

# Women in the Statistics Profession: A Status Report

**Beverley A. Carlson**

*Chair of the Committee on Women in Statistics of the International Statistical Institute*(<http://laplace.stat.cwru.edu/~mhr/isi>), and

*United Nations Economic Commission for Latin America and the Caribbean, Box 179D, Santiago, Chile, email: bcarlson@eclac.cl*

## Summary

**The mandate of the International Statistical Institute (ISI) is to foster international statistical work and interchange among statisticians and countries. However, women are under-represented in the ISI and this situation is a cause for concern in the Institute and its membership and particularly the ISI Committee on Women in Statistics (CWS). This paper analyses the representation of women in the ISI and in the statistics profession which is low in virtually every country, a pattern of generations. It looks at the diverse realities among countries and regions, and the broader context of women working in the scientific professions.**

*Key words: Committee on Women in Statistics; International Statistical Institute; Under-representation of women; Women in science; Women in statistics.*

## 1 Introduction

At the dawn of the third millennium, why are women participating in exceedingly low numbers in the statistics profession? Why are women under-represented in the scientific professions? The current impetus for these questions arises from an ongoing debate among statistics professionals about the low number of women elected to the International Statistical Institute (ISI) and a longstanding concern by women in the ISI to turn this situation around. In part, the low number of women in the ISI led to the establishment of the ISI Committee on Women in Statistics. This paper is an outgrowth of the work of the Committee. An extended version of this paper with additional contributions from a number of leading statisticians was published by ECLAC and presented at the ISI Helsinki Session in August 1999 (Carlson, 1999).

## 2 The International Statistical Institute and its Committee on Women in Statistics

The ISI is one of the oldest international scientific associations functioning in the modern world. It was established in 1885 and celebrated its centenary in 1985. The Institute is an autonomous professional society which seeks to develop and improve statistical methods and their application through the promotion of international activity and cooperation.

The ISI has just over 2,000 elected members who are the world's leading statisticians. The membership is drawn from 106 countries and their accumulated experience represents a vast store of technical knowledge, which covers the entire range of official, applied and theoretical statistics. Leaders of national and international statistical agencies are ex-officio members of the ISI. This reservoir of expertise is supplemented by that of the members of the Institute's Sections.

The five Sections of the ISI reflect the diversity of the association, the wide range of professional application and the distinct interests of the membership. The sections are the International Association of Statistical Education (IASE); the International Association of Survey Statisticians (IASS); the International Association for Official Statistics (IAOS); the International Association of Scientific Computing (IASC) and the Bernoulli Society for Mathematical Statistics and Probability. In total, there are more than 5,000 individual members. The ISI and its Sections provide a forum for the international exchange of knowledge among members, and also aim to bring in their members' expertise to assist in the practical solution of various problems.

The ISI Committee on Women in Statistics was formally established during the ISI Beijing Session in August 1995 and held its first meetings at the ISI Istanbul Session in August 1997. Initially, what had motivated the establishing of such a committee was concern among the ISI leadership over low female representation in the ISI and its Sections. The committee's Terms of Reference reflect this concern and deal with a number of factors closely related to it. They are:

- To promote and strengthen the representation of women statisticians in the ISI and its Sections.
- To help in providing opportunities for women members to assume active and visible roles in the ISI and other statistical associations.
- To collect information on women in the statistical professions in different countries and to facilitate the flow of information among women statisticians.
- To stimulate interest in statistics among women and encourage women in schools and colleges to study statistics.
- To support the compilation of statistics on women, with a view to generating relevant studies concerning women's roles in the various activities in their countries.

### **3 Women's representation in the ISI**

The discussion among the membership of the ISI about women's representation has gone on for some time with the ISI leadership seeking to implement practical solutions. However, the solutions are not simple because the problem is not simple. It first requires examining just what is the size and makeup of women's membership, in regional and country terms, and then setting these realities into the context of the distribution of the overall membership.

In part, the difficulty in recruiting qualified and interested women appears to result from the larger problem of low representation of the developing regions in the ISI and therefore the inadequate network for recruiting outstanding male and female members on a global scale. In some countries and regions, statistics is a relatively new academic area of study and so has not developed a body of professionals in proportion to their populations; in some countries it is a profession that has not had much demand until the present and so remains a small discipline. Relatively speaking, participation in ISI meetings and membership dues are costly and potential professionals from developing regions may find it difficult to meet these costs. They also may not see the value of gaining membership because the network may not be perceived to be sufficiently useful for local professional purposes or personal self-fulfillment. These factors have come up in trying to interest more colleagues in Latin America to participate.

In effect, the ISI situation is only the tip of the iceberg of a much larger issue. A major reason for low representation of women in the ISI from the USA and Canada, for example, is the very low number of women statistics professionals working in the USA and Canada. The ISI hence is a reflection of a longstanding larger reality as is seen in Billard's (1997) historical analysis of academic careers in the United States. Consequently, to change the ISI situation it is, at least in part, necessary to improve the low participation of women in the statistics profession and to do that it is necessary to understand what underlies the condition of low participation. Answers to these questions can lead to concrete remedies.

