

Fractional Statistics and Quantum Theory. Avinash Khare. World Scientific Publishing, Fanner Road, P.O. Box, 128, Singapore 912805. 1997. 309 pp.

Statistics plays a very special role in the quantum mechanics of many-particle systems. The word 'statistics' was introduced in this context because some experimental observations were first understood in terms of certain combinatorial rules which identical particles seemed to follow for filling up the various quantum states available to them. Soon thereafter, the reasons for those state filling rules became clear at a deeper level as arising from certain symmetry properties of the quantum wave functions of many-particle systems. All particles known up to now, whether they are elementary or composite, seem to follow one of two kinds of statistics, namely, Bose-Einstein or Fermi-Dirac statistics; the two kinds of particles are called bosons and fermions respectively.

Nevertheless, many physicists have wondered whether other kinds of statistics are possible on mathematical grounds, and whether some of them may be realizable (even if in a limited or approximate sense) in experimental systems. Many such 'exotic' statistics are known to be allowed mathematically. One such possibility has received a great deal of attention in recent years. This is called 'anyonic' statistics; it is possible only in two-dimensional space, and it corresponds to the wave functions of the system forming a non-trivial representation of the braid group (which is more complicated than the permutation group which physicists are usually familiar with), rather than the simple symmetric and antisymmetric representations followed respectively by bosons and fermions. The reason anyons have been studied in great detail by theorists is that there are systems which exhibit two-dimensional behaviour even though the physical world is obviously three dimensional; two phenomena where this dimensional reduction is relevant are the quantum Hall effect and high-temperature superconductivity. In the latter system, predictions based on anyonic theories have been disproved experimentally. But in the fractional

quantum Hall effect, it seems very likely that the low-energy excitations, called quasiparticles in general, are indeed anyons. Recent experiments have clearly shown that the quasiparticles have electric charges which are simple fractions of the charge of an electron. This almost certainly implies that they should also display fractional statistics, although this has not yet been confirmed experimentally in a direct way. Whether or not anyons are eventually found to play a role in the fractional quantum Hall effect, the theoretical developments in anyonic physics have led to some general concepts which have found uses in many different areas of physics and mathematics. Some examples are the idea of composites of electric charge and magnetic flux which have enabled people to understand many aspects of quantum Hall systems in relatively simple ways, and the Chern-Simons quantum field theories which have led, amongst other things, to a better understanding of the theory of knots.

The present book is an excellent introduction to several aspects of anyons. The first half of the book deals with the quantum and statistical mechanics of anyonic systems; this part should be accessible to someone with a fairly elementary knowledge of those subjects. Here the author discusses what is currently known about the energy spectrum of several anyons placed in various kinds of potentials, and how this knowledge has been used to obtain information about the equation of state of a gas of anyons. The difficulty with anyons is that the peculiar symmetry which their wave functions have to satisfy is equivalent to having long-range interactions between the particles; this makes the problem analytically insoluble for a system with as few as three anyons. One therefore has to use either numerical or perturbative methods which have a limited range of validity. The second half of the book deals with examples of field theories in which anyons play a role, and applications of anyonic theories in quantum Hall systems and in superconductivity. Parts of this discussion require some knowledge of relativistic and non-relativistic quantum field theories which have a local gauge invariance. However the discussion is quite detailed and self-contained which makes the book ideal

for a beginner to learn from. A large number of references and a list of more advanced topics are provided so that a reader can explore some technical areas more deeply. There is also a chapter on other kinds of fractional statistics which may possibly find applications in other areas of condensed-matter physics.

The author has made pioneering contributions to the subject of anyons; in particular, he and his student were the first to show that anyons arise as topological excitations in certain classes of field theories. This lucid monograph is highly recommended for those who want to do further research in the area as well as for those who are merely curious about this unusual aspect of quantum many-body physics.

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Annual Review of Public Health 1998. J. E. Fielding, L. B. Lave and B. Starfield, eds. Annual Reviews Inc, 4139 El Camino Way, P. O. Box 10139, Palo Alto, California 94303-0139, USA. Price: Individuals US \$69. Institutions US \$138. vol. 19.

The broad mandate of public health as a discipline is to improve the health of the people. In so far as it tries to achieve this through various means, viz. basic research, health management, social science research and operations research, it can be compared to farming: all the theories of farming are of no use unless they result in better food for more people. Simple as this sounds, at a deeper plane it invokes several questions. For example, what can be considered better health, and how do we measure it? What are the causes of ill health, and how do we find them? What interventions lead to improved health, and how do we make them acceptable? These are some of the dilemmas explored in the *Annual Review of Public Health 1998*.

The randomized controlled trial (RCT) is the strongest research design in epidemiology. At no other time is this more evident than when a trial comes up

with results completely repudiating the initial hypothesis.

