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NARRATIVE REVIEW

A personal perspective on a half-century of health and fitness in Canada

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Abstract

Objectives: To summarize personal impressions of Canadian research on health and fitness between the mid-1960s and 2017. **Methods:** A narrative review of personal files and published articles, supplemented by correspondence with colleagues. **Results:** Canadian interest in health and fitness was triggered in the 1960s by remarks from the Duke of Edinburgh, the passage of Federal Bill C-131, the establishment of three Fitness Research Units, the hosting of an International Symposium on Physical Activity and Cardiovascular Health, and the foundation of the Canadian Association of Sports Sciences. Early Canadian initiatives in health and fitness included standardizing fitness testing, surveying population fitness, introducing exercise clearance procedures, exploring determinants of aerobic function, evaluating the hunter-gatherer idyll, seeking to motivate population interest in a healthier lifestyle, and presentation of the resulting findings to international meetings both in Canada and overseas. A broadening of perspectives brought administrative changes to health and fitness programmes, with the appearance of specialist publications, a growing appreciation of economic dividends from a healthy society, and a focusing of attention upon the physical activity needs of women, children, the elderly, and those with chronic disease or disability. During the 1990s, the Canadian hosting of consensus conferences on health and fitness led to growing international acceptance of the "exercise is medicine" concept, and the emergence of evidence-based recommendations for exercise clearance and daily physical activity in both healthy individuals and those with various clinical conditions. **Conclusions:** The promotion of regular physical activity is now an important corner stone of health policy. However, there remains a need to define more precisely the optimal intensity, frequency and duration of exercise needed in a variety of clinical conditions, and to relate these findings to

the individual's quality adjusted life expectancy rather than simply mortality. **Health & Fitness Journal of Canada 2017;10(2):21-76.**

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Introduction

This article presents the personal perspective of Dr. Roy Shephard on a half-century history of health and fitness in Canada. It is based on his personal files and published articles, supplemented by correspondence with colleagues.

The health and fitness movement began somewhat earlier in Europe than in Canada, with the seminal studies of Jeremy Morris on occupational physical activity and the cardiovascular health of bus drivers, bus conductors, and postal workers (Morris et al., 1953; Morris and Crawford, 1958).

Some might trace the origins of Canadian interest in health and fitness to Bill Orban (Figures 1 and 2), who popularized the 5 BX and 10 BX fitness programmes in 1956, while he was working for the Canadian Department of National Defence (Orban, 1961). This simple and straight-forward exercise plan offered the possibility of enhancing personal physical fitness in 11 minutes

per day; 23 million copies of the 5BX pamphlet were sold, and it was translated into 13 different languages. However, the primary intent of the programme was to maintain the fitness of RCAF pilots in northern bases without access to gymnasia, and the programme made no specific reference to health promotion or the prevention of chronic disease.

Most Canadians would thus argue that



Figure 1: Bill Orban, a Canadian exercise scientist renowned for his authorship of the 5-BX and 10-BX exercise programmes.



Figure 2: Booklet describing the 5-BX and 10-BX exercise programmes developed by Bill Orban.

their health and fitness movement made its major debut in Canada about 50 years ago. At least in its early days of this initiative, the Canadian Association of Sports Sciences (CASS; later to become the Canadian Society for Exercise Physiology) was a key player in the movement. The 50th anniversary of the Society (2017), thus seems a good moment to reflect on the achievements of the past half-century, and to consider the challenges that yet remain to ensure that an adequate daily volume of physical activity becomes a central component of health maintenance for Canadians.

What triggered Canadian interest in Health and Fitness?

The sequence of events that likely triggered Canadian interest in Health and Fitness includes some remarks made by the Duke of Edinburgh to the Canadian Medical Association, the passage of Federal Bill C-131, the establishment of three Canadian Fitness Research Units, the hosting of the Toronto International Symposium on Physical Activity and Cardiovascular Health, and the foundation of the Canadian Association of Sports Sciences.

The Duke of Edinburgh. In 1959, HRH the Duke of Edinburgh became the first lay president of the Canadian Medical Association (Figure 3). In his acceptance speech to the association, he made some characteristically blunt comments on the perceived lack of fitness among Canadian youth. Speaking to more than 900



Figure 3: Prince Philip, Duke of Edinburgh, became the first lay president of the Canadian Medical Association in 1959. Source: <https://www.cma.ca/Assets/assets-library/document/en/about-us/presidents/prince-philip-e.pdf>

doctors and their spouses at the Royal York Hotel in Toronto, Philip stated, *"There is evidence that, despite everything, people in Canada are not as fit as they might be. Four things are necessary to change this state of affairs. Proper physical education in schools, adequate recreation facilities for all ages and sections of the community, an extension of the work of youth organizations in both scope and age, and finally an organization to promote recreational sports and to encourage people to take part in them."* Much of the material for this speech is thought to have been provided by Doris Plewes, then a Federal government fitness and sport consultant and an advocate of mass fitness programmes.

His warning words were circulated in a Royal Bank newsletter, and they sparked a vigorous debate in the Canadian media. The *Toronto Sun* implied the Prince was guilty of a major gaffe in accusing Canadians of softness, whereas the Saskatoon Star-Phoenix quoted the Vice-Chairman of the Canadian Pan-American Games Committee, who defended Philip's statement as an echoing of the sentiments of all informed sports people in Canada.

The resulting furor quickly spread to Ottawa, where members of the Federal Parliament urged the early establishment of measures to correct the lack of fitness that the Prince had identified.

Bill C-131. In 1961, the Canadian Federal Parliament under the Progressive Conservative Prime Minister John Diefenbaker gave unanimous assent to Bill C-131 ("An act to encourage Fitness and Amateur Sport"). This Bill appointed a National Fitness and Amateur Sport Advisory Council, and led to the establishment of a Directorate of Fitness and Amateur Sport, with an annual

operating budget of five million dollars. Cost-sharing agreements were then reached with the Provinces, and grants were made to various sports governing bodies.

The Bill has often been thought simply as a reaction to the comments of the Duke of Edinburgh on the fitness of Canadian youth. Advocates on this issue included Doris Plewes (above), Lloyd Percival (Director of the Toronto CBC radio "Sports College"), and the Canadian Sports Advisory Council, the Ontario Physical Fitness Committee. But as the title ("Fitness and Sport") indicates, other factors were also at work (Harvey and Proulx, 1988; MacIntosh, 1987). In particular, the Soviet Union and other socialist states in Eastern Europe were increasingly using sport to promote national identity and ideology. Canadians who lacked comparable programmes were concerned about their sagging international athletic record, particularly in the world of Olympic and World Cup hockey. The strongly nationalistic Diefenbaker was persuaded to visit the Canadian hockey team at the Chicago Pan-American Games of 1959 to offer his personal support, but the hosting of the Pan American Games by Winnipeg in 1967 and the pending Montreal Olympic Games further heightened concerns about the need for the Canadian government to bolster the prowess of Canadian competitors.

Canadian Fitness Research Units. Acting on the fitness side of its mandate, the Directorate of Fitness and Amateur Sport decided to allocate \$150,000 of its Annual Budget over each of five years to allow the establishment of three Fitness Research Units,

Given the relatively small total funding, it might have been thought

advisable for Fitness & Amateur Sport to seek the establishment of a single Fitness Research Unit. However, faced with the regional realities of Canadian politics, the Federal Agency decided to establish three such Units, one in central Canada, one on the Prairies, and one in French Canada. The University of Toronto, the University of Alberta, and the University of Montreal were thus selected as appropriate locations for these Units. John Merriman, then a cardiologist at the University of Saskatoon, and subsequently President (1972-3) of the CASS assumed responsibility for peer review of the new Fitness Programme, promoting it with an almost manic enthusiasm (Figure 4). He paid searching and somewhat dreaded periodic site visits to each of the Units as they initiated a five-year programme of

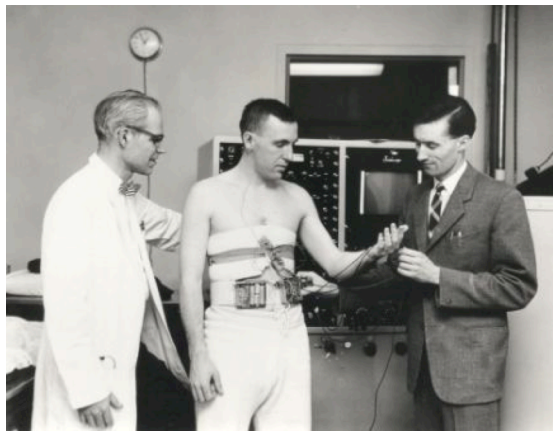


Figure 4: John Merriman (left) in the Exercise Science laboratory of the University of Saskatchewan (Saskatoon) in 1961. His subject is Don Bailey, and to the right of Bailey stands Dick Cobbold, then Professor of Bioengineering at the University of Saskatchewan. Cobbold had recently designed a telemetry unit that weighed about 5 kg and had a transmitting range of 50 m.

applied research in Exercise Physiology and Physical Fitness.

Toronto Unit. John Brown, Chair of the

Department of Physiological Hygiene in what was then known as the School of Hygiene at the University of Toronto, invited me to Canada in October of 1964, and after a flying visit to Ottawa to meet with the Minister of Health (Judy LaMarsh), I was persuaded to emigrate to Canada as Director of the Toronto Unit in November of 1964. This was a period of rapid university expansion, and I was both surprised and flattered to find that the offer included an immediate Full Professorship with tenure at the age of 35!

The Toronto Unit found somewhat cramped office and laboratory space in the School of Hygiene (Figure 5); a physical distance of about one km separated it from the University's School of Physical and Health Education. The sturdy oaken benches that had stood Charles Best in good stead for his studies of insulin many years previously were quickly filled with the supplies of the exercise physiologist, but the unsuspected persistence of a DC power source quickly burnt out one or two pieces of expensive equipment that were purchased for the Fitness Research Unit!

I also faced rather quickly the reality of living within the \$50,000 annual budget,



Figure 5: The Toronto Fitness Unit was accommodated in a small suite of rooms on the third floor of the University of Toronto's School of Hygiene (now the Dalai Lama School of Public Health).

which in 1964 dollars was stretched to cover the salary of myself, one research associate (initially Anne-Marie Pelzer, subsequently D. Edington), a full-time secretary, two very poorly paid laboratory technicians and a minimum of supplies. Any new pieces of equipment had to be justified by further grant applications, made either to government or private agencies.