How well are women represented in the ISI and its Sections? According to data supplied by the ISI in April 2000 the ISI had only 192 women members out of a total membership of 2,009. Table 1 shows that in the beginning of the 21<sup>st</sup> century only 9.6% of the global ISI membership are women. Low as this figure is, it is still a considerable improvement over the situation ten years ago. In 1989 there were only 95 women in the ISI, representing 6.4% of a total membership of 1,490. In the last five years there were 489 newly elected members of the ISI of whom some 72 were women, i.e. around 14.7%. The female membership of the ISI has doubled in the last ten years but the current pace of change will not significantly alter the sex ratio in the short to medium term. An increase in representation of three percentage points is a move in the right direction but spread over ten years the movement is clearly not fast enough. It is important, however, to examine the low membership rates in the context of the representation of women in the statistical profession as a whole. This is examined later with respect to statistics teaching in the United States and women in science in all regions of the world.

**Table 1**  
**MEMBERSHIP OF THE ISI<sup>1</sup>: 2000**

Region	Women ISI Members		Men ISI Members		Total ISI members	
	No.	%	No.	%	No.	%
<b>World</b>	192	9.6	1,817	90.4	2,009	100
<b>Industrialised Countries</b>						
<b>USA &amp; Canada</b>	47	10.3	411	89.7	458	100
<b>Europe</b>	103	10.7	860	89.3	963	100
<b>Western Mediterranean*</b>	47	13.8	294	86.2	341	100
<b>Rest of Europe</b>	56	9.0	566	91.0	622	100
<b>Japan</b>	2	1.8	107	98.2	109	100
<b>Australia &amp; New Zealand</b>	5	7.4	63	92.6	68	100
<b>Developing Countries</b>						
<b>Latin America &amp; Caribbean</b>	11	20.0	44	80.0	55	100
<b>Africa, including North Africa</b>	10	12.0	73	88.0	83	100
<b>Asia</b>	14	5.1	259	94.9	273	100
<b>Industrialised Countries</b>	157	9.8	1,441	90.2	1,598	100
<b>Developing Countries</b>	35	8.5	376	91.5	411	100

<sup>1</sup>By country of nationality

\*France, Italy, Portugal and Spain.

**Source:** B. Carlson, based on data supplied by the ISI, April 2000.

When one looks at the regional distribution of ISI membership it can be seen that more than four fifths (81.7%) of the 192 women ISI members are nationals of industrialised countries, a fraction more than for male ISI members. Only 35 women ISI members come from the developing countries of Latin America, Africa and Asia. The region with the highest proportion of women ISI members is Latin America and the Caribbean where 20.0% of the ISI members in the region are female, double the global average. It is very interesting to see that the largely Catholic Western Mediterranean countries of Italy, France, Spain and Portugal also have a high proportion of women ISI members (13.8%) compared to only 9.0% for the rest of Europe. The figure for Europe as a whole is 10.7%, a little more than the figure for USA and Canada (10.3%). Possible explanations for the “Western Mediterranean phenomenon” are discussed later in the sections on *Women in science*, and *Women in science education*, and appear to be strongly linked to a higher proportion of all-girls schools in those countries.

The higher proportion of female ISI members in Latin America is partly the reflection of the exceedingly low number of male ISI members in Latin America and the Caribbean (44) but it also reflects the same Mediterranean phenomenon found in Spain and Portugal. 12% of ISI members from African and North African countries are women, a higher representation than in most other regions, but this is based on only 83 ISI members altogether with African nationality,

a very low participation from a region consisting of more than 50 countries, 46 of which have populations of over a million.

In Asia, Japan is presented separately in the industrialised group of countries. Although it has a large number of members it has a very low proportion of women (1.8%), even lower than that found in the developing countries in Asia where the proportion of women members is only 5.1%. Women members in Australia and New Zealand are not much better represented at 7.4%, partly because of the absence of any women ISI members in New Zealand.

The large difference that occurs in male-female membership in Japan raised the question as to whether this was unique to Japan or happened in other countries as well. A special country table was prepared to check on membership by country of nationality (and also country by residence, not presented here). Table 2 shows the proportion of women ISI members who are nationals of the 20 countries with the highest overall ISI membership, presented in descending order of the female percentage.

**Table 2**  
**ISI MEMBERSHIP IN THE TOP 20**  
**COUNTRIES BY NATIONALITY: 2000**

Country	Number of ISI members	Percentage Female
SPAIN	37	16.2
FRANCE	182	13.2
ITALY	114	13.1
HUNGARY	25	12.0
USA	362	11.3
UK	136	10.3
BELGIUM	21	9.5
FINLAND	22	9.1
AUSTRALIA	57	8.8
GERMANY	94	8.5
SWEDEN	51	7.8
NETHERLANDS	55	7.3
CANADA	96	6.3
RUSSIA	18	5.6
CHINA	61	4.9
DENMARK	27	3.7
KOREA REP	32	3.0
INDIA	86	2.3
JAPAN	109	1.8
NORWAY	27	0.0

**Source:** B. Carlson, based on data supplied by the ISI, April 2000.

There is a very wide range of women's representation among the 20 countries with most ISI members, from Spain at 16.2% of its 37 members to Norway with 0.0% of its 27 members.

The composition of the 'high' and 'low' countries is striking. The Western Mediterranean phenomenon is very clear with Spain, France, and Italy taking the top three rankings (with Portugal, not in the table with only eight members, having 25% women). Only three other top membership countries have more than 10% women members —Hungary, USA and UK.

