic publication records. All Prize Studentships held by members of the cohort had a duration of three years, and the group had therefore between four and seven years of postdoctoral work experience at the time of the survey (spring 1999).

Provision of PhD research training at the Trust has undergone a number of changes since the introduction of the Prize Studentship scheme in 1986, in order to accommodate the changing circumstances and needs of both the academic research community and of the Trust. Until 1992, Trust Prize Studentships were allocated as a quota of places to selected universities. Each year, participating institutions were invited to nominate outstanding students in the biological sciences, or medical students who had undertaken an BSc Honours degree during their medical studies. The criteria used by the Trust to approve nominated individuals included the academic calibre of the candidate, the scientific merit of the proposed research project and the suitability of the proposed academic supervisor(s). As a result of an internal review of the scheme, Trust Prize Studentships were allocated from 1992 onwards to holders of Trust major research awards and the quota system was phased out between 1992 and 1995. By associating Prize Studentships with holders of programme grants or senior fellowships, the Trust believed it could better ensure that students were placed in well-funded research environments where superior facilities, training opportunities and scientific mentoring would be available to them. Between 1994 and 1996 the Trust established a number of Four-year PhD Programmes, which introduced an additional, and qualitatively different, first year of graduate training, during which students acquire research skills during short laboratory rotations and are provided with some taught course work. The first Four-year Programme was established at the University of Liverpool in 1994 and a further four Programmes were set up in 1996. Seven new Programmes are to recruit their first students in October 2000.

The diversity of studentship types provided by the Trust over the past ten years makes it important that they be reviewed in terms of the outcomes for the students and for the Trust. As a funding organization, which places most of its research grant funding in universities, the Trust considers it important to identify what proportion of its students remain in academic research and for how long, and what motivates those who leave the academic sector for other research careers. This survey of students who held their Trust awards five to eight years ago has provided important information for the Trust on the outcome of its funding and on the subsequent career choices of young research scientists. The methods used in the survey and the structures devised for analysing the information obtained have provided a blueprint for future analyses of outcomes for Trust students and the results obtained have provided a benchmark against which the outcomes of the Trust's different and more recent PhD schemes will be measured.



two

Aims and methods

Aims and methods

The objective of the study, which was carried out in spring 1999, was to gain some measure of the outcome of the Wellcome Trust's investment in postgraduate training, focusing on the career progress of a cohort of Prize Students who received awards between 1988 and 1990. By locating and contacting members of the cohort directly, it was possible to determine what proportion of the cohort has remained in academic research, to identify the alternative careers of those cohort members who did not remain in research and to obtain information on individual career choices. Using the Science Citation Index (SCI) combined with information about cohort members whereabouts, it was possible to identify the research publications to which they had made contributions over the past 11 years. For the Trust this project has served as a pilot study of the logistics of assessing the outcome of its personal support schemes.

2.1 Tracing members of the cohort

Some 125 members of the cohort obtained a PhD and every effort was made to contact these individuals in order to obtain information about their subsequent careers. In the case of 11 individuals who did not complete their training or submit a PhD thesis, the academic supervisors were contacted for information. In three cases, the individuals were contacted directly.

The Wellcome Trust's own grant records provided details of the original Trust studentship award and identified both the host institution and the academic supervisor(s). The 'final report' submitted by supervisors at the termination of the studentship usually identified the first work destination of the student and when contacted directly, supervisors were almost always able provide some details of the student's subsequent career and present whereabouts. If the supervisor could not be contacted, information was usually available either from the host department or from past colleagues in the laboratories in which the students had worked.

A preliminary Science Citation Index search from 1989 to 1998, was conducted for each member of the cohort, as a first attempt at identifying those who had remained active in research. This also provided additional information about where individuals had worked in subsequent years.

University websites provided useful information about individuals who remained in academic research. If individuals moved to the commercial sector, company details were obtained using Internet directories or telephone directory enquiries. If the individual had subsequently moved, then the personnel department or other employees of the companies were contacted. Companies were understandably reluctant to provide information directly but often offered to contact the individual on behalf of the Trust.

The British Expertise in Science and Technology (BEST) and Current Research in Britain (CRIB) databases provided some useful information for members of the cohort who had remained in academic research, although these data were not always complete or up to date.

On locating the whereabouts of cohort members, individuals were contacted and asked to provide information on their research career to date. Some 114 individuals (84 per cent of the cohort) were located and contacted. Approximately half were interviewed directly by telephone and half were contacted by e-mail, using a standard format questionnaire (see **Appendix A**). Similar information was requested in the telephone interviews – although the structure was not always rigorously adhered to and interesting perspectives were followed up. Every member of the cohort who was contacted directly was pleased to participate in the study.

2.2 Analysis of research publication data

A second and more comprehensive SCI search was carried out using the more accurate information obtained from members of the cohort about their subsequent posts, their research subject areas and their research collaborators. This enabled papers to be assigned to individuals with greater certainty and, in this way, a full publication profile was obtained for each member of the cohort.

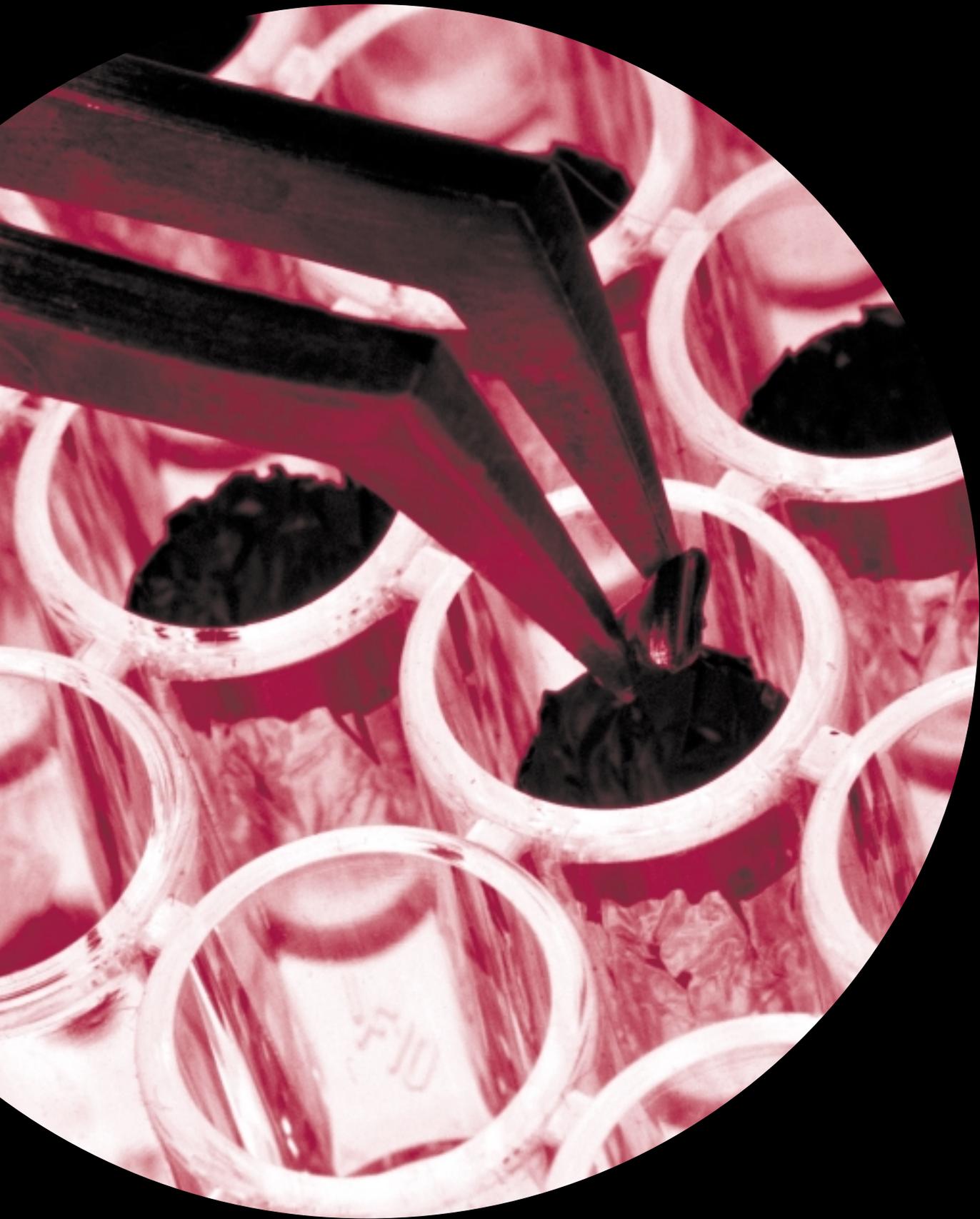
Attribution of research publications to PhD projects

Research publications were attributed to the PhD research projects if: (1) the cohort member and PhD supervisor were authors and the subject area was appropriate; (2) the publication appeared in print during the period of the studentship or was published within one year of the start of the student's first postdoctoral position; and (3) the paper was from the institution address at which the studentship had been held.