Nevertheless, the Unit quickly developed Canada's first doctoral programme in Exercise Sciences, with Terence Anderson presenting a thesis that focused upon the role of pulmonary diffusing capacity as a factor limiting maximal oxygen transport in the human body (Anderson and Shephard, 1968).

Alberta Unit. Under the overall direction of Dr. Maury Van Vliet, first Dean of Physical Education and Recreation at the University of Alberta, the Alberta Fitness Research Unit began its operations in 1966 under the leadership of Ross MacNab and Rick Alderman (a sports psychologist), with some involvement also from Mohan Singh, who had research interests in muscle strength and endurance. The Alberta Unit also began teaching doctoral students in 1967, and focused increasingly on the health implications of fitness.

Bert Taylor (CASS President 1974-75, Honour Award recipient in 1986, and now Professor Emeritus in the Faculty of Health Sciences at the University of Western Ontario), later assumed a dominant role in the Alberta Fitness Research Unit. Both within the Unit and in his subsequent career, Taylor elected to focus on the cellular aspects of exercise physiology, particularly muscle fibre typing (Taylor and Bachman, 1999). However, associates of the Unit within the Faculty of Physical Education and

Recreation also conducted an ambitious, nation-wide representative survey of cycle ergometer PWC₁₇₀ performance for a representative sample of Canadian schoolchildren (Howell and MacNab, 1968), this project being completed very successfully in an era when most laboratories gave little thought to issues of population sampling.

Montreal Unit. The Montreal Fitness Research Unit was established in the Department of Physical Education at the Université de Montréal, when this department was chaired by Arthur Sheedy. The Fitness Unit was dogged by problems of ill-health in its leadership. It was first headed by Dr. Lucien Brouha, an investigator originally from Belgium, who was best known for his introduction of a simple recovery step test measurement of physical fitness (Brouha, 1943). He was relatively old when he first accepted the appointment, and he died in Vermont at the age of 69 years.

Anne-Marie Pelzer moved from the Toronto Fitness Research Unit to replace Brouha in 1966. She also was originally from Belgium, and was an ardent Feminist, eager to examine relationships between fitness and health in women. However, her Feminism quickly brought her into conflict with the conservative university authorities of that period; she was soon placed on administrative leave, eventually resigning her appointment and returning to Belgium.

Ron Ferguson was appointed as her successor in the fall of 1967, but by this time the term of the grant was nearing its end. The practical achievements of the Montreal Unit were thus quite limited, although it did provide the initial stimulus to development of the widely used shuttle-run test that Dr. Luc Léger later presented as his M.Sc. thesis under the

supervision of Ron Ferguson (Léger, 1982).

The Toronto International Symposium.

The Canadian Association of Health, Physical Education and Recreation had already hosted a "Canadian Fitness Seminar" in Saskatoon in June of 1963, but in the fall of 1966, the Toronto Fitness Research Unit assumed scientific responsibility for organizing a much larger and broader ranging International Symposium on Physical Activity and

endorsement of the Ontario Heart Foundation, the Ontario Medical Association and the Canadian Medical Association. Substantial financial backing for the venture was also provided by the Canadian Life Insurance Association, and the Province of Ontario.

Logistics. The luncheon meetings planning the Symposium were held in the Board Room of the Ontario Heart Foundation in their former offices on Davenport Rd., in Toronto, watchfully chaired by a petite but determined lay

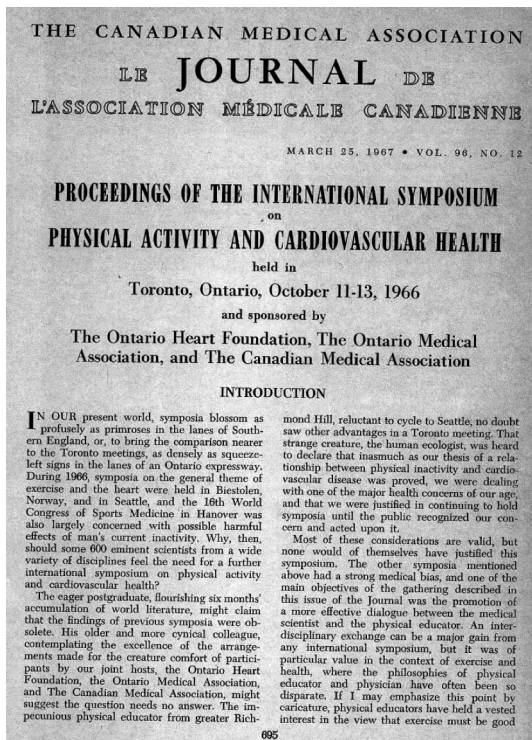


Figure 6: The Fitness Research Unit at the University of Toronto organized an early International Symposium on Physical Activity and Cardiovascular Health.

Cardiovascular Health. This was one of the earliest international gatherings where physical activity was linked specifically to the prevention and treatment of Cardiovascular disease (Figure 6). It received the enthusiastic



Figure 7: The former "Inn on the Park," site of the International Symposium on Physical Activity and Cardiovascular Health in October 1966.

volunteer, Mrs. Dorfman. Mrs. Dorfman usually organized a light ultra-low fat "healthy heart" lunch for those attending the Committee meetings. This may have been adequate for our petite hostess, but I often returned to the University feeling ravenously hungry! At this period, most of North America, including the University of Toronto's Faculty of Nutrition and the Ontario Heart Foundation were under the thrall of Ancel Keys, who argued on the rather shaky basis of the "Seven Countries Study" that cardiovascular disease was

attributable to an excessive intake of fat and particularly cholesterol (Keys et al., 1994). One of the first Master's students of the Toronto Fitness Research Unit provided an early challenge to this accepted wisdom, arguing that the problem was not the ingestion of cholesterol, but rather its hepatic synthesis because of an inadequate level of habitual physical activity (Goode et al., 1966).

The venue selected for the meeting was the former "Inn on the Park," a resort-like spa set in the sylvan environment of Wilket Creek, with beautiful trails extending down the Don Valley and up to Edwards Gardens (Figure 7). However, one of the principal speakers (P.O. Åstrand) was heard complaining loudly that the hotel had drained their pool for its fall cleaning on the day of his arrival.

Meeting format. The meeting itself tackled 36 topics relating to physical activity in the prevention and treatment of cardiovascular disease, and it attracted some 600 participants from many nations. I am glad to find in retrospect that little time was wasted on the evils of a fat diet! The format of the three-day event was unusual, with a rigid 15-minute time limit for principal speakers on each topic, and a mere three minutes for a group of three commentators (who had paid their own way to attend the symposium).

After a few brushes with the Chair (the microphone was removed from the neck of one overly loquacious participant at the 17th minute of an early presentation!), this ambitious schedule was thereafter well respected by all participants. Evening visits were paid to local sites of interest, including the Toronto Rehabilitation Centre (where Dr. Terry Kavanagh had

recently initiated his now world-renowned Cardiac Rehabilitation Programme), and North York's luxurious "Fitness Institute" (Figure 8), recently opened by Lloyd Percival to provide exclusive fitness and cardiovascular health facilities to Toronto's elite). I recall my York University teaching assistant of 1966 (a very young and dapper Norm Gledhill) efficiently marshaling delegates into a fleet of TTC buses headed to these destinations, and making many other major logistic contributions behind the scenes.

Publication of the proceedings. During the 1960s, good English language skills were less prevalent in Europe than they are today. Papers were typed and revised by the investigator and/or a departmental secretary, often being submitted in rather rudimentary English. The organizers of many international scientific conferences thus found themselves struggling not only to collect but also to rewrite outdated papers, received from speakers as long as two years after the original event. However, the full proceedings of the Inn on the Park symposium were published in good literary form and distributed to



Figure 8: Delegates visited the Fitness Institute, opened by Lloyd Percival in North York to provide cardiovascular health programmes to Toronto's elite.

some 25,000 physicians and physiologists as two special issues of the Canadian Medical Association Journal within the space of four months (Shephard, 1967). One of the main reasons for what was a very quick turnaround in the pre-computer era was that speakers were not paid their traveling expenses until they had furnished a manuscript of reasonable quality! Typewriters were available to errant meeting participants, and there were reports that at least one overseas delegate spent most of two nights typing in order to receive his travel reimbursement! One speaker also argued that the CMAJ was not a sufficiently prestigious venue for his paper. He was politely reminded that he had agreed to publication of his presentation in the CMAJ, and he was given two options—immediate submission of his manuscript, or publication of a taped transcript of his somewhat garbled talk. One look at what he had said at the meeting convinced him to forward the manuscript without further delay.

Foundation of the Canadian Association of Sports Sciences (CASS).

CASS was intended to bring together the knowledge of members of the Canadian Medical Association (CMA) and the Canadian Association of Physical Health Education and Recreation (CAHPER) in a way that would facilitate the application of ideas from fitness experts to problems of rehabilitation and health maintenance. Preliminary discussions were held between three representatives of the Canadian Medical Association (CMA) (Sam Landa, John Merriman, and Max Avren), and an equal number of delegates from CAHPER (Don Bailey, Howard Nixon, and John Leicester), CASS was formally inaugurated at a scientific meeting organized by Gordon Cumming that

accompanied the Winnipeg Pan American Games of 1967 (Figure 9). Sam Landa of Saskatoon was the first President of CASS, followed by Max Avren of Winnipeg. The primary objective of the new organization, as seen at the time, was to achieve a rapprochement of the divergent interests in Health and Fitness represented by the CMA and CAHPER.

Unfortunately, the high hopes of a sharing of ideas between physical educators and physicians were quickly quashed. By 1969, the physicians (who at that time were mainly interested in providing medical support for international competitions, rather than in developing health-related fitness) had established a steering committee to organize an independent Canadian Academy of Sport Medicine (CASM). The first president of this group was Edward Percy. From the viewpoint of the physicians, it was argued that an organization specific to medical practitioners would give them a stronger clinical focus; further, it would permit the

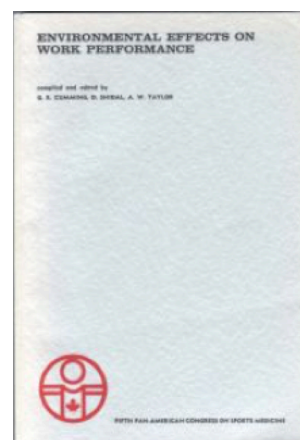


Figure 9: The Canadian Association of Sports Sciences (CASS) was officially inaugurated at a scientific meeting in Winnipeg that accompanied the Pan American Games of 1967. The published account of the meeting bears the title "*Environmental effects of work performance.*"

development of examinations that would allow certification of Sport Medicine as a specialty recognized by the Canadian Medical Association. As the interests of CASM broadened to include the effects of exercise on health, the title of the group was expanded to the Canadian Academy of Sport and Exercise Medicine. These separatist trends had the effect of limiting the subsequent role of CASS in promoting health and fitness. Rather, they encouraged the interest of members in the more esoteric aspects of exercise physiology.