On the other hand, Japan, with only two women members out of 109 is not alone at the bottom of the table and is not even in the last place. Last place 'honors' go to Norway with no women out of 27 ISI members and Denmark is near the bottom with only one woman out of its 27. It is surprising to discover that these two Nordic countries, coming from a region so well known for its gender balance are totally imbalanced with respect to ISI membership. Is this a reflection of low numbers of women in the statistics profession in these countries or an omission? Three other countries, India, Korea Rep. and China, have less than 5% women members. In addition, outside the table, Austria with 14 ISI members, New Zealand with 11 members, Ireland with 10 members, Poland with 10 members, and Pakistan with 10 members, like Norway, do not have a single women member among them.

It is notable that Japan, India and China, with respectively the 5<sup>th</sup>, 8<sup>th</sup> and 9<sup>th</sup> largest ISI membership accounting for 256 members, have only seven women members among them. Surely, this cannot reflect the proportion of senior women working in statistics in these countries? If only these three major countries, full of excellent statisticians, were merely to attain the current average female membership of 9.6% they could bring to the ISI 18 excellent new women members. Where are these 'missing' ISI women and how do we recruit them?

#### **4 Women's representation in the ISI Sections**

There are 97 countries in the world which are represented in the ISI or its Sections by one or more women members, coming from 61 different nationalities. The representation of women is much better in some of the Sections of the ISI, as shown in Table 3.

Women's representation is highest in the International Association for Statistical Education (IASE) at 30.4%, the International Association of Survey Statisticians (IASS) at 23.7%, and the International Association for Official Statistics (IAOS) at 18.7%. By contrast, the International Association for Statistical Computing (IASC) and the Bernoulli Society for Mathematical Statistics and Probability are just a little above the main ISI position of 9.6%. These differences in women's participation among the sections show a strong tendency for women to belong to the "applied statistics Sections" with proportionately fewer women in the "hardcore statistics", mathematics and computing Sections. Taking the five Sections together, the percentage of women members is 16.7%, nearly double the percentage for the ISI itself. The ISI has fallen behind all five of its Sections in recruiting women members. This disparity needs to be investigated further.

**Table 3**  
**MEMBERSHIP OF THE SECTIONS OF THE ISI: 1999**

ISI Sections	Women members		Men members		Total members	
	No.	%	No.	%	No.	%
<b>International Association of Statistical Education (IASE)</b>	170	30.4	390	69.6	560	100
<b>International Association of Survey Statisticians (IASS)</b>	369	23.7	1,188	76.3	1,557	100
<b>International Association for Official Statistics (IAOS)</b>	94	18.7	408	81.3	502	100
<b>International Association of Scientific Computing (IASC)</b>	76	11.3	598	88.7	674	100
<b>Bernoulli Society for Mathematical Statistics and Probability</b>	162	10.7	1,349	89.3	1,511	100
<b>ISI</b>	192	9.6	1,817	90.4	2,009	100

**Source:** B. Carlson, based on data supplied by the ISI and the IASS, July 2000.

The main difference between the ISI and its Sections is that membership in the ISI is by election of members of the ISI while membership in the Sections is by application by interested professionals. It could be that while women are taking the initiative to join the Sections, ISI members who are overwhelmingly men have not taken sufficient initiative to recruit women. (Five existing members of the ISI are required to propose the election of a new ISI member.) Again, this needs to be examined in the context of the representation of women in the *statistics profession* as a whole, both in regions and countries, where women's representation is often very low and the low ISI membership is simply a reflection of low numbers of women in the statistics profession.

The regional and country figures are a good starting point for understanding whether the low number of women members indeed represent a special ISI gap, e.g. the extreme situation in Norway and Japan or the low percentage in Asia as a whole. Decision-making members of the ISI tend, more often than not, to come from the industrialised world and they would have a better network for recruiting outstanding women into the ISI. The question is how to discover the outstanding women in countries that have very low representation. Furthermore, there is the equally important issue of the overall low representation in the ISI of both men and women from developing countries, the reasons for it and how to change it.

It is not a question of women having to reach the very top of the statistics profession to be nominated for the ISI. Most men members of the ISI are just in the upper echelons and there are certainly many first class women statisticians at that level who could contribute to the ISI. It is a matter of finding them, attracting them and sponsoring them to join the ISI. Such a campaign

would definitely mean a personal commitment on the part of its existing members. The ISI Permanent Office, working with the CWS and other Committees and Sections, could be successful in finding good women statisticians who have been overlooked and take the necessary steps to get them nominated. The ISI Permanent Office could also serve an important monitoring and reporting function through publishing regular reports on the progress of the recruitment of women.

The Italian National Statistical Institute has established an Equal Opportunity Committee and the President of the Committee asserts that when women have equal opportunity they are successful more often than not (Sabbadini. 1998). Over the last eight years the representation of women in the Italian National Statistical Institute has improved consistently because a great deal of recruitment and promotion was subject to public competition. Between 80 and 90% of the winners of the public statistics competitions were women. For her Committee, the best positive action was open competition. Many national statistical agencies have established a similar body—Nanjamma Chinnappa, former President of the International Association of Survey Statisticians, had a similar responsibility in Statistics Canada— and those that have not yet established such bodies would benefit from doing so.

## **5 Women in statistics teaching**

An important factor in the current limitations of statistics on women and the low participation of women in the statistical profession could well be the inadequate representation of women in the *teaching* of statistics. It is notable that the ISI, with its low representation of women, is still better off in gender terms than tenured statistics faculty in US universities. It is surprising to realise that, in the United States, the teaching of statistics at the university level is almost exclusively a male profession, (Loftsgaarden 1998). The latest data on this situation, as shown in Table 4, reflect the situation in the statistics departments of US colleges and universities in 1995.