Some difficulties arose in attributing publication accurately to PhD research projects if students remained in the same host institution or laboratory working in the same subject area, or subsequently returned to it. Strict adherence to the above criteria may, therefore, have underestimated the numbers of contributions made by those individuals. For students who immediately left the laboratory and host institution at which the studentship was held and did not subsequently return, publications were included which appeared at any time later, provided that (1) the subject area was appropriate; (2) the PhD supervisor as well as the cohort member were co-authors; and (3) the paper included the address of the original host institution but did not include any institution where the cohort member subsequently worked.

Attribution of research publications to Prize Fellowship holders

For the 31 individuals who received Prize Fellowships from the Trust in order to remain in the same laboratory to extend the work of their PhD, a combined estimate was made of papers which could be attributed to either the studentship or the fellowship. In this case, the combined total included all papers (1) on which the cohort member was an author and on which either the PhD supervisor or fellowship sponsor were co-authors; (2) which included the address of the host institution; and (3) which were published between the start of the PhD studentship and one year after the end of the Prize Fellowship.



Results

3.1 Cohort characteristics

In the three-year period 1988–1990, a total of 136 Prize Studentships were awarded, to 58 women and 78 men (Table 3.1). The larger number of men than women was due to a disproportionate number of men being awarded studentships in 1988 than in subsequent years, when the numbers were very similar.

Table 3.1 Numbers of men and women comprising the cohort by year of award

Year of award	Sex		Total
	F	M	
1988	13	27	40
1989	20	23	43
1990	25	28	53
Total	58	78	136

The majority of Prize Students in the cohort (86 per cent) were under 25 when they began their studentship and a substantial proportion (68 per cent) were aged 22 or under (Table 3.2). It is likely, therefore, that most students started their PhD studies soon after completing their first degree. There was no difference in the age distributions of the male and female members of the cohort as a whole – the mean age at the start of their PhDs was 22.5 for men and 22.6 for women.

Table 3.2 Age distribution of the cohort

Age at start of PhD	Sex		Total
	F	M	
20	1	2	3
21	21	32	53
22	13	24	37
23	7	6	13
24	6	5	11
25–29	6	4	10
30 or above	2	5	7
Unknown	2	0	2
Total	58	78	136

3.2 PhD completion

3.2.1 Completion rate

Very few individuals did not submit a PhD thesis (**Table 3.3**). The overall completion was greater than 90 per cent, although more women than men failed to complete their PhDs.

Table 3.3 Proportion of the cohort submitting a thesis

	PhD thesis submitted		Total
	Yes	No	
Male	74 (94.8%)	4 (5.2%)	78
Female	51 (87.9%)	7 (12.1%)	58
Total	125 (91.9%)	11 (8.1%)	136

Of the 11 individuals who did not submit, eight resigned their studentships within the first two years. The reasons given either by the individuals themselves or by their academic supervisors included illness, maternity and, most commonly, a fairly rapid realization that they were unsuited to research. One individual elected to complete a Master's degree instead of a PhD. Of the group who failed to complete, four started medical degree courses. The others took up careers in information technology (IT), pharmacy, publishing and science administration.

3.2.2 Completion time

Completion time was measured from the start date of the Prize Studentship award to the date of the student's viva examination, since this was the date individuals most reliably remembered – many could not recollect accurately the date of submission of their thesis. All members of the cohort who submitted their PhD were recommended for the award of a PhD on examination and none was asked to resubmit.

Over half of the students who completed (55 per cent) were examined and recommended for award of a PhD within three-and-a-half years of starting their studentship (**Figure 3.1**), and 81 per cent completed within four years. Within five years, that is two years after the end of the studentship, the completion rate had risen to 95 per cent. These results for Trust-funded students are broadly comparable to published results from the UK Research Councils (**Table 3.4**). Six individuals in the Trust cohort took longer than five years, of whom two had taken substantial breaks during the period of their studentship. Many of those who took longer than four-and-a-half years began a first postdoctoral position before submitting their PhD thesis and several encountered substantial delays between thesis submission and examination.

Table 3.4 Five-year completion rates for Research Council and Wellcome Trust students

Funding agency	Year of start of studentship		
	1988	1989	1990
Wellcome Trust	93% (40)	88% (43)	81% (53)
MRC [†]	77% (231)	88% (322)	72% (393)
BBSRC ^{*‡}	-	-	84%
EPSRC ^{*§}	-	81%	80%
SERC ^{*¶}	80% (2631)	-	-

Source: The Wellcome Trust, DTI, OST

* Data not available.

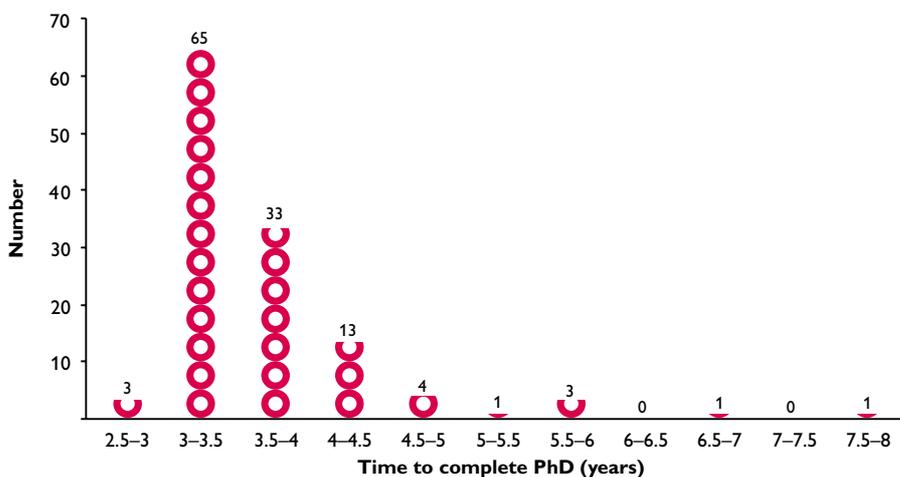
† Medical Research Council.

‡ Biotechnology and Biological Sciences Research Council.

§ Engineering and Physical Sciences Research Council.

¶ Science and Engineering Research Council.

Figure 3.1 PhD completion time

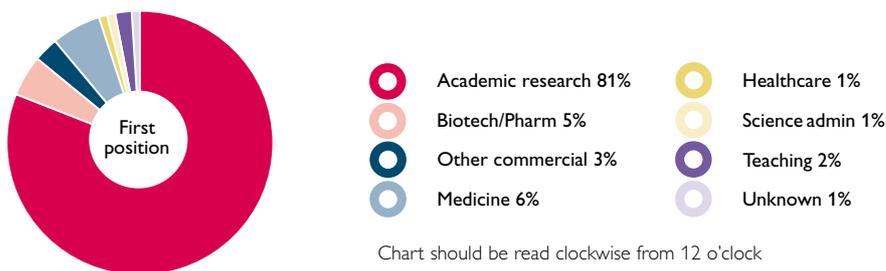


n=124 (of 125 students who completed their PhD). Time is measured from the start of Trust award to successful PhD examination

3.3 Career destinations

The career destinations of the 125 members of the cohort who completed their PhD degree are presented in Figures 3.2a, 3.2b and 3.2c. **Figure 3.2a** identifies the first postdoctoral positions of the cohort, **Figure 3.2b** shows the career destinations of the cohort three years after the date individuals took up their first postdoctoral appointment, and **Figure 3.2c** shows the careers of the cohort at the time of the survey (spring 1999), that is five to eight years after termination of their Trust studentship, or four to seven years after taking a first postdoctoral position. Two individuals had not completed three years of postdoctoral work at the time of the survey and are not therefore included in the data in Figures 3.2b and 3.2c.