Beta-carotene and retinoids were hailed as a breakthrough in chemoprevention of cancer in the eighties. This followed from a series of valid observations, that eating lots of fruits and leafy vegetables rich in these pigments seemed to prevent the onset of cancer. As a logical follow up, a number of experimental studies in populations, with randomization, were designed to test the efficacy of these chemicals in chemoprevention. The alpha-tocopherol/beta carotene (ATBC) trial in Finland, the beta-carotene and retinol efficacy trial (CARET) study in the US, the Linxian study in China and several others were examples.

However, not only did all of the trials not show any positive effect for the chemical, many of them demonstrated a statistically significant higher risk for lung cancer in subjects receiving high dose of beta carotene. This effect was more pronounced in smokers. Moreover, the longer the period of regular intake of beta-carotene, the greater the risk. These findings have generated a spate of explanations and hypotheses. Many studies have also been stopped mid way considering the harmful effect of beta-carotene. The whole episode underscores the need for scientifically designed studies on the population before recommendations are made regarding diet and other lifestyle factors which can affect millions of people. The potentially health-promoting effects of vegetables and fruits in diet remain unexplained. (Chemo prevention of lung cancer. The rise and demise of beta-carotene, Gilbert S. Omenn.)

Archie Cochrane was the great champion of the randomized controlled trial (RCT) in medicine. He wanted every newly proposed mode of therapy – and most of the already existing ones – to be subjected to the randomized controlled trial to prove its efficacy. His ideas have had so much influence on current medical thinking that the RCT has become a holy cow in medicine. The Cochrane collaboration has been established specifically to further this cause.

In spite of this, unfortunately, many important treatment modalities have not been subjected to RCT. Part of the problem is that this is impossible to do,

given the ethical and humanitarian constraints. Outcomes research in medicine tries to address this problem by analysing large observational databases of existing therapies to assess their effect on outcomes. Existing statistical techniques to control for other variables, however, have proven far too inadequate to answer important questions.

Newhouse and Mc Clellan describe, with an example of data on the efficacy of cardiac catheterization in acute myocardial infarction, the applicability of a technique borrowed from social science research, viz. instrumental variables research, in such situations. An instrumental variable is one that produces variation in the treatment variable, and cannot independently affect outcome. The variation in outcome and the variation in the treatment variable in groups determined by levels of the instrumental variable can be compared to estimate the effect of the treatment variable.

The authors also discuss how the technique cannot completely replace the RCT, but would hugely augment the power of the RCT in clinical decision making. To borrow their own words, while the RCT has more internal validity, IV has greater external validity. This is because the RCT focuses on the *average effect of a treatment: it tells us what effect we could expect in a patient similar to a subject in the RCT.* IV, on the other hand, draws attention to *marginal effects: what additional benefit we can expect from increasing the existing rate of intervention.* The article is a great argument for the fact that the spirit of Cochrane notwithstanding, medical research cannot depend on RCT alone. (Econometrics in outcomes research: The use of instrumental variables, J. P. Newhouse and M. Mc Clellan.)

Improvement in health status of the population has always been regarded as one of the positive effects of socialist rule. In fact, the health achievements of states such as China and Cuba are legendary. After the revolution in Russia in 1917, the Soviet authorities also launched a programme of building up the health infrastructure. By the seventies, this had paid rich dividends, with the Soviet Union achieving health standards comparable to any western nation and a doctor–population ratio among the best in the world.

After the collapse of the communist regime in eastern Europe, one of the most surprising fall out has been the downturn in health conditions experienced by all these nations. R. E. Little's article on 'Public health in Central and Eastern Europe and the role of environmental pollution' discusses the causes of this debacle.

It is surprising to learn that life expectancy in countries of the former Soviet Union for 15–60 year-old males is currently lower than that in countries of sub Saharan Africa. Between 1989 and 1994, life expectancy for men declined by 5–6 years in many of these countries. The important features of this collapse in health levels are:

1. It affected men much worse than women;
2. In women, there was an accompanying trend in falling fertility: the abortion rates in some of these countries are unbelievably high, with women reporting as many as ten abortions in a lifetime being not unusual;
3. Though all countries in the region experienced a decline in the early phase from 1989 to 1992, some of them, like the Czech republic recovered whereas in the former Soviet Union and countries such as Bulgaria and Romania, there seems to be a slide back in health conditions of the people.

What are the causes of this phenomenon? It has been known for some time, even before the collapse of the Soviet Union, that tobacco and alcohol use were among the highest among males in this country. These have contributed much to the male mortality. Added to these have been new problems like increasing crime rate, rise in poverty and malnutrition, and the contribution of life stress. The author of this article examines the data in the light of a new hypothesis – whether the decline in health standards has come about as a result of the heavy industrial pollution by the factories. In an effort to catch up with Western industrialized states, the Soviet Union in the seventy odd years of its existence made heroic efforts to exploit its vast natural resources. In the absence of an organized environmental awareness movement and an open press,

overexploitation and pollution on a large scale were the order of the day – To attribute the excess mortality to this would be quite natural.