It can be seen that in the autumn of 1995, there were only 40 tenured women statistics faculty teaching Ph.D. and MA courses in US universities and only another 38 who were tenure-eligible, out of over 921 possible tenure or tenure eligible positions. Women made up only 5.5% of full-time tenured statistics faculty in the United States meaning that nearly 95% of tenured faculty who were teaching statistics were men. This condition will not have changed very much in the few years since that inquiry.



**Table 4**  
**FACULTY IN UNIVERSITY DEPARTMENTS OF STATISTICS,**  
**UNITED STATES OF AMERICA: AUTUMN 1995**

Category	Ph.D. Courses			MA Courses			Ph.D. and MA courses combined			Total faculty
	Tenured	Tenure eligible	Other and part-time	Tenured	Tenure eligible	Other and part-time	Tenured	Tenure eligible	Other and part-time	
<b>Women</b>	32	36	50	8	2	9	40	38	59	137
<b>Men</b>	617	135	128	73	18	16	690	153	144	987
<b>Total</b>	649	171	178	81	20	25	730	191	203	1,124
<b>Women as % of total</b>	4.9%	21.1%	28.1%	9.9%	10.0%	36.0%	5.5%	19.9%	29.1%	12.2%

**Source:** B. Carlson, based on data appearing in Loftsgaarden (1998).

It is interesting to see that as one moves from tenured faculty to tenure-eligible faculty and then to part-time and other faculty, the percentage of women increases. The striking divide occurs between women who are tenured faculty and women who are tenure-eligible faculty teaching Ph.D. courses. The fact that 21% of tenure-eligible faculty are women compared to only 5% of tenured faculty might suggest that the situation will improve as the tenure-eligible faculty gets tenure. On the other hand, it might merely indicate that women teaching statistics have difficulty getting tenure even when eligible. The much larger percentage of women in part-time and other positions is not a very reassuring sign.

Even including tenure-eligible and other faculty including part-time teachers, women statistics teachers in universities accounted for only 12.2% of the total faculty. This amazing disparity raises many questions. Why is this so? Why are not more women teaching statistics? Is this a recent phenomenon or a longstanding one? In fact, the age distribution of tenured and tenure-eligible women faculty tends to lean toward the younger age cohorts but even then the female representation is still very low. One would assume that more women would be seeking statistical careers, especially with the evolution of the information age, where statistics and data are central to many professions and appear everywhere in the public dialogue, in newspapers, on television, in magazines, etc. (Albers 1992). There is nothing inherent in a statistics career that might account for the low participation of women, unlike careers that take women away from their families, are labour or travel intensive, etc. This surprising phenomenon surely warrants a follow-up study to discover the reasons. The gender gap is just not what we would have logically thought to be the case. What is the comparable situation in other industrialised and developing countries? Is this a unique US situation or is it common to most universities in the world? We need to undertake further enquiries.

What does the almost non-existence of women in the teaching of statistics mean for statistical production? Are statistics gender-biased because teachers of statistics are almost exclusively men and so the female perspective is not sufficiently reflected in university statistical research, curriculum design, role models and statistical production? And do the “statistics in society” that we produce and read about reflect this gross distortion in statistical faculty teaching in colleges and universities? These questions need to be further researched and documented.

It is common knowledge that until the last 10 years or so, women's reproductive health and women's health in general in the United States was a seriously under-researched area and large funds have consequently been injected into research programmes in these areas. This serious gap in health research about women would have been less likely had there been a larger number of senior women researchers in the field making decisions about research directions. As gender equity became a focus of national and international concern during the last 20 years, the discipline of gender statistics and its practice has also developed, in response to new demands for gender-based data and the need to provide guidance on producing national statistical reports on women and men and analysing trends and statistics on women (United Nations 1995b and 1997).

Acknowledging that meaningful gender-based data are often lacking, the Platform of Action adopted by the Fourth World Conference on Women recommends that national, regional and international statistical services and relevant governmental and United Nations agencies in cooperation with research and documentation organizations work to "improve data collection on the full contribution of women and men to the economy, including their participation in the informal sector(s)" and to "develop an international classification of activities for time-use statistics that is sensitive to the differences between women and men in remunerated work, and collect data disaggregated by sex " (United Nations, 1995a). As a response, the UN Statistics Division, in collaboration with other UN agencies and governments, has initiated work on a multiyear project to promote the collection of time-use data in developing countries; compile statistics on "difficult to measure" sectors of the economy and "improve the measurement of paid and unpaid work in labour force statistics" (United Nations, 1999). In each of these cases, together with a panorama of further areas, a gender-balanced profession would undoubtedly enrich statistical production and interpretation.