Because of high travel costs, attendance at early meetings of CASS was relatively sparse. The economics of the annual meetings were further compromised by a decision to offer simultaneous English/French translation of proceedings, even in strongly Anglophone cities such as Vancouver and Saskatoon. The Francophone attendance at meetings was usually quite limited, and almost all of those who attended the CASS sessions spoke excellent English. Speakers were occasionally disconcerted to see a group at the rear of the room laughing at attempts of the commercial translator to express scientific terms in an acceptable French. I argued that we should expect Canadian academics to show reasonable fluency in both of Canada's official languages, and eventually it was decided that attempts to translate the proceedings were an unwarranted expense. However, most of the official documents of CSEP are still made available in both official languages.

As the scope of Exercise Science increased, other members of CASS with interests in Biomechanics, Sociology, Psychology, and Psychomotor Learning began organizing their own specialized conferences, further fragmenting Canadian expertise in the Sports Sciences.

The issue of "discipline separatism" was debated vigorously at a number of annual meetings, and the hope was frequently expressed that CASS might serve as an umbrella organization, bringing together all who were interested in the scholarly study of Health and Fitness. Distinguished lecturers in disciplines other than Exercise Physiology were invited (at great expense) to give major presentations at the annual meetings of CASS to accommodate the burgeoning sub-disciplines, but sadly, an audience of only three or four people sometimes greeted the lecturers.

Finally, the Exercise Physiologists recognized that they were the only people strongly committed to CASS, and in consequence its name was changed from CASS to the Canadian Society for Exercise Physiology (CSEP) in 1992. The new organizational format proved effective. Meetings began to attract a growing attendance, including Exercise Scientists with interests in Biochemistry and Nutrition, and there was a growing participation of investigators from northern United States. The reformatted Society also began a liaison with the Canadian Federation of Biological Societies, starting in 2000.

Important initiatives of CASS and CSEP have included the publication of two journals (below), the development of position stands on a number of key issues, and the certification of Exercise Physiologists.

Early Canadian initiatives in health and fitness. Early Canadian initiatives in health and fitness, often directed by the Fitness Research Units, but sometimes developed by other faculty, mainly in faculties of physical and health education, centred largely around discovering whether the Canadian population was

indeed as lacking in fitness as the Duke of Edinburgh had alleged. Steps in this process included standardizing methods for the determination of aerobic and overall fitness, developing simple procedures for pre-exercise screening, comparing the fitness levels of Canadians with people from other nations, and exploring the hunter-gatherer idyll. There was also interest in examining the determinants of maximal aerobic power, in reporting Canadian discoveries to international fora, in encouraging major health and fitness groups to hold their scientific meetings in Canadian cities, and in developing methods of motivating the Canadian population to greater levels of habitual physical activity.

Standardizing methods of fitness measurement. The Human Adaptability Project of the International Biological Programme (IBP) was initiated by Joe. Weiner of the London School of Hygiene during the 1960s (Weiner, 1964). It proposed a concerted attempt to document the biological characteristics then existing in various small and geographically isolated tribes that had adapted culturally and genetically to challenging habitats, but had not yet been “contaminated” by modern civilization. Given that many investigators would be involved, it was thought important to standardize the methods employed, and in 1966 the Toronto Fitness Research Unit was charged with organizing a working party of top-level international exercise physiologists with this objective in view. All of the investigators concerned spent three months during the summer of 1966 working in the Toronto laboratories, and the findings were summarized both in the IBP test manual (Weiner and Lourie, 1969) and a special W.H.O. publication for which I served as

Rapporteur (Shephard, 1968).

Until the 1960s, estimates of fitness in North America had been based largely upon physical performance tests, but during the 1960s the perception emerged that the best single measure of a person's physical fitness was the maximal oxygen intake, whether measured directly on the laboratory treadmill with discrete gas analysis, or predicted from sub-maximal step or cycle ergometer testing. It was recognized that anaerobic capacity and power were also important measures of performance fitness, and with the appointment of Oded Bar-Or to McMaster University in 1981, the Israeli Wingate test became a component of many Canadian fitness assessments. Measurement of body fat content was generally by underwater weighing, or using the skinfold predictions recommended by John Durnin in Glasgow.

Physical performance tests. Until the mid-1960s, both the Canadian Association of Physical Education and Recreation and its American counterpart relied on a battery of physical performance tests to evaluate the health of school children. The procedures (which differed slightly between Canadian and U.S. investigators) were carefully described by the two associations, but performance tests became discredited when Gordon Cumming in Winnipeg and the Toronto Fitness Research Unit demonstrated that the scores obtained reflected largely a combination of an individual's motivation and his or her body size (Cumming, 1978; Drake et al., 1969).

Direct measurement of maximal oxygen Intake. During the 1960s, the direct treadmill or cycle ergometer measurement of maximal oxygen intake became accepted as the best single

measure of an individual's health-related fitness, but there was concern that inter-laboratory differences of technique might be hampering comparisons between investigators, hence the IBP working party on methods of measurement (above).

In collaboration with the World Health Organisation, the IBP working group met for three months during the summer of 1966 in the laboratories of the Toronto Fitness Research Unit (Shephard, 1968; Shephard et al. 1968a, b, c). Working party participants were drawn from many of the main health and fitness centres around the world, and a large part of the Toronto School of Hygiene was commandeered to provide space for this project; even the ancient vats in the basement, originally used to prepare insulin, were pressed into service by Japanese participants as they compared skinfold predictions of body fat with underwater weighing determinations. In order to evaluate various potential test protocols, a panel of 24 highly motivated young men committed themselves to a very demanding schedule, completing measurements of maximal oxygen intake five times per week for a total of five weeks. Gas samples for individual estimates were still collected in a vast array of Douglas bags, but fortunately Beckman infra-red CO₂ detectors and paramagnetic oxygen analyzers had replaced the tedious chemical analysis of gas composition by Haldane apparatus.

Direct measurements of maximal oxygen intake and a range of cognate variables were also made for the first time on a representative sample of Toronto school children. The children were found able to perform maximal tests, although they demonstrated plateaus of oxygen consumption less consistently than the panel of well-motivated young adults. For

this reason, the assessment of all-out effort in children subsequently moved to use of the shuttle-run test, as developed by Luc Léger (1982). Work from the Toronto laboratory demonstrated that all-out testing was also possible in healthy seniors aged 65-85 years (Sidney and Shephard, 1977), but as with studies of children, some Canadian investigators opted for sub-maximal walking tests when appraising elderly clients (Cunningham et al., 1986).

The IBP working party demonstrated that in adults, maximal oxygen intake could be measured quite successfully not only on a treadmill, but also on a cycle ergometer and during a simple stepping task, although there were small systematic differences between the three approaches, reflecting differences in the volume of muscle activated. With the population of young and relatively fit men, mean values were four percent smaller when stepping and seven percent smaller when using a cycle ergometer relative to the standard set by the treadmill.

Shuttle Run. The multi-stage shuttle run (Léger, 1982) is also a maximal aerobic test, developed by Luc Léger in the Montreal Fitness Unit (Figure 10). Subjects begin the test at a pace demanding seven metabolic equivalents (METs) of energy expenditure, and the load is increased by one MET every two minutes. This test has the advantage of requiring a minimum of equipment. Scores are also relatively independent of the running surface, and the inter-class correlation coefficient is high (0.975 when performed by young adults). The shuttle run score predicts the directly measured maximal oxygen intake without systematic error, although as with other indirect approaches, there is a standard

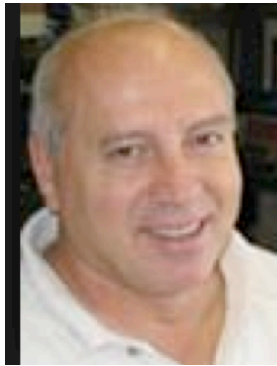


Figure 10: Luc Léger developed the multi-stage shuttle run while a graduate student in the Montreal Fitness Research Unit.

error of at least 10% relative to the direct measurements.

Sub-maximal testing. During the 1960s, there was a strong demand for sub-maximal test procedures, as many physicians were still unwilling to allow any measurements of maximal oxygen intake, even on healthy young adults, unless tests were performed under their direct supervision. The I.B.P. working group demonstrated that even in young adults, sub-maximal predictions differed from direct measurements of maximal oxygen intake with a coefficient of variation of about 10% (5 ml/[kg.min]). The data was thus only adequate for assessing aerobic fitness in large populations. Nevertheless, some investigators continued to use submaximal tests to advise individual clients about their fitness levels.

PWC₁₇₀. In preparation for a national survey of Canadian schoolchildren, investigators at the Alberta Fitness Research Unit, led by Howell and MacNab (1968), opted for use of the PWC₁₇₀, the physical working capacity observed on a cycle ergometer when exercising at a

heart rate of 170 beats/min. This approach has the advantage of reporting what the client actually achieved, rather than making a peak heart rate prediction of dubious merit, although if the PWC₁₇₀ is applied to older adults, aging makes the task of cycling at a heart rate of 170 beats/min progressively more demanding and closer to the individual's peak effort.

Åstrand-Ryhming Nomogram. Many investigators in Canada preferred to make a heart rate extrapolation to predict the oxygen consumption at what was assumed to be an individual's maximal heart rate, using for this purpose a simple nomogram popularized by Åstrand and Ryhming (1954). It is interesting to note that in the title to their paper about the nomogram, a parenthesis indicates the authors' view that the predicted maximal oxygen intake was synonymous with the individual's physical fitness; however, Åstrand and Ryhming fell into the trap of terming the output of their nomogram an aerobic capacity rather than aerobic power (a capacity rather than a rate of oxygen delivery).

In order to facilitate the electronic handling of sub-maximal exercise data, the Toronto Fitness Research Unit developed a simple computer programme to carry out the calculations underlying the Åstrand nomogram (Shephard, 1970).

Canadian Home Fitness Test. One of the interesting findings from the IBP Working Party was that subjects could be brought to within three to four percent of their treadmill maximal oxygen intake using a simple double step, climbed and descended by repeatedly taking three paces in each direction. Previous authors had tended to dismiss the potential to determine aerobic fitness through step testing, perhaps because many of them

had used taller steps that subjects found difficult to climb. However, an eight to nine inch double step test was shown to offer a valuable alternative to the treadmill, particularly when testing people in their own homes or in remote communities that lacked the power supply needed to operate a treadmill.