After examining the evidence, the author comes to the conclusion that pollution is only one among the many factors that have contributed to decreasing life expectancy, and not the sole cause. The public health lesson from all this seems to be that just as spectacular health gains are possible through social intermediation, social change can also result in spectacular health collapse. There is no room for complacency in the face of health gains.

It is received wisdom that estrogen use in postmenopausal women is associated with a large spectrum of benefits. These include protection from heart disease as well as prevention of bone fragility leading to fractures. But all these come at a cost: the increased risk of breast cancer. In spite of this, postmenopausal estrogen is the most commonly prescribed drug in the United States. The paper by Barrett Conner and Grady weighs the risks and benefits of estrogen use in postmenopausal women by looking at published literature. The impetus for this is the realization that coronary heart disease has become the greatest threat to the health of postmenopausal women. Though breast cancer risk steadily increases with age, in absolute terms heart disease far outweighs this.

In such a situation, much depends on the strength of the evidence in either case. Most of the studies reporting the association between use of estrogen and reduction in heart disease rates have been observational studies. They are subject to a number of biases. Estrogen is supposed to act through lowering of LDL cholesterol, elevation of HDL cholesterol, effects on clotting factors and other actions. But most of these studies are not free from a bias which results in a spurious protective effect. For example there could be 'a healthy women effect', which means that the women taking estrogen are more likely to be educated, financially sound and more compliant. There could be an exaggeration of the protective effect because women taking estrogen may tend to use the health system more effectively.

Reviewing the effects of estrogen use on the risk of breast cancer, there is

about 32% higher risk for users compared to non-users. There is also an increase in the risk for endometrial cancer, thrombo embolism and gall bladder disease. The authors conclude that estrogen therapy could be beneficial if the risk for heart disease is reduced by at least 30%. This article brings out the essential dilemma of public health practice, i.e. making decisions with imperfect knowledge. (Hormone replacement therapy, heart disease, and other considerations, E. Barrett-Conner and D. Grady.)

Cancer is perhaps the most important public health problem of modern times. It is the second leading cause of death. Therefore prevention of cancer assumes great importance in health policy initiatives. Many cancers are not easily amenable to prevention, but an estimated 75 to 80% of all cancers can be prevented. Although avoidance of tobacco is perhaps the single most effective and well-known approach for cancer prevention, other behavioural modifications such as changes in diet are also important. Protection from sun exposure; it has been shown, can prevent over 80% of skin cancers. The attempt to modify behaviour in this regard is a major public health initiative in many Western countries. Success in this attempt is marred by two important factors: (1) the lack of awareness of the risks of sun exposure and (2) the social preference for a suntan.

Studies on the effectiveness of interventions to increase sun protection report a mixed response. Another approach is to increase surveillance, so that cancers are detected early. Screening facilities at health fairs, festivals have had some success. Such fairs need to be promoted on a larger scale if this important public health problem is to be effectively tackled. (Successful behavioural interventions to prevent cancer. The example of skin cancer. A. Baum and L. Cohen.)

An important contribution in the *Annual Review of Public Health* in 1998 is an autobiographical piece of '60 years in public health' by Lester Breslow. Scanning the development of public health over the last half century from a personal vantagepoint, Breslow provides powerful insights into the successes and failures of the discipline, and the possible reasons. He sketches out

the emergence of public health from a fragile, tentative relationship with the field of medicine to a profession in its own rate. The anecdotal nature of the article lends it a refreshing intimacy. There are two messages that emerge from the essay: (1) the importance of leadership and team work, and (2) the need for commitment. And, as the author says in the concluding paragraph, the possibility of having fun.

As always the *ARPH* chooses its essays with care, with an eye on relevance to practice as well as research content. Public Health, as a career option for medical graduates, loses out to clinical medicine because of its perceived lack of 'glamour' and lower earning potential. This review establishes emphatically that it does not take a back seat at least in intellectual appeal.

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Software review

Extend: Simulation Software. Version 4 for Macintosh or Windows. Imagine That Inc., 6830 Via Del Oro, Suite 230, San Jose CA 95119-1353 USA. Email: extend@imaginethatinc.com. Web Site: <http://www.imaginethatinc.com>. Price: US \$695.

Extend from Imagine That Inc. is simulation software which the company advertises as software for the next millennium. I had not seen this software before, and therefore, was not sure of what to expect from it. But I was pleasantly surprised with its abilities after working with it for a few days. *Extend* is supplied on a CD, accompanied by a Users Manual which covers various topics such as building a model, enhancing the model and running the model with the blocks provided with the model. It also has extensive discussion on the programming language ModL with which new blocks can be created. Software can run on both Windows as well as Macintosh platforms. The requirements for Windows version are: 486, Pentium or Pentium Pro computer, 8