## **6 Women in science**

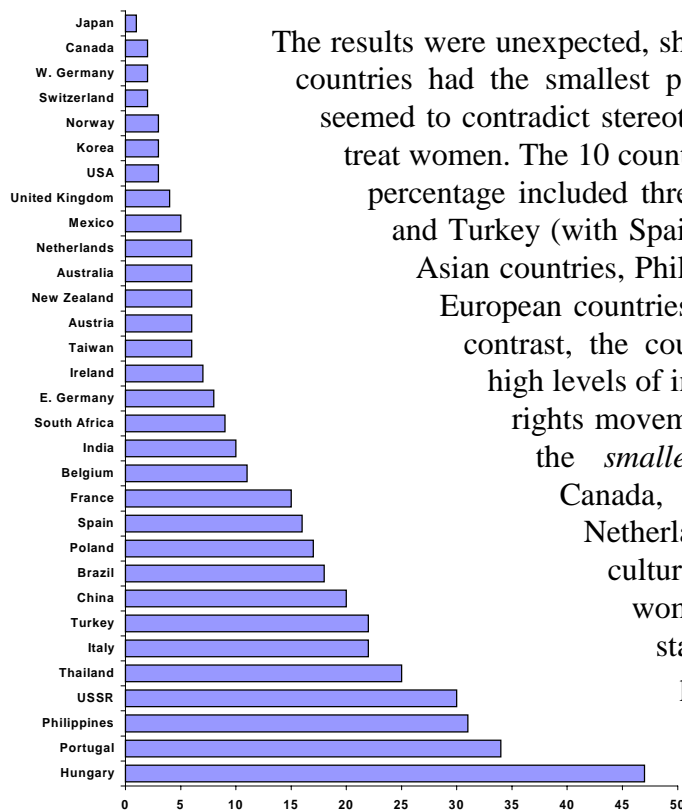
It is useful to examine women's participation in statistics within the overall context of women in the scientific professions since they have similar patterns and it would appear that the explanations for the current and longstanding situations have similar origins. While hard data on these questions are difficult to find, this lacuna has been complemented by some innovative qualitative research. The serious lack of data led to several large international studies, notably by Megaw (1991) and others in *Science* (1994). These, together with investigative reports (Fehrs 1990), begin to give shape and form to the underlying causes and contexts for the low participation of women in statistics and the sciences. It will be seen that it is not a uniform condition and we have much to learn from the varying realities across countries.

The participation of women in science, much like that in statistics, is not only an issue of equity but is crucial to the development of a healthy science and technology sector and the direction and implementation of appropriate science policy and research. In general, regardless of country or type of tertiary institution, the status occupied by academic women, particularly in the sciences, has been consistently below that enjoyed by men. This is especially true in countries that have not yet enacted anti-discrimination legislation (Billard 1997). Available information on the actual participation and experiences of women in science is surprisingly sparse as it is in the field of statistics. This was acknowledged in a special 1994 issue on “Women in Science” (*Science* 1994). The special issue compared the representation of women in various scientific fields among some 40 countries. Industrial and developing countries, as well as countries in transition where the status of female scientists and their participation in science had been traditionally very high, much higher than in the rich market economy countries, were included in the international comparison and country analysis.

Figure 1 shows the percentage of women working in university physics faculties for 31 countries based on a survey sent out to 1,000 university physics departments throughout the world by Jim Megaw, Chairman of the Physics Department of York University, Ontario, Canada.

**Figure 1.**

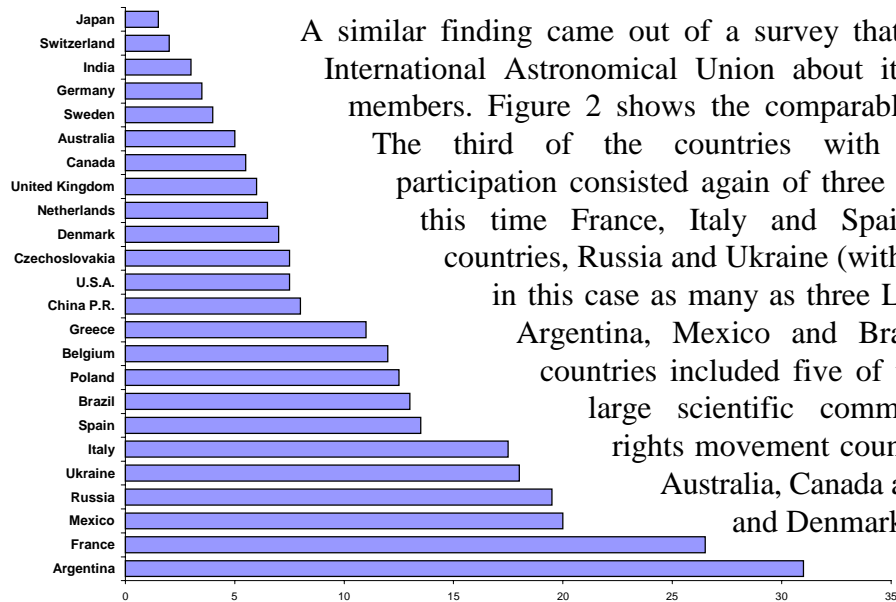
**PERCENTAGE OF WOMEN IN UNIVERSITY PHYSICS FACULTIES: 1991**



The results were unexpected, showing that some of the most industrialised countries had the smallest percentage of women physics faculty, and seemed to contradict stereotypes about national cultures and how they treat women. The 10 countries with the *largest* female physics faculty percentage included three Mediterranean countries, Portugal, Italy and Turkey (with Spain and France in 11<sup>th</sup> and 12<sup>th</sup> place); three Asian countries, Philippines, Thailand and China; three Eastern European countries, Hungary, USSR, Poland; and Brazil. By contrast, the countries with large physics establishments, high levels of industrial development, and strong women's rights movements provided six of the 10 countries with the *smallest* female physics faculty percentage: Canada, Germany, Norway, USA, UK and Netherlands. Clearly, data like these indicate that culture is a powerful influence on how well women do in science in general as well as in statistics in particular. The Mediterranean phenomenon of much higher percentages of women ISI members is also observed in the scientific professions. What do these statistics tell us?