The Toronto double step test (Shephard, 1967) first found extensive application in the IBP studies of circumpolar populations. In the chosen community of Igloolik, most of the population in 1970 spoke only Inuktituk, so an appropriate stepping cadence was maintained by chanting the Inuit equivalent of one-two-three on a rising and then on a descending scale throughout the test. The double-step test worked very well in Igloolik, and its effectiveness as a means of testing large populations was further demonstrated in Saskatoon, where in a joint study with investigators from the University of Saskatchewan, groups of 16 subjects of similar age and sex climbed and descended long double benches to a rhythm set by metronome (Bailey, Shephard and Mirwald, 1976; Figure 11).

The test was later used both in the first Canadian Fitness Survey (1981) and as part of a package (the Home Fitness Kit) intended to increase physical activity in the general population.

6-Minute walk. In collaboration with Don Paterson, one of the doctoral graduates from the Toronto Fitness Research Unit, David Cunningham (Figure 12), developed a large geriatric rehabilitation programme at the University of Western Ontario. Some treadmill measurements of maximal oxygen intake were made on this population, but many observations of aerobic performance were made in terms of the distance clients could walk in 6

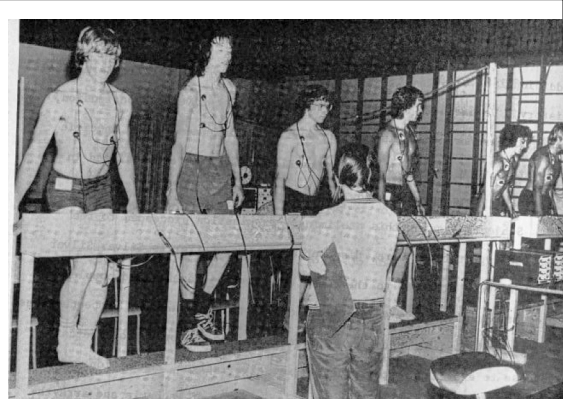


Figure 11: The double-step concept of the Canadian Home Fitness Test was evaluated on a large population sample in Saskatoon in 1973. Groups of 16 age and sex-matched subjects performed the double-step test simultaneously to a rhythm set by a metronome.

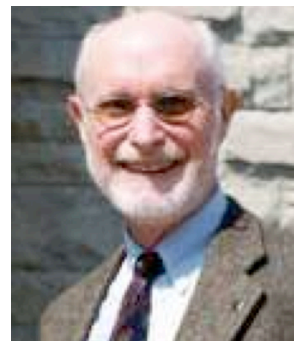
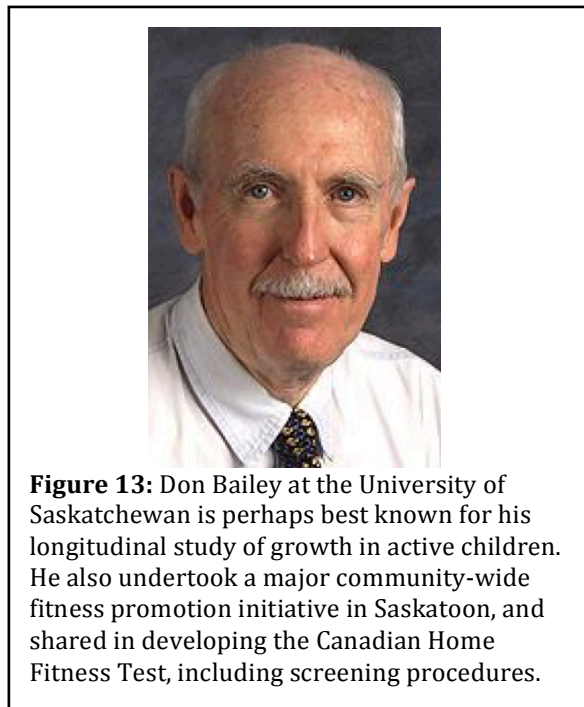


Figure 12: David Cunningham has pursued studies of health and fitness for many years at the University of Western Ontario. He is perhaps best known for his leadership of the Canadian Centre for Activity and Aging.

minutes (Cunningham et al., 1986). As with other sub-maximal tests, the procedure provided meaningful group estimates, but the error was too large to allow evaluation of individual subjects.

Pre-exercise screening. When planning the Saskatoon evaluation of the Home Fitness Test concept, Don Bailey (Figure 13) and I had an extensive preliminary discussion of test safety. We recognized

that the stepping test was essentially self-limited. Moreover, it was never carried to more than 70-75 % of the individual's maximal oxygen intake, and the risk associated with three minutes of effort at this intensity was very low. Nevertheless, we considered it prudent to develop a brief questionnaire to identify high-risk individuals who should consult their physicians before undergoing the double-step test.



David Chisholm evaluated the questions that were asked in this project against his clinical judgment in a large sample of adults who were attending the Pacific National Exhibition (Chisholm et al., 1975), and based on this experience the PAR-Q screening tool was developed (Shephard, 1988). The PAR-Q has since found widespread acceptance as a screening tool, both in Canada and around the world. Many years of practical experience on large populations have demonstrated that it offers a safe clearance procedure not only for sub-

maximal exercise testing, but also and for those entering a moderate intensity exercise programme. The main practical difficulty in use of the PAR-Q has been that a rather high proportion of people (about 20 per cent of adults) are advised to seek further guidance from a physician. Minor modifications of the questionnaire (Thomas et al., 1992) failed to adequately eliminate unnecessary referrals.

Recognizing the potential of the PAR-Q instrument, an enthusiastic team led by Norman Gledhill and Veronica Jamnik at York University and Darren Warburton and Shannon Bredin at the University of British Columbia (Figure 14) set about the task of a detailed, evidence-based restructuring of the questionnaire (Warburton et al., 2011a). The new instrument was devised to be completed electronically, and if users showed a positive response to any of the questions, a carefully validated algorithm led the individual through a series of probing questions, with a final conclusion of clearance for exercise, referral to an exercise professional, or referral to a physician. This process remained true to the original intentions of the authors of the PAR-Q providing an evidence-based update and revision.

The original attempts to develop a screening form for use by physicians (the PAR-MED-X) met with limited acceptance. Most physicians found the documents too complicated and time-consuming to complete during a brief clinical consultation. Under the direction of Drs. Gledhill and Warburton, the PAR-Q+ Collaboration have now revised the PAR-MED-X into the ePARmed-X+ (www.eparmedx.com), with the intent that it can be used by either Physicians or Qualified Exercise Professionals with advanced specialized training. In the new version, an electronic decision tree

Figure 14: Key members of the PAR-Q+ Collaboration.



Dr. Norman Gledhill has served as a Professor of Kinesiology at York University since 1966. He has played a lead role in developing tests of fitness for employment in relationship to equal employment opportunity legislation, and in the certification of fitness and health professionals, as well as sharing with Drs. Warburton, Bredin, and Jamnik in developing the new PAR-Q+ and ePARmed-X+.

Dr. Veronica Jamnik is an Associate Professor at York University. She has been involved in examining the mechanisms underlying differential training responses, advancements in pre-participation screening, and bona fide occupational fitness requirements.



Dr. Shannon Bredin, at the University of British Columbia, is currently Editor-in-Chief of the *Health and Fitness Journal of Canada*. She has played a key role in the knowledge translation of the health benefits of physical activity. She also serves as key member of the PAR-Q+ Collaboration ensuring that the new risk stratification process is consistent with current advancements in the field.



Dr. Darren Warburton currently directs the laboratory of Physical Activity Promotion and Chronic disease prevention at the University of British Columbia. He has played a leading role in developing the *Health and Fitness Journal of Canada* and in preparing and validating electronic versions of the PAR-Q+ questionnaire.

comprehensive screening process. This process has already led to a marked reduction in the number of clients sent to see a physician (particularly those living with a chronic medical condition).

Comparing fitness levels between nations. Given the geographic constraint of a widely dispersed population, obtaining representative data on the health and fitness of the Canadian population is a daunting challenge. Some early studies were thus based on moderately representative groups, such as those attending the Canadian Nation Exhibition. However, CAHPER was able to obtain measurements of PWC₁₇₀ on a representative sample of schoolchildren, and the first Canadian Fitness Survey was able to evaluate a stratified random sample of Canadians from ages seven to 65 years.

Data from non-random sampling. The first attempt to assess the fitness of Canadian adults was based on volunteers attending the Canadian National Exhibition in 1996. Cycle ergometer tests on a large sample of this population provided sub-maximal predictions of aerobic power (Shephard and Pelzer, 1966).

The findings were compared with levels of aerobic fitness reported from other nations (Shephard, 1966). Both for men (Figure 15) and for women, the Canadian data seemed to lie a little above the average for most other nations, with the exception of Sweden, where data reported by P-O Åstrand in his 1952 doctoral dissertation were substantially higher.

Canada's motivational agency ParticipACTION considered this article as proof that Canadians were unfit, and they built a television advertisement around

speeds progress through a

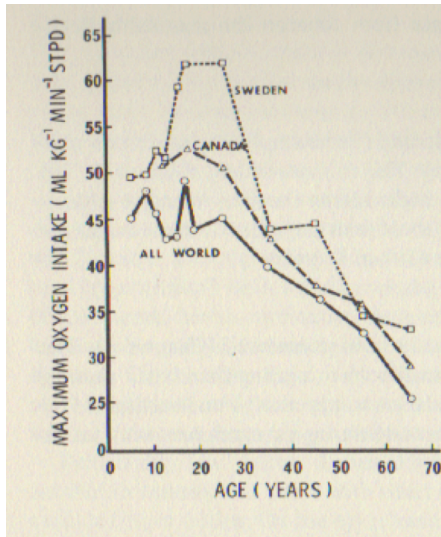


Figure 15: The maximal oxygen intake for 6633 non-athletic men from various countries around the world compared with data for 505 Torontonians and data for Swedish men, based largely on the doctoral thesis of P-O Åstrand, published in 1952.

this graph, showing a young Canadian man being out-run by an elderly Swede. However, it later transpired that the supposed superiority of the Swedes was due to non-random sampling; Åstrand had deliberately excluded those who were obese from his sample, and about a third of those he tested were "rather fit."