Figure 3.2a First postdoctoral positions

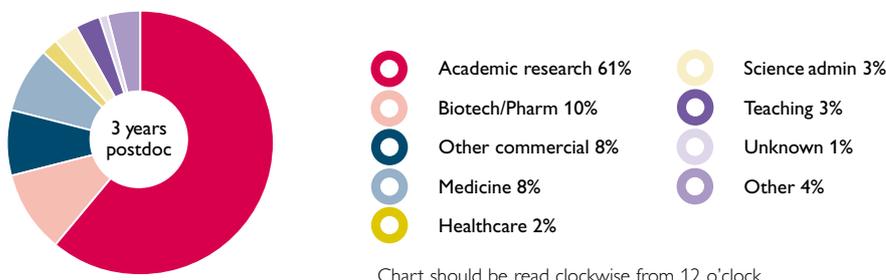


3.3.1 The departure from academic research

Just over 80 per cent of the cohort took up a first position in academic research upon completing their PhD. Three years later, this figure had fallen to just over 60 per cent. At between four and seven years after taking up a first postdoctoral position, less than half of the cohort (58 individuals) remained in academic research.

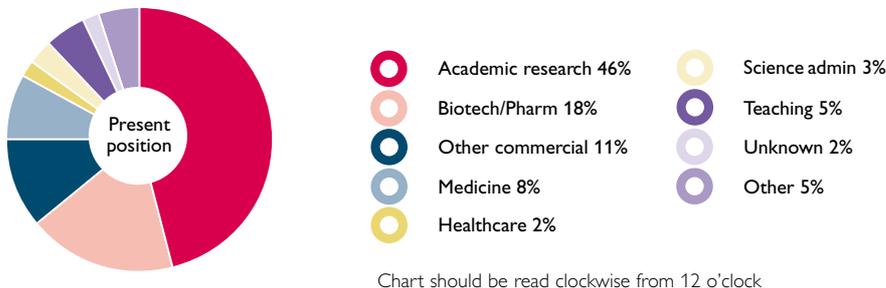
Of the 58 individuals who remained in academic research in 1999, several held permanent positions in research institutions and had reached group leader status. Some 41 either had permanent positions or held long-term research grants or fellowships.

Figure 3.2b Positions of cohort at three years



Members of the cohort who elected to leave academic research consistently identified three reasons for doing so: Many cited the lack of job security inherent in short-term academic contracts and the need to apply for research funding continually. Another reason often cited was the lack of a defined career path or career structure in academia. The third, and almost universal, reason was that academic research was underpaid when compared to the salary opportunities available elsewhere, for example in the commercial sector. In addition to the issues of salary, job security and career prospects, a number of individuals stated that a primary factor influencing their decision to leave academic research was an unfavourable research climate in the academic community.

Figure 3.2c Positions at the time of the survey



Individual comments on this issue, which are representative of the views of many of the cohort, are included here:

- One individual who left academic research after three postdoctoral years:

“My decision was influenced by the difficulty of getting grants to carry out research in academia and the constant financial pressure behind novel research, together with low academic salaries. Having written many postdoctoral fellowship grant applications, the thought of having to do this constantly to fund a lab was not appealing.”

- One woman left academic research for a career in publishing after three years:

“I decided to move away from academic research as I wished to have a job with more security, job satisfaction and prospects. After not very successful PhD and postdoctoral projects in terms of publications, due I feel to no fault of my own, I felt that I had very little or no future in academia.”

- One man who left academic research after one year stated:

“I very much enjoyed academic research. However, career prospects are perceived to be poor. There appears to be little opportunity for people like me (highly productive researchers) to actually make a career out of doing high-quality research.”

- One woman who left academic research after one year said:

“I left mainly because I had become very disillusioned. Academic research is very competitive and appears to attract personalities which are extremely egotistic. It appeared to me that academics don’t as a rule aim to achieve a project goal or to achieve a scientific result but to concentrate on personal goals instead. In short, I did not like to work in such an atmosphere.”

- One member of the cohort, who left academic research after five years, succinctly made an important point:

“My personal opinion is that it is a tragedy for these individuals to have to give up something they love doing in order to have a reasonable home life, some sort of reasonable salary compensation and some job security. None of the people I know in this position were looking for a free ride but rather to be treated reasonably and honourably in their educational/research careers.”

3.3.2 The movement from academic research to industry

A significant proportion of the individuals who left academic research during the four- to seven-year period following completion of their PhD are now working in the industrial sector; for pharmaceutical or biotechnology companies. Although only 5 per cent of those who completed their PhD went to industry for their first position, this had increased to 18 per cent by the time of the survey.

The handful of individuals who went into industry, either immediately after finishing their PhDs or within one postdoctoral year, said that they had been attracted to the industrial environment by greater opportunities for teamwork and greater work variety as well as better facilities for their chosen research. Those who entered academic research on completing their PhD but moved to industry after two or more postdoctoral years, commonly stated that they had become increasingly disillusioned with academic research and that their move to industry had provided them with a career structure, greater job security and a substantially larger salary. In addition, a smaller number of individuals said they had been attracted to the pharmaceutical industry because they wanted to do clinically orientated research which had a more direct impact on healthcare. A number of individuals who left academic research for industry after three or more postdoctoral years would have preferred to remain in research in an academic environment, but found the offers they obtained from industry too good to turn down.

- An individual, who entered the industrial sector after one postdoctoral year in academic research, said:

“My reasons for leaving academia were the challenges of industry and working with the latest technology to tight-limit time-scales. Despite the kind sponsoring of the Wellcome Trust, funding in academia seems increasingly hard to get and only several key institutes can compete with the resources available in a commercial environment.”

- Another individual who also left academic research after one year stated:

“I’m result-orientated and perform much better under pressure working to short-term deadlines... working in academia I missed the interaction with other people as part of a team. Business has provided many opportunities for project-based teamwork.”

- One individual who left academic research after four years said:

“...although I feel intellectually under-challenged, I am very happy with the salary ‘package’ I have and the opportunities that abound in the clinical sector. I do miss the basic science endeavour and in all honesty would have preferred to remain in that environment. However, under the current climate I have no doubt I made the correct decision.”

- One individual, after a three-year academic research position in Switzerland, decided to return to an industrial position in the UK:

“The reasons for leaving academia are multifold: a desire to return to the UK, financial incentive, immediate scientific accountability. That is, I’ll work on something that affects enough people, that is commercially profitable to research, and hopefully a dilution of the over-competitiveness, wasteful duplication of effort and ego that presides over most academic research today.”

- One individual who completed seven postdoctoral years in the USA and made the decision to leave a long-term NIH grant to go into industry said:

“...of course industry is far more lucrative than academia. The adage that scientists do it for the love not the money gets old!”

- One individual said that, after four years in academic research:

“I made tentative enquires in the private sector (essentially to determine if I was marketable) and was astounded by the responses I obtained both in terms of number of responses and in salary and benefits offered.”

- A researcher who left academic research after five years stated:

“I moved to industry because I felt I would gain more. I was approached by [X] and felt I couldn’t turn it down. Overall, it outweighed staying in academia.”

Although almost all the individuals who left academic research for industry have remained in the industrial sector; three individuals spent some time in industry before taking an academic appointment.

- One individual who worked for a biotechnology company for six years before taking a permanent academic post said:

“I did not want to go through the postdoc system and liked the stability of industry. I returned to academia having bypassed the postdoc system and got the position I wanted.”