**Source:** *Science* (1994) “Comparisons across cultures: women in science, a special report”, vol. 263, 11 March, Washington, D.C.

**Figure 2.**  
**PERCENTAGE OF WOMEN MEMBERS OF THE INTERNATIONAL**  
**ASTRONOMICAL UNION: 1992**



A similar finding came out of a survey that was undertaken by the International Astronomical Union about its percentage of women members. Figure 2 shows the comparable data for 24 countries. The third of the countries with the *largest* women's participation consisted again of three Mediterranean countries, this time France, Italy and Spain; two East European countries, Russia and Ukraine (with Poland in 9<sup>th</sup> place); but in this case as many as three Latin American countries, Argentina, Mexico and Brazil. The "worst" eight countries included five of the highly industrialised, large scientific community, strong women's rights movement countries, Germany, Sweden, Australia, Canada and UK (with Netherlands and Denmark just behind).

**Source:** *Science* (1994) "Comparisons across cultures: women in science, a special report", vol. 263, 11 March, Washington, D.C.

Both surveys show that Mediterranean and Latin American countries have a higher female participation in the scientific professions than the Northern European and Anglo-Saxon countries. Interestingly enough, Latin America and the four Western Mediterranean countries had the highest percentage of women ISI members of any region. In this connection, university enrolment data in UNESCO's World Education Report and the UNESCO Statistical Yearbook show that the female enrolment in the natural sciences, mathematics, etc. is proportionately higher in the Mediterranean countries of Portugal, Spain, France and Italy than it is in Northern Europe or North America (UNESCO 1999, 1997). A priori, one would expect that women's participation in science professions would be higher in the countries where these professions are considered world leaders, where these professions were developed and where they have existed for a longer time, e.g. in North America, Northern Europe. However, the facts are otherwise as is illustrated in the findings in Figures 1 and 2. What is behind these surprising differences?

A Portuguese researcher, Beatriz Ruivo, found that in newly emerging economies in Latin America and Eastern Europe women made up 20 to 50% of the scientific researchers as opposed to fewer than 10% in the United States and Northern Europe (as reported by Barinaga 1994). Her speculation was that the large entrenched systems in advanced countries had been established when women were not in the labour market in large numbers and that men had become accustomed to a workplace without women and actively blocked them from coming in. Personal experience confirms this. I liked chemistry and physics in secondary school and thought seriously

of pursuing a career in chemistry. I happened to have a family friend who did professional recruiting for the chemical industry and his advice was to forget chemistry because “the men didn’t like women in the labs; it made them feel uncomfortable” (I took his advice). Countries like Portugal and Spain and countries in Latin America were building their science sectors at the same time as women entered the labour market in large numbers and Ruivo posits that there was therefore more acceptance since the profession had not had time to become entrenched.

On the other hand, science is a low-status and low paying profession in many countries where women are well represented, for example, Eastern Europe and the countries of the former Soviet Union (Carlson, 1995). Shobhana Narasimhan, a physicist at Brookhaven National Laboratory saw this situation when she was growing up in India. While women are well represented in Indian science, there are few women in engineering, which is a more prestigious and higher paid profession than basic science (Michels 1994).

In Latin America the evidence is mixed. Engineering and hard sciences remain predominantly “male” professions, while women often choose professions which are extensions of their traditional domestic roles, like university teaching (Rico, 1997) and the “feminization of universities” has also been observed. Others attribute the concentration of women in academia to lower university salary structures while male counterparts have more access to higher paying private sector jobs (Katz, 1999). Although women have entered the labour market in huge numbers in the last 25 years, in general terms wage gaps persist which are higher at higher educational levels (Arriagada, 1998). On the other hand, social class often counter-balances gender among Latin American elites. Elite class networks give women access to high positions and prestigious jobs. Women are sensitized through their upbringing and their education in all-girls schools to believe that they can achieve whatever they want in society, including entrance to the scientific professions. “In certain countries the pecking order is rich men, poor men, rich women, poor women; and in other countries it’s rich men, rich women, poor men, poor women. (Oey, in *Science* 1994)”.

## **7 Women and science education**

Whatever the cultural pattern or class privilege, the education system has to be able to deliver qualified prospects, be they men or women. This means taking a lot of science and mathematics courses at school. A lot of exposure to science and mathematics at school not only prepares girls for the possibility of a scientific occupation; it gives them sustained exposure in a non-competitive setting to these subjects, providing a chance to discover them. Owona Sakrejda, a Polish-born physicist now working in the United States, supports this view and thinks that the high number of women researchers in former communist countries is in part due to educational policies requiring both boys and girls to study mathematics and science through secondary school, which gives students the chance to see whether they like the subjects and excel in them, and meanwhile they learn them. In the United States, by contrast, mathematics and science are not compulsory subjects but optional. It is easy to get out of them and peer pressure, from both girls and boys, can persuade girls to stay away from mathematics and science because they have a reputation for being tough courses and are not considered girls’ subjects in some schools.

Countries in which mathematics, science and foreign languages are compulsory courses throughout secondary school, with science subjects being taught in progressive courses at every grade level, have been able to attract more girls and women to science than countries in which these courses are elective.