PWC₁₇₀ of Canadian schoolchildren. In 1966, the Canadian Association for Health, Physical Education, and Recreation (CAHPER) under the leadership of Max Howell (Figure 16) and the University of Alberta embarked on a unique, ambitious and innovative programme, taking Monark cycle ergometers into schools to measure the PWC₁₇₀ on a large and statistically representative sample of Canadian children aged 10 to 17 years (Howell and MacNab, 1968). This survey allowed them to develop norms of PWC₁₇₀ for the entire school-age population of Canadians, and

provided a benchmark against which the aerobic fitness of individual children could be judged. The mean values of the Canadian children had a fitness level similar to or a little poorer than that reported for other developed countries; however, when the survey was repeated some 15 years later (Gauthier et al., 1983), values were seven percent higher for the boys and 20% higher for the girls.



Figure 16: Max Howell of the University of Alberta led the CAHPER study of PWC₁₇₀ involving a representative sample of Canadian school children aged 10-17 years.

Canadian Fitness Surveys and the CLFRI.

Having devised a readily portable test of aerobic fitness (the double step test, above), and an appropriate preliminary screening procedure (the PAR-Q test), Health Canada decided to undertake the ambitious project of making repeated measurements of multiple components of Health and Physical Fitness on a large and representative sample of the Canadian population at all ages between 7 and 65 years. In September of 1980, the Canadian Fitness and Lifestyle Research Institute was established for this purpose, under the very effective direction of Cora Craig (Figure 17). Their first nation-wide survey was completed in 1982 (Canada Fitness Survey, 1983). This provided

extensive data, including height, body mass, blood pressure, double-step test estimates of maximal oxygen intake, push-up and sit-up tests of muscular endurance, dynamometer measurements of handgrip strength, skinfold caliper data on sub-cutaneous fat thicknesses, girths and bone diameters, sit and reach tests of flexibility, and questionnaire estimates of habitual physical activity (Shephard, 1986). In general, findings confirmed the earlier non-representative data showing



Figure 17: Dr. Cora Craig, Director of the Canadian Fitness and Lifestyle Research Institute, has directed several surveys of Fitness and Physical Activity in large and representative samples of the Canadian population of all ages from 7 to 65 years.

that the fitness of Canadians was similar to that observed in other developed countries.

Partly because of the large costs involved in this endeavour, most subsequent surveys used questionnaires rather than direct physiological measurements to track on-going levels of physical activity and fitness in the Canadian population. However, the prognostic value of the double-step test data was underlined in a seven-year follow-up of participants in the 1982 survey. There had been 691 deaths of subjects over this period, and all-cause mortality and cardiovascular mortality was significantly increased in those with poor scores on the fitness test (Arraiz et al., 1992).

Gaston Godin, a doctoral student at the University of Toronto (Figure 18), concluded that many of the questionnaires used to estimate physical activity in the large population studies are ineffective because they were too long and complicated (Godin and Shephard, 1985). He devised a very simple questionnaire which has been widely used around the world, and yields correlations with objective measures of fitness that compare very favourably with more lengthy instruments, whether the latter are completed alone or with the help of an exercise professional.



Figure 19: While a graduate student at the University of Toronto, Gaston Godin, developed a simple physical activity questionnaire which has been widely applied around the world. He has himself used this questionnaire for studies of the behavioural influences underlying health and leisure behaviour.

The large-scale use of pedometer/accelerometers to measure physical activity patterns was a part of the Canadian Health Measures Survey, led by Dr. Mark Tremblay of the Children's Hospital of Eastern Ontario (Figure 19), and sponsored by Statistics Canada and the Public Health Agency of Canada. This has further underlined the large systematic errors in many of the original questionnaire estimates of habitual physical activity, and it has allowed exploration of the concept that sedentary time as well as the duration of physical

activity may have consequences for an individual's future health (Larouche et al., 2016).



Figure 19: Mark Tremblay and his colleagues at the Children's Hospital of Eastern Ontario have studied activity patterns and sedentary time in large surveys of children using accelerometers.

The hunter-gather idyll. During the 1960s, the idea gained currency amongst those interested in health and fitness that people would improve their health if they returned to the physically vigorous lifestyle demanded in hunter-gatherer societies (Shephard, 2015). Thus, there was a systematic collection of data on health and fitness in isolated neolithic tribes, and longitudinal studies were made of the Canadian Inuit community of Igloolik as it progressively adapted to a much more sedentary "Western" lifestyle.

Health and fitness in neolithic societies.

One of the central objectives of the IBP was to collect data on the health and fitness of isolated tribes who had lived for many generations in demanding habitats. Roy Shephard of the Toronto Fitness Research Unit (Figure 20) was charged by Dr. Wiener, Director of the Human Adaptability Project of the IBP with the collation and analysis of this data, a task that was completed in 1978 (Shephard, 1978a).



Figure 20: Roy Shephard directed the Toronto Fitness Research Unit, and was associated with the University of Toronto for some 50 years. He undertook several projects for the IBP, including the standardization of fitness testing, collation of data on the fitness of populations living in demanding habitats, and a longitudinal study of health and fitness in the circumpolar community of Igloolik.

Although fitness levels were high in a few of these communities, in many the findings were unremarkable. There are several reasons why physiological adaptations to a demanding habitat were often limited. Perhaps the most important was that survival was favoured by hunting skills and an ability to transmit these talents to younger members of the tribe rather than by exceptional aerobic fitness or muscular strength. Moreover, many of the populations that were studied lived at the junction of several differing eco-systems, and adaptations that might have helped success in one environment might actually have been a disadvantage at a different time in the year, when the hunters moved to a differing environment.

IBP studies of Inuit. It was agreed with Dr. Wiener that one of the North American contributions to the IBP Human Adaptability Project would be a systematic study of human adaptations to the arctic environment, as seen among three differing Inuit populations. The U.S. made some measurements of maximal

oxygen intake at Fort Wainwright, Alaska, and Scandinavian investigators also completed limited observations on a Greenlandic population, but the most comprehensive study was undertaken at a field station in Igloolik, at the tip of the Melville Peninsula (Figure 21).

Much modern laboratory equipment was flown to this community, allowing a full range of sophisticated tests of health and fitness to be completed by all willing villagers from primary school to old age (Shephard and Rode, 1996). Members of the research team also accompanied the Inuit on traditional hunting expeditions, obtaining unique data on the very high metabolic cost of such activities, and allowing an economic analysis of relationships between the energy expended in hunting and the caloric yield in terms of foodstuffs. One unique feature of the Canadian study is that investigators continued to visit the village over the next 20 years, thus allowing documentation of a progressive deterioration in health and fitness as the community became acculturated to a southern Canadian lifestyle (Shephard and Rode, 1996), with major reductions in daily energy expenditures, and a transition from country food to the less nutritious diet purchased at the village store.

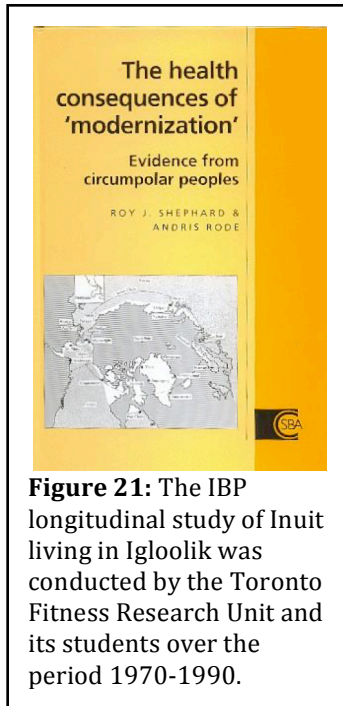


Figure 21: The IBP longitudinal study of Inuit living in Igloolik was conducted by the Toronto Fitness Research Unit and its students over the period 1970-1990.

Determinants of maximal oxygen intake. Given the importance of maximal oxygen intake to the assessment of aerobic fitness, the Toronto Fitness Research Unit made a systematic analysis of the determinants of peak oxygen transport. It examined potential variables such as maximal voluntary ventilation, alveolar dead space, maximal pulmonary diffusing capacity, the oxygen carrying capacity of the blood, the maximal cardiac output and the maximal oxygen diffusing capacity of the active tissues. By treating these elements as a linear series of conductances, it was demonstrated that the maximal pressure gradient (and thus the limiting factor) for oxygen transport in a healthy individual was the product of maximal cardiac output and the oxygen-carrying capacity of the blood (Shephard, 1971). Also worthy of note is Norm Gledhill's seminal research on blood doping and the immense role of diastolic performance in maximal cardiac output.

Contributions to international fora. Canadian investigators interested in health and fitness have made major contributions to major international fora. Beginning in the 1960s, they showed a willingness to present and defend their new knowledge repeatedly on the world stage. On a per capita basis, Canadian attendance at international (and often American) meetings typically exceeded that of their more wealthy U.S. peers. For example, Don Bailey noted that at the 10th Annual meeting of the American College of Sports Medicine (ACSM), held in Minneapolis in 1963, five of 40 papers came from Canada. Possibly the scattered population of Canada accustomed its scientists to the rigours of international travel. Certainly, I can remember crossing the Atlantic in both directions on two and

even three occasions in some months. Moreover, fluency in one or more foreign languages gave many Canadians an important practical advantage over their American counterparts.

Canada has contributed three presidents to the ACSM (Claude Bouchard, John Sutton, and myself), and Claude and I have also received the Honour Award of ACSM. Claude Bouchard has also been President of both the North American Association for the Study of Obesity, and the International Association for the Study of Obesity, and I have served as Rapporteur to the WHO meeting of investigators on exercise tests in relation to cardiovascular function (Shephard, 1968).

Hosting of international meetings in Canada. Despite U.S. tax regulations making it difficult for their scientists to attend meetings outside of the U.S., a joint meeting of CASS and the American College of Sports Medicine was held at Toronto's Inn on the Park in May of 1971 (Figure 22). The terms of the agreement with ACSM regarding this meeting stipulated that registration fees would be distributed on the basis of nationality, and since many Canadians normally attended the ACSM annual meeting, but relatively few Americans had previously participated in Canadian events, this proved a very

advantageous arrangement for the coffers of CASS. The joint meeting followed hot on the heels of the Front de Libération de Québec crisis of October 1970, and the decision of the hotel chef to process a "bombe flambé" into the final dinner produced a mixture of amusement and consternation!

The third International Symposium on the Biochemistry of Exercise was attracted to Quebec City by Fernand Landry in 1976, as a part of a major multidisciplinary meeting associated with the Montreal Olympic Games, and the Biochemistry group has paid return visits to the University of Western Ontario (at the invitation of Albert Taylor, in 1988) and to the University of Guelph in 1999.