- Another individual worked in industry for only one year before returning to academia said:

“I entered industry because I was given the opportunity to head my own group performing basic research...however...the [commercial] climate changed so I looked for a position back in academia where I felt I could pursue my research interests more successfully.”

3.3.3 Careers in medicine

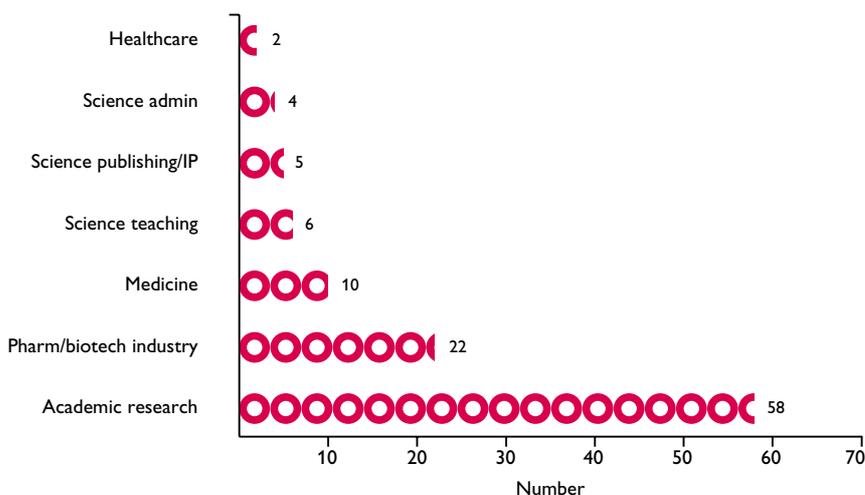
The Trust has a Research Training Fellowship scheme designed to enable medical and dental graduates to undertake PhD research training following completion of their medical training. However, a small numbers of medical students elect to intercalate a PhD within their medical degree, usually between the preclinical and clinical years. The Prize Student cohort contained nine intercalating medical students, seven of whom were men. Eight completed their PhD and returned immediately to their clinical training, and one individual took a short postdoctoral research position before doing so. One student resigned her studentship after two years and returned to medical school.

3.3.4 Other career destinations

A significant number of individuals left the academic sector and took up careers outside research. Thirteen individuals (11 per cent) were currently employed in the commercial sector, outside the pharmaceutical and biotechnology industry, in business or finance, and in science publishing and intellectual property work. Other career destinations included teaching of science at secondary school or higher education level, science administration and healthcare, including pharmacy and regional health work. Individuals who have left paid employment, either through choice or because of ill health, are included in the category 'other' (Figure 3.2c).

In summary, although the majority of the cohort no longer works in academic research, a substantial proportion is still active in research and the great majority of individuals continue to work in related fields of science, medicine and healthcare (Figure 3.3).

Figure 3.3 Cohort members working in science and medicine in 1999



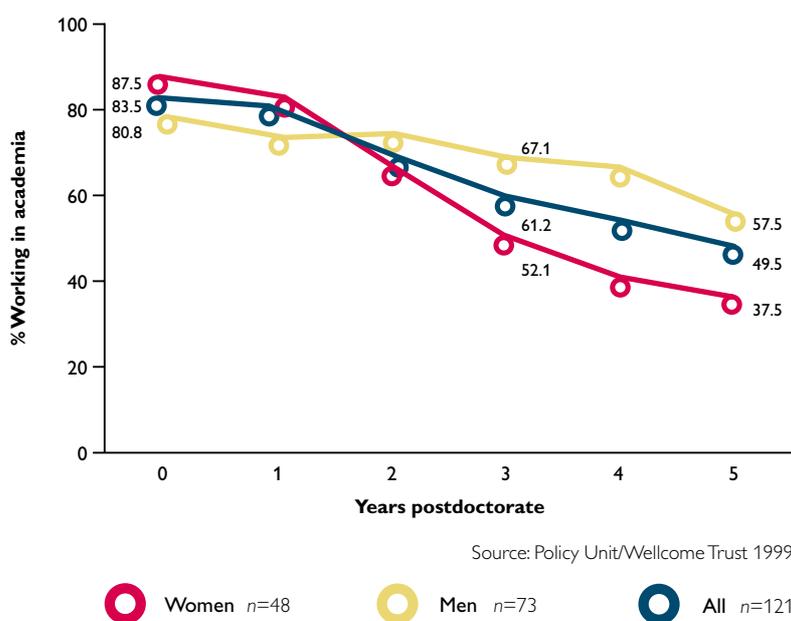
3.4 Academic research career profile of cohort

This section focuses on the research careers of those members of the cohort who remained in academic research. The first section describes the differences in the numbers of men and women who remained in academic research, the second and third sections examine research experience gained outside the UK and the sources of research grant funding held by individuals during their postdoctoral careers, and the fourth presents an analysis of the research output of the cohort in terms of contributions to research publications.

3.4.1 Differences between the academic research careers of men and women

For the 121 individuals (73 men and 48 women) who obtained a PhD and had completed five postdoctoral years by the time of this survey, the proportion that remained in academic research steadily diminished with each successive postdoctoral year (Figure 3.4).

Figure 3.4 Proportion of men and women remaining in academic research over five postdoctoral years



More than 80 per cent of individuals took a first position in academic research and there was only a small difference between the numbers of women and men who did so. The slightly higher proportion of women in academic research at the outset is accounted for by the fact that all but one of the eight medical students who immediately returned to medical school were men.

For the cohort as a whole, there was a progressive decrease, to just under 50 per cent at five years postdoctorate, in the proportions of individuals who remained in academic research. The decrease was more pronounced and more rapid for women than for men – after five postdoctoral years, less than 40 per cent of the women in the cohort remained in academia, compared to over 55 per cent of the men. The departure of women was particularly marked at between one and three years.

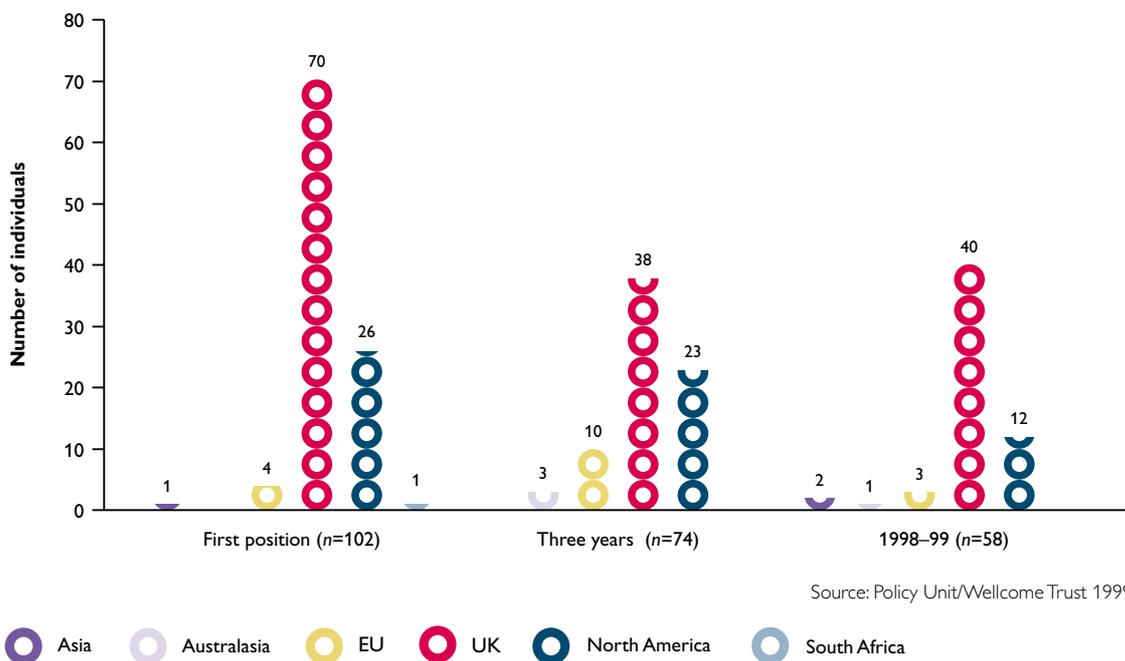
Seven of the 48 women in the cohort left academic research positions to have children and have not returned to research. A number of these women stated that the demands of a career in academic research were simply not conducive to having a young family and that other career options, such as teaching or scientific writing, became more attractive. This view was shared by one man who left academic research for intellectual property work:

“We had just had our first child and I felt that bench research with the long hours (previously happily given) was less attractive when combined with family responsibilities.”