A major reason given for Italy's excellent record in awarding advanced degrees in science and mathematics to women is the educational policy in Italy of mandatory mathematics and science classes combined with a policy of teaching all science subjects every year. Another reason put forward is the higher proportion of all-girls secondary schools in Italy and Megaw has argued that all-girls schools benefit the attitude of girls to science. All-girls secondary schools in Catholic countries like Italy, Spain, and Portugal, as well as in Latin America, are more common than in non-Catholic countries. Megaw's international survey (1991), of over 400 physics departments confirmed that women were better represented as both students and faculty in predominantly Catholic countries, meaning an advantage for southern European and Latin American countries. A 1992 survey of the British Institute of Physics found that nearly 60% of its women members had attended all-girls schools compared to a national figure of only 13% of women having attended all-girls schools. It is much harder for a scientific subject to get a reputation for being unfeminine if the only pupils in the school taking the scientific subjects are girls.

Once in the workplace, family-friendly societies help women to manage the demands of science and the demands of family responsibility and keep women in science. Whereas in the United States childcare is a major problem for working mothers in highly demanding professions, in other cultures —Latin American, Southern Europe, China— working women are much more likely to have childcare and other support from family members, household help, which is still traditional in many countries, and affordable daycare. In North America and Northern European countries extended daycare is often prohibitively expensive and family support systems are less common since the extended traditional family is less common, families are dispersed, and other female family members are more likely to also be out in the workplace. Another factor, at least in the United States, is the notion of self-dependence, independence where families feel that family responsibilities are kept within the nuclear family and where mothers of working women do not feel automatically obliged to look after the grandchildren. By contrast, in China where the work demands are also intense, families often leave their child in the hands of the parents, sometimes not only a daycare situation but as a permanent arrangement.

The European Union International Workshop on Women and Science in 1993 (Logue 1993) concluded that three rules govern the distribution of women in science, and these rules would seem to apply equally to the distribution of women in statistics. First, the number of women pursuing careers in scientific and technical disciplines is small in relation to the number trained in such disciplines. Second, there is a disproportionate distribution of women among disciplines: more women are in the biological sciences than in mathematics and physics. Third, the higher one goes in any scientific hierarchy the lower is the percentage of women. The European Union also noted the Mediterranean phenomenon, already pointed out with respect to women in statistics professions. In its International Workshop Report on Women and Science, it was observed that there was a "North-South" divide within Europe with the southern

Mediterranean countries having higher percentages of women at all levels in the scientific professions. Furthermore, in Northern Europe the absolute figures for women scientists had remained static whereas in USA, by contrast, the figures had increased.

## **8 Concluding remarks and proposals for the future**

The CWS will continue to advocate for strengthening the participation of women in the statistics profession and has contacted statistical societies recommending that more women participate in the ISI family and developed a list of correspondents. It has also recommended a number of women members for appointment to ISI committees. In response to a CWS initiative, the ISI is restricting its 2001 Jan Tinbergen awards to young women nationals of developing countries. For the Seoul 2001 session of the ISI, the Committee is organizing an invited paper meeting on "Measuring the contribution of women and minorities in society" and co-organizing with the IASE another invited paper meeting on "Women's contributions to leadership in statistical education", as well as a contributed paper meeting in connection with the Committee's ongoing Characterizations project.

The CWS website is becoming a very useful instrument and colleagues are encouraged to consult it, send information of interest and use it as a focal point for ideas, information, activities, research, —a network for interchange and learning, to build knowledge about women working in the statistics profession in our increasingly inter-connected world. The website, which is managed by Dr. Mary Regier, Case Western Reserve University in Cleveland, Ohio, on behalf of the CWS, can be consulted at <http://laplace.stat.cwru.edu/~mhr/isi>.

One clear recommendation for raising women's representation in the ISI is to target recruitment in the countries with no women members — Austria, Ireland, New Zealand, Norway, Pakistan, Poland — and large countries having very low numbers of women — Japan, India and China — and finally other countries with surprisingly low female percentage like Denmark. Large countries like Japan, India and China are likely to have many excellent women statisticians and just bringing these three countries up to the current ISI average female membership of 9.6% would add a good number of excellent new women members.

Such a campaign would definitely mean a personal commitment by existing members. The ISI Permanent Office, working together with the CWS and other Committees, could mobilize ISI members from these countries who may very well not be aware of the situation in their countries and could be in a position to identify potential outstanding candidates to recommend. The five ISI sections provide a good pool of potential ISI members and a little research to find notable candidates from the sections would probably yield some very good prospects. A further challenge for the ISI is to attract new members, both men and women, from the under-represented countries.

Following the positive experience in the statistical offices of Italy and Canada, it is suggested that national statistical agencies that have not yet established Equal Opportunity Committees would benefit from doing so. Senior ISI members could support such an initiative in

their countries. Italy and Canada, as well as other countries that have implemented successful recruitment and promotion policies, are encouraged to share their experiences, e.g. through the CWS website.

A related question is why more women are not teaching statistics and why so few of those hold tenured positions in US universities. These questions require additional research to investigate the current state of affairs, for example through a survey of members (both men and women) of the American Statistical Association. Similarly, the ISI could consider surveying its membership about the statistics profession in their respective countries to gain a clearer understanding of where statistics fit in academic programmes and university curricula and to learn about the occupations and specializations of statistics professionals following their academic training. It is clear from the small amount of information examined in this paper that we do not know enough about how statistics are practiced around the world beyond the ISI. Having larger numbers of women in statistics in some countries is not necessarily a sign of enlightenment but sometimes may be a reflection of the lower-paying jobs and the lower prestige that the profession has in some countries and academic settings.