A major meeting of the International Society for Exercise Immunology was also hosted in Toronto, by Pang Shek and Roy Shephard, in 1996, with the proceedings published as a special issue of the *Canadian Journal of Physiology and Pharmacology* (76[5],1988).

The European Pediatric Work Physiology Group visited Trois Rivières for its seventh meeting in October of 1975 (Lavallée and Shephard, 1977), and Oded Bar-Or subsequently drew the North American Pediatric Exercise Society to Southern Ontario for at least one of their biennial meetings. Other major events drawing international scientists to Canada were the several consensus gatherings on fitness and health, discussed below.

Developing techniques of population motivation. Canadian scholars quickly recognized that motivation was the key to enhancing the fitness of the Canadian population. Methods of achieving this included publicizing the findings from the Canadian fitness surveys (as noted above), devising a Home Fitness Kit, and

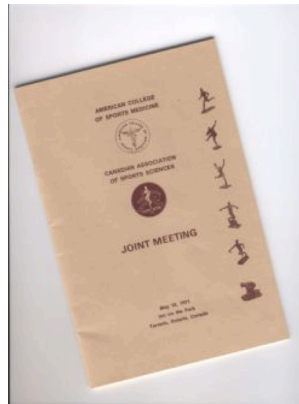


Figure 22: A joint annual meeting of CASS and ACSM was held at Toronto's Inn on the Park in 1971.

developing an advertising campaign through a government funded agency (ParticipACTION).

The Canadian Home Fitness Kit. The Canadian Fit Kit was a promotional package introduced by the Directorate of Fitness & Amateur Sport. Among other items, it included the PAR-Q screening test leaflet and a long-playing gramophone record (Figure 23) that provided an age and sex-specific set of musical rhythms; the latter allowed people to estimate their cardio-

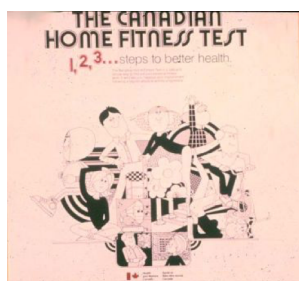


Figure 23: The long-playing gramophone record included in the Canadian Home Fitness Kit.

respiratory fitness by performing the double-step test at home, and subsequently to choose an appropriate exercise programme based on this information.

The idea of a fitness kit seemed to have some commercial potential, but neither Don Bailey nor I had any experience in the marketing of long-playing records, so we decided to "sell" the idea to ParticipACTION, the Crown Corporation which had been set up in 1971 to promote the fitness of the Canadian population. The contract specified that Don and I would each be paid one third of a cent for exclusive rights, although we have yet to receive this unique payment!

When placed under government sponsorship, the concept faced the inevitable bureaucratic hiccups. A group of musicians was hired to provide suitable martial music to guide the stepping rhythm, but only after it had been composed and recorded did someone in

Ottawa realize that the band should have played in $\frac{3}{4}$ rather than $\frac{4}{4}$ time. However, the error was corrected, and a suitable package was eventually assembled for mass use. This included the PAR-Q clearance sheet (below), the LP recording, instructions for carrying out a sub-maximal exercise test, and some simple exercises that could be performed based on the test results.

Dr. Gordon Cumming (Figure 24) was quick to point out that if a cheap turntable was used to play the music, there was still a problem of cadence as the needle approached the centre of the disc, but this issue was resolved by a change to taped and then CD versions of the music. A substantial volume of the test package was eventually sold through the unlikely outlet of official government book-stores, although I suspect that with more aggressive commercial marketing, distribution could have been increased by at least an order of magnitude.



Figure 24: Gordon Cumming was a pediatric cardiologist from Winnipeg who regularly attended meetings of the European Pediatric Work Physiology group. He quickly criticized field performance tests, and argued for their replacement by objective measurements. Interest in ECG identification of exercise-induced myocardial ischaemia led him to accept a post as Medical Director of Great West Life Insurance in 1981.

ParticipACTION. *ParticipACTION* was designed as a nation-wide motivational programme to increase the habitual physical activity of the Canadian population. It was founded as a not-for-profit Crown Corporation in 1971, with Lester B. Pearson as its first Chair, and Philippe de Gaspé Beaubien, the Chair of the *Canadian Council for Physical Fitness & Amateur Sport*, as its first President.

The name was chosen to skate diplomatically around the connotation of hard work that some people found in the words “*exercise*” and “*fitness*.” Prime Minister Pierre Trudeau agreed to contribute \$2.5 M to the project, provided that Beaubien could raise \$2.5 M from the private sector; Beaubien matched the contribution in part by securing a large number of valuable public service announcements. Russ Kisby (Figure 25) was hired as Director-General in 1972.

“*Public service announcements*” soon appeared on television and in buses, and a pilot fitness project was launched in the city of Saskatoon. One controversial 15-second film showed a 60-year-old Swede jogging effortlessly beside a puffing 30-year-old Canadian. Other slogans included: “*Jog to the rear of the bus. If you’re like most Canadians, it’s the only real exercise you’ll get today,*” and “*Canada, the true north, soft and free.*”



Figure 25: Russ Kisby served as Director General of ParticipACTION from 1972 until his retirement in 2000.

In 1974, *ParticipACTION* launched a newspaper, and two years later activity trails were built in 100 Canadian communities. Other initiatives included a booklet high-lighting the lack of fitness among children (“*What’s the Matter with Kids?*” 1979), and an employee fitness booklet (1980-81) directed to 100,000 workers and their families.

In 1982, *ParticipACTION* Saskatoon challenged 100 Canadian towns to exceed the level of habitual physical activity found among their citizens. Other initiatives sought to improve eating and to increase exercise in schools, to provide a training plan for the Canadian Forces (*Exprès*), and to distribute “*Health Saver*” pamphlets to Canadian family physicians. In the 1990s, the emphasis shifted to active living, and in 1998, *ParticipACTION* joined with *Health Canada* to launch *Canada’s Physical Activity Guide to Healthy Living*.

By the turn of the 21st century, government funding of *ParticipACTION* had shrunk to a level where it was difficult to maintain an effective national publicity campaign. Moreover, the “*public service announcements*” that were initially the mainstay of the organisation had become a rarity. Thus, with the retirement of Russ Kisby in 2000, *ParticipACTION* officially ceased operations. However, it was revived in 2007, and now is placing increased emphasis upon social media as a means of raising the public’s awareness of the need for regular physical activity.

Broadening Perspectives. The middle years of Canada's half-century of health and fitness were marked by broadening of perspectives. In addition to some significant administrative changes, specialist publications appeared, there was growing discussion of the economic

impact of a healthier society, and there was increased quality control of fitness data. Interest was focused upon health and fitness in sub-groups of the population such as women, children, the elderly and those with special needs, exercise programmes blossomed in the prevention and treatment of many chronic diseases. There was also increasing recognition of the impact of an appropriate level of physical activity upon immune function.

Administrative changes. A key factor associated with the development of health and fitness initiatives across Canada was a change in name of what had previously been termed physical education programmes, with a growth in the acceptance of Kinesiology as an academic discipline by other university departments across Canada. This recognition was accompanied by the establishment of rigorous graduate programmes in exercise, health promotion and fitness science, together with the certification of professional specialists in these domains.

Departmental name changes. A change in the name of academic programmes and an associated change in the underlying curricular philosophy were potent factors in developing recognition of Canadian expertise in health and fitness science. Schools and Faculties which had formerly focused on the training of sports coaches, trainers and teachers of physical education turned to the preparation of students with a broad understanding of the science underlying human performance and health. The trend began in two of Canada's newer universities, Simon Fraser and Waterloo, as in 1967 they each established what they termed Kinesiology programmes. Other more

conservative universities, with a longer history, progressively followed their example.

The term Kinesiology remains a popular descriptor for faculties focusing on health and fitness, although there have been other choices (for example Kinanthropology in Sherbrooke and initially in Ottawa), and Human Kinetics (at the University of Guelph, the University of Windsor, and currently in Ottawa).

Academic acceptance. Academic acceptance of the health and fitness movement by medicine and other university departments has been helped by the change in name and curricular philosophy of former Faculties of Physical Education.

In Britain and some European countries applied health research was for long welcomed with less than open arms. I can recall attending meetings of the British Physiological Society when leading members of the Society would walk out of a Meeting, rather than audit a paper in Applied Physiology. Persistence of this prejudiced attitude caused many applied scientists to emigrate to Canada and elsewhere. Canadian acceptance of the need for human studies examining interactions between exercise and health, the provision of appropriate research funding, and the welcoming of scientists who had been denied opportunity for such investigations in their countries of birth all contributed to growth of the health and fitness movement in Canada.

Opportunities for graduate education. A number of early Canadian investigators who were interested in health and fitness found it necessary to travel to the United States in order to complete their doctoral training. Nevertheless, with impetus

provided by the Fitness Research Units and the change in academic focus at many other universities, Canada began to develop its own Ph.D. programmes in these areas of knowledge, beginning the 1960s. The first doctoral candidates graduated from the University of Toronto in 1966 and from the University of Alberta one year later.

The emphasis of the new programmes was rigorously scientific, backed by laboratory facilities and curriculae that were superior to what had previously been available in U.S. physical education-centred faculties that granted doctoral degrees, and indeed comparable with the excellent programmes in clinical physiology that were already offered in a few Scandinavian laboratories. The new emphasis quickly attracted not only doctoral candidates, but also post-graduate research fellows who later gained outstanding international reputation. Notable post-doctoral fellows in Toronto included the late Oded Bar-Or (from the Wingate Institute in Israel), Henri Vandevale (Hôpital Pitié Salpêtrière, Université de Paris VI), Dr. Vetencourt of Caracas, Venezuela, Dahong Zhuo (Ghuanzuo, China), several distinguished Japanese colleagues (Keiji Yamaji, Shoji Shinkai, Yuki Aoyagi and Masa Suzui), and members of the IBP Working Party on the Standardization of Exercise Testing (Oded Bar-Or, Israel; Spinne Benade, South Africa; Mervyn Davies, U.K.; Serge Degré, Belgium; Pietro di Prampero, Italy; Rune Hedman, Sweden; Kenji Ishii and Makoto Kaneko, Japan; Jean René LaCour, France; Kjell Myhre, Norway; and Vaclav Seliger, Czechoslovakia).