3.4.2 Postdoctoral experience outside the UK

The geographical locations of members of the cohort at first postdoctoral position, after three postdoctoral years, and between four and seven years after taking their first position are illustrated in **Figure 3.5**. Of those who remained in academic research, just over two-thirds (70 of 102) took a first position in the UK. A further quarter (26 of 102) took up postdoctoral positions in North America (USA or Canada). Three years later, the proportion of academics working in the UK was 51 per cent (38 of 74), while the proportions working in North America and elsewhere in Europe had increased. By 1999, the proportion working in the UK had risen to over two-thirds (69 per cent; 40 of 58) and just less than a quarter (21 per cent) were working in North America.

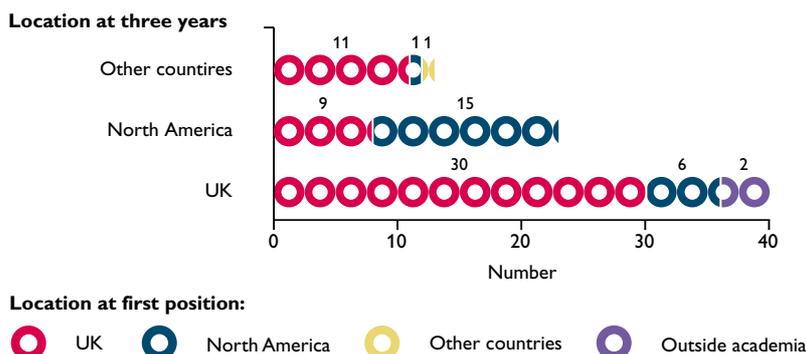
Figure 3.5 The geographical location of academics at first, three years and current position



Figures 3.6a and **b** illustrate the movements of individuals between postdoctoral positions in different countries. Of the 70 individuals in the UK at their first postdoctoral position, 30 remained in academic research in the UK at three years and 19 left the UK in the subsequent three-year period to take up research positions overseas (**Figure 3.6a**). Twenty-one individuals left academic research over the same period.

Of the 32 researchers working overseas in their first position, only six had returned to academic research in the UK at three years and 17 remained in academic research at overseas institutions (Figure 3.6a). Nine individuals working overseas for their first position left academic research during that time.

Figure 3.6a Three years postdoctorate



A number of individuals who left academic research after completing postdoctoral positions abroad, described how they found conditions for academic researchers in the UK inferior to those in the country in which they had worked.

- One individual, who received a Wellcome Prize Travelling Fellowship to South Africa and left academic research after completing a third postdoctoral year in the UK, said:

“The factors that induced me to leave academic research were multiple. One was the shock of trying to survive on a postdoc salary in Oxford – even a comparatively generous Wellcome one – after enjoying quite a comfortable standard of living in South Africa, where the exchange rate is increasingly favourable.”

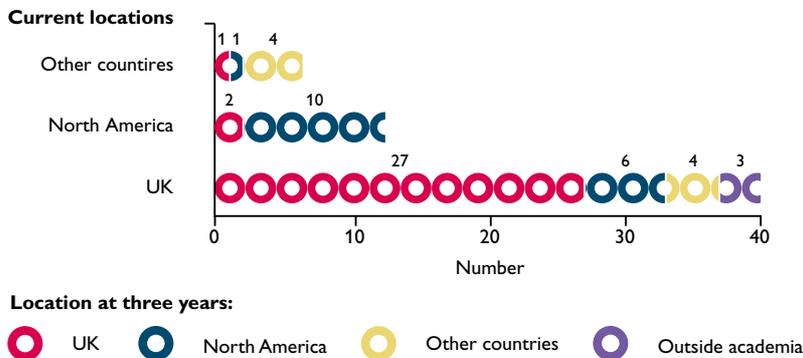
- One woman completed a two-year research position in Sweden and left academic research for a career in science administration on returning to the UK, citing:

“Poor career structure, poor pay, poor status of universities. Equipment is also far inferior in UK universities.”

These data show that a significant number of academic researchers left the UK between one and three years after completing their PhD. Of the 49 individuals who took a first postdoctoral position in the UK – and were still in academic research three years later – 19 had moved abroad. Very few of those who went abroad for their first postdoctoral position had returned to the UK at three years.

In spring 1999, at the time of the survey, 40 of the 58 individuals in academic research (69 per cent) were located in the UK (Figure 3.6b). This group comprised 27 individuals who had been working in the UK at three years, ten who had returned to the UK from elsewhere, and three who returned to academic research from industry and medicine. Fifteen individuals currently in academic research in the UK had held at least one postdoctoral position outside the UK. Of the 18 academics currently working outside the UK, only three had been working in the UK at the three-year stage. Nine individuals currently in academic research positions outside the UK have remained overseas for their entire postdoctoral career.

Figure 3.6b Current postdoctoral locations



Between four and seven years after taking a first postdoctoral position, a significantly greater proportion (71 per cent compared to 51 per cent) of those individuals working in academic research were located in the UK than was the case at the three-year stage. Only three individuals who were working in the UK at three years have since left the UK. The majority of individuals who worked outside the UK, therefore, did so within the first three postdoctoral years. A significant proportion (ten of 25) of those individuals who were working outside the UK at the three-year stage have since returned to the UK, although just over half have not.

3.4.3 Sources of funding

Figures 3.7a, b and c identify the funding sources of those members of the cohort who were working in academic research at first position, three years after taking their first postdoctoral position and at the time of the survey.

Thirty-eight of the individuals who took a first UK position were funded by the Wellcome Trust, with the Research Councils providing the majority of support for the remainder (Figure 3.7a). Six individuals were funded by the Trust through its International Prize Travelling Fellowship scheme to spend two years in research outside the UK before returning to a UK research position for a further year.

Figure 3.7a Source of funding for first postdoctoral position

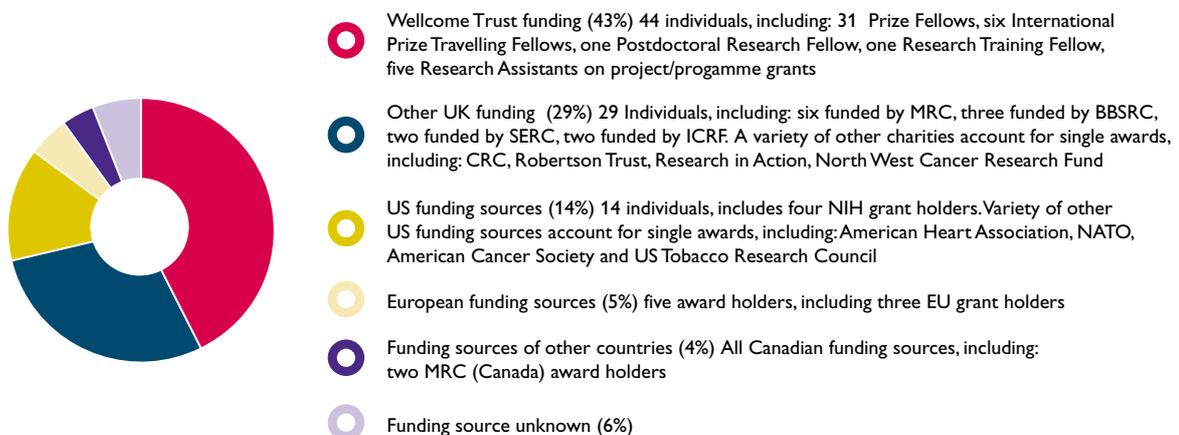
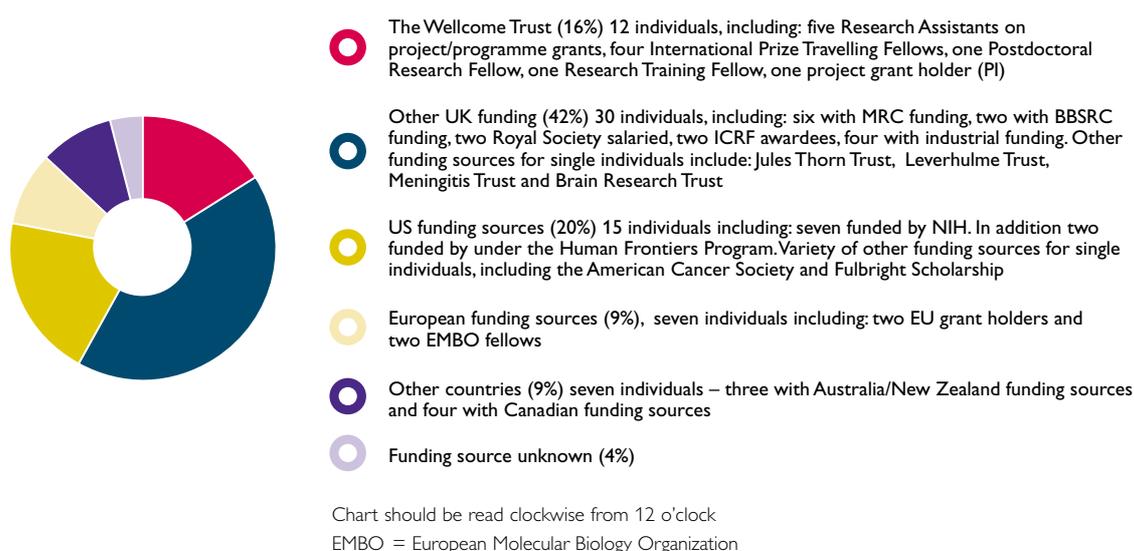