It is also good to know that the pioneering work by Jim Meegaw and others to investigate women in science has been taken up by the European Commission Directorate General for Research. The Directorate is concerned with the under-representation of women in European scientific research, its challenges and measures to address the problem. It has recently held a conference on "Women in Science: making change happen" based on its report "Science Policies in the European Union: promoting excellence through mainstreaming gender equality". It will be well worth watching and learning from this work and considering its relevance for other regions and countries.

## References

- Albers, D.J., Loftsgaarden, D.O., Rung, D.C. & Watkins, A.E. (1992). *Statistical Abstract of Undergraduate Programs in the Mathematical Sciences and Computer Science in the United States: 1990-1991 CBMS Survey*, MAA Notes, **23**, The Mathematical Association of America.
- Arriagada, I. (1998). *The Urban Female Labour Market in Latin America: The Myth and the Reality*, Serie mujer y desarrollo, **21**, (LC/L.1034), Women and Development Unit, Santiago, Chile, Economic Commission for Latin America and the Caribbean (ECLAC).
- Barinaga, M. (1994). "Surprises across the cultural divide" *Science*, **263**, Washington, D.C., March.



- Billard, L. (1997). "Academic careers for women", *International Encyclopedia of Education*, 3<sup>rd</sup> Edition.
- Carlson, B. (1999). *Women in Statistics: the Profession Speaks (LC/R 1916)*, Santiago, Chile, Economic Commission for Latin America and the Caribbean (ECLAC).
- \_\_\_\_\_. (1995). *Women and Gender in Countries in Transition: A UNICEF Perspective*, United Nations Children's Fund (UNICEF), New York.
- Fehrs, M. & Czujko, R. (eds.). (1990), *Proceedings of the Conference on the Recruitment and Retention of Women in Physics*, New York, American Institute of Physics.
- Katz, J. (1999). Personal Communication.
- Loftsgaarden, D.O. & Watkins, A.E. (1998). "Statistics teaching in colleges and universities: courses, instructors and degrees in fall (1995)", *The American Statistician*, **52**, No. **4**, November.
- Logue, H.A. & Talapessy, L.M. (1993). *Women and Science International Workshop Report*, European Commission (EU) (ed.), Brussels.
- Megaw, W.J. (1991). "Gender distribution in the world's physics departments", *International Meeting on Gender and Science and Technology*, Melbourne, Australia.
- Michels, K. (1994). "Women in science and technology in developing countries: overcoming barriers", *AWIS (American Women in Science) Magazine*, **23**, No. **3**, July/August.
- National Science Foundation (1990). *Women and Minorities in Science and Engineering*, Washington, D.C., National Science Foundation.
- Osborn, M. (1994). Status and prospects of women in science in Europe, *Science*, **263**, Washington, D.C., March.
- Rico, N. (1997). *Female Human Resources Development: Growth and Equity as Priorities*, Serie mujer y desarrollo, **15**, (LC/L.947), Women and Development Unit, Santiago, Chile, Economic Commission for Latin America and the Caribbean (ECLAC).
- Sabbadini, L. (1998). Statement at the ISI Committee on Women in Statistics meeting on The Role of Women in Statistics, Aguascalientes, Mexico.
- Science (1994). "Comparisons across cultures: women in science, a special report", **263**, 11 March, Washington, D.C.

Stofte-Heiskanen V. (eds.) (1991). *Women in Science*, Berg, Oxford.

UNESCO (1999). *UNESCO Statistical Yearbook, 1999*, Paris.

\_\_\_\_\_ (1997). *World Education Report*, Paris.

United Nations (1999). "Demographic, social and migration statistics: gender issues in measurement of paid and unpaid work" (E/CN.3/2000/13). *Economic and Social Council, Statistical Commission, Thirty-first session, 29 February-3 March 2000*, "

\_\_\_\_\_ (1997). *Handbook for Producing National Statistical Reports on Women and Men*, ST/ESA/STAT/SER.K/14, United Nations, New York.

\_\_\_\_\_ (1995a). *Report of the Fourth World Conference on Women, Beijing, 4-15 September 1995* (A/CONF.177/20).

\_\_\_\_\_ (1995b). *The World's Women 1995: Trends and Statistics*, ST/ESA/STAT/SER.K/12, United Nations, New York.

## Résumé

Les statistiques sont à la base de l'analyse empirique et les statisticiens professionnels en sont les praticiens. La qualité de l'analyse globale est fonction des méthodes statistiques appliquées aux plans national et international. L'Institut International de Statistique a pour objectif de promouvoir les études internationales et les échanges entre pays dans le domaine de la statistique. Les femmes sont très peu représentées au sein de l'Institut, situation qui suscite de vives préoccupations chez les responsables et membres de ce dernier; le problème touche plus particulièrement le Comité sur les Femmes en Statistique de l'Institut. Ce document analyse la représentation des femmes dans le métier de statisticien, qui s'avère être faible dans la quasi-totalité des pays, tendance qui se maintient depuis des générations. Il examine les réalités diverses existant dans différents pays ou régions. L'auteur se penche également sur la situation plus générale des femmes qui exercent des professions scientifiques.