Specialist certification. Under the able leadership of Norm Gledhill and Art Salmon, the Canadian Society of Exercise

Physiology (CSEP) in 1981 established a professional standards programme that offered certification to health and fitness professionals who met specified academic standards (Warburton and Bredin, 2009). Certification served to protect consumers by regulating standards of practice, and it gave appropriate recognition to those professionals who had taken the time to receive advanced qualifications. There are currently two levels of certification in Canada: the *CSEP Certified Exercise Physiologist® (CSEP-CEP)* and the *CSEP-Certified Personal Trainer* (CSEP, 2014).

In 2007, Canada also saw establishment of the *College of Kinesiologists of Ontario*. This College regulates the profession of kinesiology in accordance with the Regulated Health Professions Act of 1991 and the Kinesiology Act, of 2007. Requirements cover such issues as minimum standards of education, use of title and designations, fees and billing, professional boundaries and collaboration, scope of practice and controlled acts, record keeping, mandatory reporting, and prevention of sexual abuse (College of Kinesiologists, 2017).

In 2014, a new association, The Health and Fitness Federation of Canada (HFFC) was founded to focus entirely on fitness practitioners. All funds generated by the HFFC are spent on fitness initiatives without the need to subsidize the meetings and business of an associated academic group. The Federation offers certification and insurance for HFFC Certified Personal Trainers and HFFC Certified Exercise Physiologists. The official journal of the HFFC is the Health and Fitness Journal of Canada and the programme textbook, which expands beyond the CPAFLA, is the Physical Activity and Lifestyle “r” Medicine or PALM. This program builds upon the

pioneering early work of leading Canadian academics and practitioners (such as Dr. Norman Gledhill, Dr. Art Salmon, Dr. Art Quinney, Dr. Veronica Jamnik).

Publications. Through journals, position stands, and the publication of authoritative texts Canadian investigators have played a major role in disseminating new information on health and fitness over the half century.

Journals. When CASS was founded, there was hope of publishing a health and fitness-related journal jointly with the American College of Sports Medicine (ACSM). But despite strong pleas to the first editor-designate of *Medicine & Science in Sports* (Bruno Balke), the loudest of the U.S voices on the ACSM Board expressed confidence in their ability to publish a journal without Canadian participation. As a small tribute to the Canadian overtures, I became a section editor of *Medicine & Science in Sports* for the first five years of its publication.

The Board of CASS continued to press for a journal that could be distributed to its members as a component of annual dues, and the *Canadian Journal of Applied Sport Sciences (CJASS)* was launched in 1976, with an on-line version dating from 2013. The first editor was Bert Taylor (1975-79), and he was succeeded in turn by Eric Bannister of Simon Fraser University (1980-84), David Cunningham (1985-1988), Roy Shephard (1988-1991), David Cunningham (1992-94), Phil Gardiner and François Perronet (1995-1999) and Terry Graham (2000 – to date).

In its early years, CJASS published articles covering a wide range of areas of health and fitness. The National Research Council Press became the publisher of the

journal in 2006, and reflecting a progressive restriction of the range of topics to exercise and nutrition the title was changed to *Applied Physiology, Nutrition & Metabolism* (APNM).

As the focus of APNM changed, members of CSEP (and other underrepresented fitness professionals) who were involved in the delivery of clinical health and fitness programmes felt a need for a journal that addressed their interests more specifically. Thus, in 2008, the open-access, on-line *Health & Fitness Journal of Canada* was born under the very capable leadership of Dr. Shannon Bredin. Its stated mission is to publish information that “*can be applied directly to improve the health and well-being of Canadian Society.*” Four issues are currently published each year, with articles that cover a wide range of topics in Health and Physical Activity.

Other Canadian journals that have continued to publish articles relating to health and fitness include the *Canadian Medical Association Journal*, the *Canadian Family Physician*, the *Canadian Journal of Public Health*, and the *Clinical Journal of Sport and Exercise Medicine*.

Position Stands. CSEP currently has posted five position stands on its web-site:

- Joint SOGC / CSEP Clinical Practice Guidelines: Exercise in Pregnancy and the Postpartum Period
- Resistance training in children and adolescents
- The use of instability to train the core in athletic and nonathletic conditioning
- Taking a Stand: Balancing the BENEFITS and RISKS of physical activity in children
- Getting the most out of your

stretching routine

In the context of this article, perhaps more important has been the development of a series of clear evidence-based guidelines for physical activity in the general population, the elderly and youth, published jointly in APNM and the Canadian Journal of Public Health (Health Canada/CSEP, 1998; 1999; 2002a, b).

Standardization of Fitness Assessment
Prior to the release of the Canadian Standardized Test of Fitness (CSTF) in 1979, existing fitness assessment protocols focused on the assessment of motor fitness, with the interpretation of results limited to comparisons with percentiles. The CSTF was the first Canadian fitness assessment battery to include all the important fitness components, although interpretation of the results was still based on percentile comparisons. The CSTF was revised in 1981 and again in 1986, during which time the assessment of body composition evolved from percentile comparisons to a health-risk interpretation.

By the early 1990s, the focus in fitness assessments for the general population was shifting gradually to a health-related interpretation. At the same time, evidence was accumulating on the health benefits of moderate intensity physical activity, an intensity that is unlikely to result in higher levels of fitness. In addition, increasing recognition was being given to the influence of various lifestyle behaviors on health status. The CPAFLA, which was released in 1996, (created by Gledhill and Jamnik) broadened beyond the CSTF and included the assessment and health-related interpretation of fitness status, physical activity participation and lifestyle behaviours. As outlined above, Drs. Gledhill and Jamnik have recently replaced the CPAFLA with the Physical

Activity and Lifestyle “r” Medicine or PALM.

Major texts. Canadian authors have written many seminal texts analyzing and summarizing current knowledge in various areas of health and fitness. In addition to the major volumes summarizing the consensus conferences on fitness and health, as discussed below, we may highlight some important contributions.

Aerobic fitness was discussed in *Endurance Fitness* (Shephard, 1969), and the relationship between aerobic fitness and health was explored in *Aerobic Fitness and Health* (Shephard, 1994). A detailed template for establishing Bona Fide occupational fitness requirements for physically demanding public safety occupations was provided in *The Proceedings on the Consensus Forum on Establishing Bona Fide Occupational Requirements* (Gledhill et al Toronto 2000). The economic importance of this relationship was covered in *Economics of Enhanced Fitness* (Shephard, 1986b). Applications to the health of children were examined in *Frontiers of Activity and Child Health* (Lavallée and Shephard, 1977), *Physical Activity and Growth* (Shephard, 1982a), *Pediatric Sports Medicine for the Practitioner; From physiological principles to clinical applications* (Bar-Or, 1983), and *Growth, Maturation and Physical Activity* (Malina, Bouchard and Bar-Or, 2004). Issues of health and fitness for the elderly were addressed in *Physical Activity and Health* (Shephard, 1997), *Active Living among Older Adults: Health Benefits and Outcomes* (O'Brien-Cousins and Horne, 1999), *Physical Activity and Aging* (Shephard, 1978), *Aging, Gender, Physical Activity and Aging* (Shephard, 2002a), *Physiology of exercise and healthy aging*

(Taylor and Johnson, 2008) and *Exercise, Aging and Health; Overcoming Barriers to an Active Old Age* (O'Brien-Cousins, 2014). The needs of special populations were covered in *Proceedings of the First International Conference on Sport and Training of the Physically Disabled Athlete* (Steadward, 1979) and *Fitness in Special Populations* (Shephard, 1990). The rehabilitation of cardiac patients has also provided material for several texts, including *Heart Attack? Counter-Attack!* (Kavanagh, 1976), *Exercise and Ischaemic Heart Disease* (Shephard, 1981), and *Exercise and the Heart in Health and Disease*, (Shephard and Miller, 1999)

Other more specialized texts have reviewed issues related to obesity and dietary restriction (*The Genetics of Obesity*, Bouchard, 1994; *Physical Activity and Obesity*, Bouchard, 2000; *Optimizing Physical Performance during Fasting and Dietary Restriction*, Bouhlef and Shephard, 2015), cancer (*Physical Activity and Cancer*, Courneya and Freidenreich, 2010), genetics (*Genetics of physical fitness and performance*, Bouchard et al., 1997), immune function (*Physical activity, training and the immune response*, Shephard, 1997b), exercise and the viscera (*Physical Activity and the Gastro-intestinal Tract*, Shephard, 2017a; *Physical Activity and the Abdominal Viscera*, Shephard, 2017b) and the monitoring of habitual physical activity (*The Objective Monitoring of Physical Activity: Contributions of Accelerometry to Epidemiology, Exercise Science and Rehabilitation*, Shephard and Tudor-Locke, 2015).

Economic impact of a healthy society.

Canadian researchers quickly recognized that governmental funding of an initiative such as an increase of population health and fitness would be facilitated if it could

be demonstrated that gains in health were reflected in greater productivity and/or reduced health-care expenditures. Specific contributions of Canadian investigators to this area of research included the calculation of economic losses, based on the differences of health care costs between active and inactive individuals and the prevalence of inactivity, a quasi-experimental analysis of the impact of a work-site fitness programme on health, fitness and corporate profitability, an analysis examining the economic impact of small changes in exercise behaviour on health-care expenditures, and a comprehensive text summarizing findings for both occupational and leisure exercise programmes.

Overall economic impact. John Armstrong (1965) of the Ontario Heart Foundation made some preliminary estimates of losses to the Ontario economy associated with coronary heart disease in terms of output and immediate medical costs; extrapolating this data to 1976, it was estimated that the annual losses from heart disease would probably be as high as \$300 per wage earner (Shephard, 1977).

It was recognized that the indirect costs, although probably large, were difficult to calculate with any great precision. Nevertheless, Peter Katzmarzyk (Figure 26) and his associates computed estimates for the Province of Ontario in 2009 (Katzmarzyk et al., 2009). Direct and indirect annual costs associated with habitual inactivity (an energy expenditure of less than 6 kJ/kg per day) were \$1.02 B and \$2.34 B respectively, while the corresponding figures for obesity (a body mass index > 30 kg/m²) were \$1.60 B and \$2.87 B (Katzmarzyk, 2011).



Figure 26: Peter Katzmarzyk estimated the direct and indirect costs of inadequate physical activity and obesity for Canada and for the Province of Ontario.

Quasi-experimental study of a work-site fitness programme.

A quasi-experimental trial of the economic impact of a work-site fitness programme was organized by the University of Toronto, with the enthusiastic support of Art Salmon (Figure 27) and his colleagues at Fitness Ontario.



Figure 27: Art Salmon of Health Ontario, made many notable back-room contributions to health and fitness in Canada, including playing a key role in the quasi-experimental work-site fitness study, and the organization of international consensus conferences of health and fitness.