Chart should be read clockwise from 12 o'clock

ICRF = Imperial Cancer Research Fund
 CRC = Cancer Research Campaign
 NATO = North Atlantic Treaty Organisation
 EU = European Union

At three years, when just over 50 per cent of the cohort (38 individuals) working in academic research was based in the UK, the Trust supported nine individuals, with the remainder in receipt of funding from a range of other UK funding sources including the Research Councils and a number of biomedical charities. (Figure 3.7b). Four individuals were supported by Trust International Prize Travelling Fellowships at this stage.

Figure 3.7b Source of funding for academics at three years



In 1999, four to seven years after taking up a first postdoctoral position, 11 of the 40 individuals working in UK academic research were Trust funded (Figure 3.7c). Five individuals were employed on Trust project or programme grants, three were principal investigators (PI) on Trust project grants and held permanent academic appointments, and three had obtained Trust Career Development Fellowships. The majority of individuals who remained in UK academic research were funded either by Research Councils or other Government funding sources. Eleven individuals cited their host institution or Higher Education Funding Council as their source of support, which suggested that their primary role was in teaching rather than research.

Figure 3.7c Source of funding for academics in 1999



The Wellcome Trust contribution to postdoctoral grant support

The Wellcome Trust's contribution to the support of those who remained in academic research, either as project/programme support or as fellowship support, ranged from 43 per cent of individuals at first position to 16 per cent at three years and 19 per cent at four to seven years (Figures 3.7a, b, c).

Thirty-nine individuals obtained Trust postdoctoral fellowships for their first position, six obtained Trust fellowships for their second position and three obtained Trust Career Development Fellowships between four and six years after obtaining their PhD (Table 3.5). The majority (31) of Trust fellowships held were Prize Fellowships, which are available only to Trust PhD students and provide an opportunity for individuals to capitalize on the results of their PhD research by remaining in the same host laboratory for a short period of time. Other Trust postdoctoral fellowships which are available for individuals within a few years of obtaining a PhD are specifically designed either to allow individuals to carry out research outside the UK (Prize Travelling Fellowships) or to obtain advanced research training in the UK (Postdoctoral or Research Training Fellowships). Thirteen members of the cohort obtained Trust fellowships of this kind.

Table 3.5 Wellcome Trust awards to members of the cohort

Award type	1st postdoc position	2nd postdoc position	3rd/4th postdoc position
Prize Fellowships	31	-	-
Prize International Travelling Fellowships	6	2	-
Research Assistant (project or programme grants)	5	7	-
Postdoctoral Research Fellowships	1	1	-
Advanced Research Training Fellowship	1	-	-
Research Career Development Fellowship	-	1	2
Project grant (principal investigator)	-	1	3
Total	44	12	11

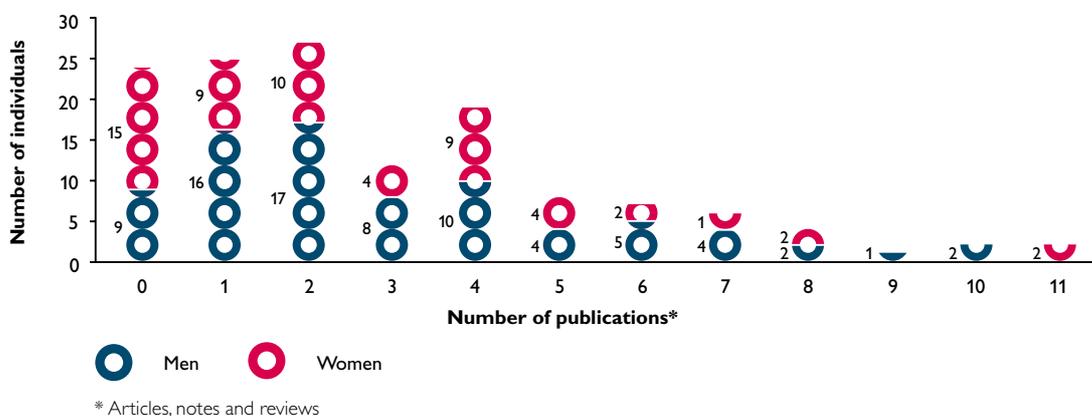
Eleven members of the cohort obtained positions on Wellcome Trust project or programme grants for their first and/or subsequent postdoctoral positions.

3.4.4 Research publication output

(i) Research publications attributed to Trust studentships

Research publications on which a member of the cohort was an author were attributed to the PhD research project if they appeared in print during the period of the studentship or were published within one year of its termination and were from the institution address at which the studentship was held. (Figure 3.10).

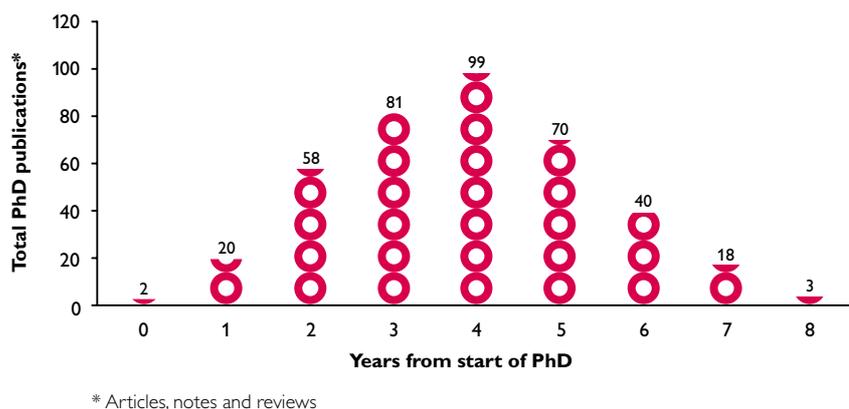
Figure 3.10 Publications assigned to the Prize Studentship



A total of 391 publications, 40 per cent of the total cohort publications, could reasonably be attributed to the research carried out during the PhD studentships, with an average of 2.88 publications per student (2.65 for women and 3.03 for men). Of these, just over half (54 per cent) were first-author publications. Twenty-nine members of the cohort (18 men and 11 women) contributed to five or more articles from their PhD research. The research projects of 24 individuals did not result in a publication – this was true for 12 per cent of the 78 men and 26 per cent of the 58 women in the cohort.

Less than half the papers (41 per cent) attributed to the PhD projects were published before the end of the studentship (Figure 3.11). The majority appeared either in the final year or within two years of the end of the studentship.

Figure 3.11 Publication date of papers assigned to PhD



(ii) Publications attributed to Prize Studentships and Fellowships combined

The numbers of publications which could be attributed to either the studentship or to the subsequent Prize Fellowship were analysed for the 31 members of the cohort who remained in the host laboratory for a short period in order to extend their PhD research work.

A total of 196 publications could be attributed to these individuals, who made a contribution to, on average, just over six (6.32) publications. Half of these publications (98 of 196) were attributed to the studentship and half to the fellowship, although it was difficult to attribute some publications accurately to one or other award.

The differences in publication output over the period 1989 to 1998 of individuals who received Prize Fellowships and those who did not, are presented in **Table 3.8**. Although the numbers of papers attributed to the studentships of both groups are essentially the same, those individuals who held Prize Fellowships have subsequently been more productive.

Table 3.8 Publication output of Prize Fellows and non-Prize Fellows

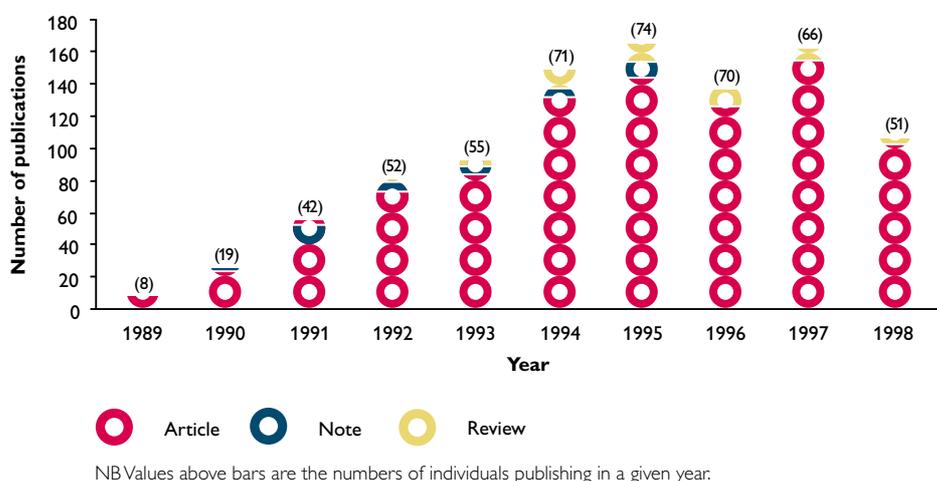
	Prize Fellows (31)	Non-Prize Fellows (94)
Average number of PhD publications	3.16	3.06
Average total publication number to 1998	9.42	7.24

(iii) Research publications of the cohort from 1989 to 1998

By the end of 1998, the 136 members of the 1988–1990 Prize Student cohort had contributed to a total of 982 articles, notes and reviews in peer-reviewed journals (**Figure 3.8a**). The number of publications on which cohort members were authors increased each year from 1989 to 1995, that is from within a year of the first studentship awards until between two and four years after the termination of their studentships. This annual output was sustained over the subsequent three years, despite the departure from research of a substantial number of the cohort. In 1998, 51 individuals contributed to the total output of just over a hundred publications.

Only 14 of the cohort failed to publish (**Figure 3.9**), six of whom had resigned from their studentships. Of the eight who completed their studentship and did not publish, five were women. Thirty-four members (25 per cent) of the cohort had each contributed to ten or more publications by the end of 1998.

Figure 3.8a Total publications for 1989–1999



In just over 50 per cent of publications for the period as a whole (a total of 496 papers), the cohort member was first author (Figure 3.8b). This proportion varied little between 1989 and 1996, that is during the period when cohort members were either still students or in their first postdoctoral position.

Figure 3.8b Number of first-author publications by year

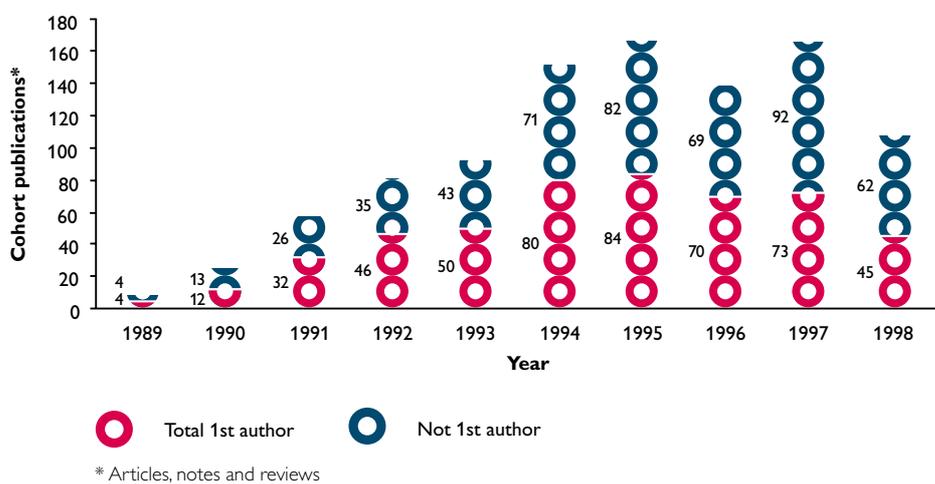
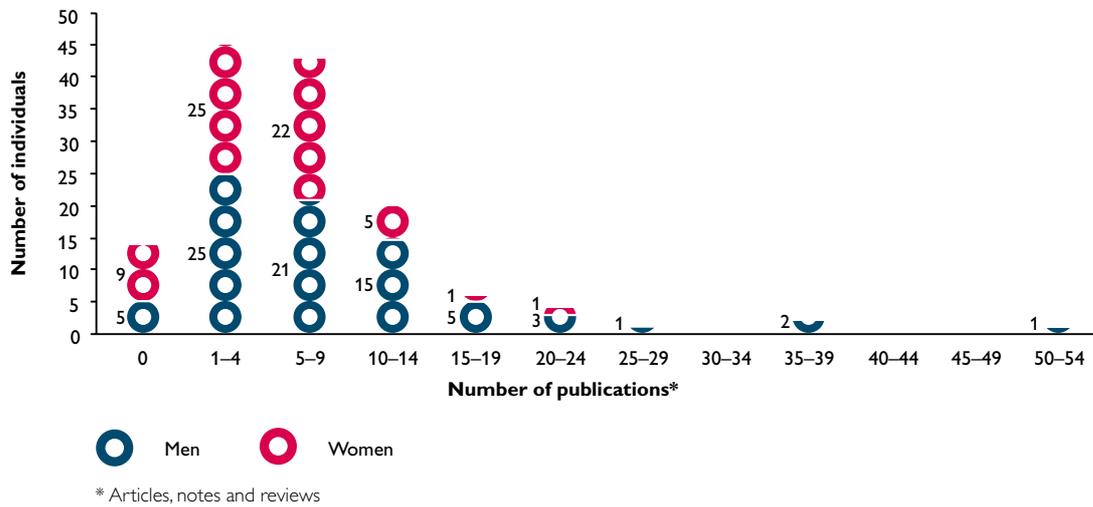


Figure 3.9 Individual publications



(iv) Research publications of cohort members remaining in academic research

The 58 individuals (41 men and 17 women) who remained in academic research at the time of the survey had contributed to a total of 624 publications (64 per cent of the total) by the end of 1998 (Table 3.9). The average number of publications attributed to the PhD projects of these individuals was not significantly different from the number attributed to the PhD research projects of those who did not remain in research (3.16 compared to 3.03).

Table 3.9 Publications of cohort members who remained in academic research

	Contribution to publications (1989–1998)		
	No	Total	Average
Men	41	509	12.41
Women	17	115	6.76

The average number of publications for those women who remained in academic research was considerably lower than for men (6.76 compared to 12.41).

(v) Publication and career path analysis of the 'most productive' of the cohort

Publication output is only one measure of research productivity or of the research of an individual, particularly because of the considerable differences in publication patterns for different research disciplines. Nevertheless, consideration of the research careers of those members of the cohort who have each contributed to more than 15 research publications, some 10 per cent of the cohort, provides some interesting information.

Fourteen individuals, 12 men and two women, contributed to a total of 341 publications, just over a third of the output for the cohort as a whole. The number of publications, on average, attributed to PhD projects of these individuals was significantly higher than for the cohort as a whole (6.43 compared to 2.88).

All members of this group remain actively engaged in research, two in the industrial sector. At the time of the survey (spring 1999), five of the 14, including the two most prolific authors, were working outside the UK, four in North America and one in Asia. Two other individuals worked outside the UK at some point in their postdoctoral careers but have since returned.

Six of this group have received Wellcome Trust funding during their postdoctoral careers and all received Trust funding for their first postdoctoral position – five through Prize Fellowship awards and one through a Postdoctoral Research Fellowship. Three have since received further Trust funding through project grants, all as principal investigators. Of the four individuals who have contributed to more than 25 publications, two had received Trust Prize Fellowship awards.



four

Discussion

Discussion

PhD completion and attributable research publications

Over 90 per cent of the cohort obtained a PhD, almost all within four years of the start of their three-year Trust studentship. Only a handful of students resigned their studentship awards, usually because of a fairly rapid realization they that they neither enjoyed nor had an aptitude for laboratory research. This completion rate is broadly similar to those of the Research Councils for a contemporary population of students.¹ No Trust student failed at thesis examination and none was asked to resubmit a revised thesis. The research projects carried out by Trust students resulted in contributions to, on average, three original research publications, the majority of which were published either in the final year of the studentship or in the subsequent two years. Almost two-thirds of the members of the cohort each contributed to between one and four papers. This considerable research productivity is an important recognition of the contribution these Trust-funded students made to the work of their host laboratories. Although the acquisition of other, more generic skills has become an increasingly important issue in UK postgraduate research training programmes, research results remain the most important outcome of a PhD in most biomedical research disciplines. The number and quality of research publications which arise from work carried out by PhD students are the contemporary measures of their competitiveness for the best postdoctoral research positions and for this reason it can be a cause for some concern if three or four years of laboratory research yields no results that can be published. However, this was the case for only a minority of the Trust cohort and it is recognized that there are considerable differences in the publication norms for different disciplines within the biomedical sciences. In addition, it is increasingly the case that there are outcomes from research which would not be identified through a search of the Science Citation Index (SCI), for example, software development and patent outcomes. It is not appropriate, therefore, to conclude that the research projects of these students yielded no useful outcome.

Subsequent careers

The fact that the great majority of the members of the cohort obtained a first postdoctoral research position indicates that they had gained the necessary credentials for a research career. The choice, for most of them, of an academic research position is also evidence of a sustained enthusiasm and motivation for the academic environment. Although considerable numbers of the cohort subsequently left the academic sector for the pharmaceutical or biotechnology industries, citing better salaries and greater job security as the primary reasons for their departure, almost three-quarters of those who left academic research, either after a first academic postdoctoral position or later, still work in science, medicine or health-related fields. None of the cohort has been involuntarily out of work for any significant period of time.

Substantial numbers of those members of the cohort who have remained in academic research obtained some postdoctoral academic research experience outside the UK. At the time of the survey, almost half had returned to the UK and a significant number of those who remain in academic research in the UK today have obtained research group leader status or command long-term research grant funding.

Wellcome Trust support for postdoctoral careers

Of those members of the cohort who took a first position in academic research in the UK, over half were supported by the Trust, either as research fellows or as postdoctoral research assistants. Other sources of support were the Research Councils and other charities. Of those individuals who were still Trust-funded at the time of the survey, half were in receipt of Trust career awards or had obtained permanent academic appointments and were in receipt of competitive research grant funding. Those individuals who held short-term Trust Prize Fellowships immediately following completion of their PhD doubled their research publication output during the period of their fellowship. This suggests that, by providing research continuity, these Trust fellowships gave students a significant advantage at the start of their academic research careers.

Research productivity in subsequent research careers

The cohort as a whole has contributed to almost 1000 research publications (SCI) to date. The most prolific 10 per cent of the cohort contributed to 35 per cent of the total research publication output for the cohort.

Differences between men and women

There were some notable differences between men and women and in their research productivity both during the period of their PhD studentships and in their subsequent academic research careers. A greater proportion of women than men did not contribute to any research publications as a result of their PhD project and this may have been a contributing factor to an earlier disillusionment with research and, hence, an earlier departure from the academic sector. Many more women than men left academic research within the first few years but only a handful did so to have a child. It will be important to understand the motivation of these women in leaving and to identify in more detail the sectors to which these women moved. For those women who did remain in academic research, their publication output over the four- to eight-year period covered by the survey has been only half that of the men. It is not known how many of these women were employed in less than a full-time capacity, nor if there were differences in the amount of teaching or administration associated with their academic positions. It will be important to look more closely to see if there are important structural or cultural differences between the opportunities for men and women in academic research careers which could account for these considerable differences in career choice and outcome.

The current situation for PhD students

This study looked at the outcome and career choices of a group of Trust-funded PhD students who completed their PhDs almost a decade ago and its findings paint a picture of a group of highly successful individuals who have remained within the biomedical and health-related industries, many in research positions and almost half still in the academic sector. The findings for this group of Trust students are not substantially different from those of a recent study of UK Research Council-funded students of similar vintage.¹ However, an opinion survey of a population of current Trust-funded PhD students, published as a companion report to this one,² suggests that today's students are more disillusioned with academic research and are increasingly anxious about the poor prospects offered by a career in university teaching or research. The disillusion caused by the perceived low status and poor pay in the academic sector is accompanied by a contrasting perception of increased opportunities within the commercial research sector, as a result of recent advances in key areas such as genomics and other areas of bioinformatics. These new opportunities may contribute to a quite different set of aspirations and career outcomes for today's PhD students. In recognition of the difficulties and uncertainties caused by a poor academic career structure, it may be that today's students will place substantially more importance on obtaining a wider training in generic and commercially marketable skills than did the students of a decade ago. It will be extremely interesting to look at some of the key issues raised by this cohort study using groups of Trust-funded students who have completed their PhD more recently – and to map this Trust picture onto the wider UK academic research training landscape.

References

1. *Office of Science and Technology Survey of Postgraduates Funded by the Research Councils*. The Office of Science and Technology (OST), 1998, www.dti.gov.uk/ost/ostbusiness/index.htm.
2. *Review of Wellcome Trust PhD Research Training: The student perspective*. London: The Wellcome Trust, March 2000.



Appendix A

Details of the survey enquiry

The following standard enquiry was sent to those former students contacted by email. The same information was requested from those interviewed by telephone.

PRISM (the Wellcome Trust Policy Research Unit) are presently conducting an internal review of the Wellcome Trust PhD prize studentship programme. As part of this review, we are collecting career-path information for scientists who received Wellcome prize studentships. The aim of this is to track the career progression of Wellcome PhD students and to discover how many have benefited from their postgraduate training.

Firstly, could you confirm that you were indeed the recipient of a prize studentship (and we haven't contacted the wrong person!). If this was indeed the case, I was wondering if you could spare a few moments of your time to let us know what you have been doing since your PhD.

All we require is very brief details of your career path since completing your PhD to the present day. Namely:

1. Your submission date, viva date and award date for your PhD (month and year is fine, we don't need the exact day!).
2. If you have held any postdoctoral positions, we would be very grateful if you could tell us, for each position:
 - The dates you were at the post
 - Your job title
 - The department at which you worked
 - Your funding source
 - The duration of the project
 - The topic you worked on (one-line summary perfect)
3. If you have left academia, we would be very interested to learn where you have worked; what kind of work you have done; and, very briefly, the factors which influenced your decision to move away from academic research.
4. If you have an up-to-date publication list to hand, I would be very grateful if you could send me a copy.

If you have any questions at all regarding this enquiry, please do not hesitate to contact me by phone or e-mail at the address below. Thank you very much for your time and I look forward to hearing from you soon.