Most previous employee fitness studies had simply reported uncontrolled data on the short-term changes associated with introduction of work-site fitness programmes, and the apparent "responses" were inevitably vulnerable to

"Hawthorne" effects. However, the Toronto study compared one-year changes in fitness and health between an experimental site (the Canada Life Assurance head office, Figure 28) and a closely comparable control site (the nearby North American Life Assurance Company).



Figure 28: A quasi-experimental study of the health and economic benefits of employee fitness programmes compared an experimental site (Canada Life Assurance) with a control site (the nearby North America Life Assurance).

A detailed analysis of potential economic benefits was undertaken, showing small immediate gains in terms of productivity, absenteeism, and employee turnover, and a particularly unique feature of the study was a direct comparison of Ontario Health Insurance Plan Medicare billings between the two companies before and after institution of the programme (Shephard et al., 1982). There was no evidence that programme participation caused any increased costs from cardiac problems or musculo-skeletal injuries, and indeed there were small reductions in physician office visits and hospital usage at the experimental company over the year of observation.

On the other hand, despite the cachet of a research trial and the opening of a pleasant facility in the basement of the Canada Life office building, only about a

third of the company initially participated in the fitness and lifestyle programme, and at the end of a 10-year follow up continuing exercisers had become a small minority, many of whom had been active elsewhere before the programme was introduced.

Small changes in exercise behaviour.

Many studies of interactions between habitual physical activity and health care costs have made the rather unrealistic assumption that populations suddenly change from being "inactive" to meeting at least the recommended levels of daily physical activity. (Warburton et al. 2016; Warburton et al., 2017a; b). However, a study conducted by Yuki Aoyagi (Figure 29) in conjunction with the University of Toronto examined the economic benefits associated with much smaller changes of behaviour by a small segment of an overall community (Aoyagi and Shephard, 2011).



Figure 29: Yuki Aoyagi completed a doctoral programme at the University of Toronto. He has since continued to work with the university, making extensive accelerometer studies of inter-relationships between physical activity and health in the community of Nakanojo, Japan.

Long-term pedometer/accelerometer data for a large group of seniors living in Nakanojo, Japan, were classified into quintiles. The prevalence of 11 common chronic conditions was noted for each of these quintiles, along with the associated medical costs. It was thus possible to

estimate the savings that would accrue for each person who could be persuaded to increase their current level of physical activity by one quintile. The greatest savings were associated with moving from the lowest to the next higher quintile, showing where (from a cost-efficiency perspective) the greatest health promotional effort should be concentrated.

Comprehensive analysis. Sandy Keir (Figure 30), at Health and Welfare Canada, organized an early conference on employee fitness (Keir, 1975), and he encouraged the University of Toronto to prepare a detailed analysis of the



Figure 30: Sandy Keir, of Health and Welfare Canada, organized an early Ottawa conference on employee fitness programmes.

economic consequences of worksite and leisure activity for his ministry, looking not only at the likely benefits of enhanced physical activity, but also at the probable costs of changing population behaviour. The main findings from a lengthy governmental report were subsequently condensed to a commercial monograph (Shephard, 1986b). It was acknowledged that specialized exercise programmes could be costly, and participation was difficult to maintain. For this reason, the health promotional policy of the Canadian government shifted from formal programming to encouraging inclusion of the activity needed for health into daily life through such mechanisms as active

computing.

Quality control of laboratory data. Even when using what seemed a mutually agreed test protocol for the measurement of maximal oxygen intake, early Canadian investigators often found substantial inter-laboratory differences in the values that they were reporting for the same individual. This was a critical problem when it was necessary to monitor the physical condition of athletes in different regions of the country. Many countries have yet to institute formal quality control of health and fitness data, but Canada took this important step when Norm Gledhill and Art Quinney (Figure 31) organized a process of Laboratory Accreditation project during the 1980s.



Figure 31: Working with Norm Gledhill, Art Quinney of the University of Alberta organized a programme for the evaluation and accreditation of fitness testing laboratories during the 1980s.

The problem of disparate test results was traced to systematic laboratory errors in determining the concentrations of oxygen and carbon dioxide in expired gas and the power outputs developed on badly calibrated cycle ergometers. The standardization project examined the accuracy of data reported by any given testing laboratory on a panel of subjects with known maximal aerobic powers; the findings were carefully reviewed before that laboratory was certified as an *Accredited Fitness Appraisal Centre*.

Norman Jones (Figure 32) and his colleagues at McMaster University further organized an inter-laboratory standardization of ergometers (Jones and Kane, 1979), using a portable torque generator as a part of the Ontario multicentre trial of cardiac rehabilitation (below).



Figure 32: Norman Jones of McMaster University is best known as a respiratory physiologist, but he also organized an inter-laboratory standardization of cycle ergometers as a part of the Ontario multicentre cardiac rehabilitation trial.

Similar inter-laboratory discrepancies in reported absolute values almost certainly arise in other areas of clinical physiology, and a similar rigid quality control of data is needed before the reported data can be accepted with confidence.

Women. Canadian contributions in issues specific to physical activity in women have included studies of menstrual irregularities, exercise during pregnancy, and cultural deterrents to a physically active lifestyle.

Menstrual irregularities. Jerilynn Prior (Figure 33) of the University of British Columbia has taken an important role of discussions of the menstrual irregularities and the "female athletic triad" that develop with female participation in ultra-long-distance events such as

marathon runs and in sports that encourage the development of a negative energy balance such as figure skating and gymnastics (Prior, 1990).



Figure 33: Jerillyn Prior of the University of British Columbia has made major contributions to the understanding of the menstrual irregularities that result from excessive physical activity relative to energy intake.

Exercise and pregnancy. Larry Wolfe of Queen's university spear-headed the development of the recommendations for active living during pregnancy (Wolfe et al., 1995; Kochan-Vintinner et al., 1999). Among other findings, he demonstrated that moderate exercise had a favourable effect upon the course of pregnancy, both for the mother and for the newborn infant, provided hyperthermia or hypoglycaemia was avoided.

Cultural constraints on physical activity. Pat Vertinsky of the University of British Columbia (Figure 34). has made extensive studies of female participation in physical activity over the course of recent history, underlining the cultural constraints and medical prejudice that have frequently hampered women from taking optimal levels of exercise over the past century (Vertinsky, 1994). She has been vigorously seconded in this thesis by Helen Lenskyj of the Department of Sociology at the University of Toronto (Lenskyj, 1986).



Figure 34: Pat Vertinsky of the University of British Columbia has documented the cultural constraints that have made it difficult to take an appropriate amount of physical activity over the course of recent history.

Children. Specific issues arising when examining relationships between physical activity and health in children have been examined by several Canadian laboratories. Initiatives have included the standardization of assessment procedures for children (above), longitudinal studies of physical activity and growth in Saskatchewan and Igloolik, a quasi-experimental study of the benefits arising from additional physical education for primary school students, and a review of methods for encouraging adequate physical activity in obese children.

Saskatchewan growth and development study. The Saskatchewan growth and development study was initiated by Bill Orban (above), but over the course of its history (1964-1973) the main investigator was Don Bailey. Repeated measurements of anthropometric and fitness related parameters were obtained on a substantial sample of physically active boys living in Saskatoon; this allowed the calculation of detailed growth curves, and to relate these curves to the involvement of the boys in sports programmes (Bailey et al., 1986).

Growth and development in Igloolik. Community-wide surveys of fitness and

health were completed in 1970, 1980, and 1990 on all children living in the circumpolar community of Igloolik (Shephard and Rode, 1996). This allowed an examination of the impact upon growth processes of the transition from a hunter-gatherer culture to a lifestyle where physical activity was much less prevalent, and where there was a reliance upon store-bought rather than country grown foods. Over the 20 years of observation, the growth spurt shifted to a substantially earlier age, and there was an increase in standing height and body mass at any given age. Moreover, health-related fitness deteriorated, with increases in skinfold thicknesses, and decreases in maximal aerobic power and muscular strength.

Quasi-experimental study of physical education for primary school students.

The Trois Rivières study, led by Hugues Lavallée (Figure 35), was a large scale and unique quasi-experimental study of 546 primary school students, designed to examine the effects of incorporating five hours per week of professionally taught



Figure 35: Hugues Lavallée, of the University of Quebec at Trois Rivières, directed a quasi-experimental study examining the effects of an hour per day of physical education upon the health and fitness of primary school students.

physical education into the entire curriculum for grades one through six.

Unlike other such studies, a quasi-experimental model was adopted, with students in preceding and succeeding classes under the same teachers serving as the control group. The classroom intervention was carefully monitored by telemetry to ensure that the five hours of exercise per week were kept in the training zone of intensity, and it was also demonstrated by diary records that there was no substantial compensatory reduction in leisure activity when experimental students returned to their homes. All study participants attended the laboratory annually for a sophisticated range of investigations of health and fitness.

Despite previous contrary reports that had been based on small samples, it was demonstrated that the programme initiated at Trois Rivières was able to increase aerobic fitness and muscular strength in what were prepubertal children. Measures of academic attainment were also obtained from the schools involved and from success in Province-wide exams. These data countered the usual argument against school physical education programmes (a "lack of curricular time"); experimental students had at least as good an academic performance as the control students (although they necessarily spent 14 percent less of their school day learning academic material).

Finally, because of low population mobility in this region of Québec, François Trudeau (Figure 36) and his associates at Trois Rivières were able to reexamine the participants when they had reached the ages of 30-35 years and 40-45 years. These unique long-term observations showed a modest persistence of the effects of the intervention in terms of more favourable physical activity habits and a greater likelihood of being non-

smokers (Shephard & Trudeau, 2005).



Figure 36: François Trudeau at the University of Quebec at Trois Rivières was able to collect follow-up data on individuals who had participated in the original quasi-experimental study of primary school physical education after the elapse of 30-35 and 40-45 years.

Exercise programmes for obese students. Oded Bar-Or (Figure 37) first visited Canada as a member of the WHO/IBP Working Party on the Standardization of Fitness Testing in 1968. After a stint at the Wingate Institute in Netanya, where he developed the “Wingate Test” of anaerobic power and capacity, he accepted an appointment at McMaster University. There, he became an acknowledged world expert and international lecturer in Pediatric Work Physiology, serving as a prominent member of the European Work Physiology Group, and writing what has become a standard text of Pediatric Sports Medicine. He focused much of his research and clinical attention on overweight children, being one of the first in the scientific community to express concern about the growing worldwide epidemic of obesity. **Aging.** Specific Canadian contributions in the area of exercise and aging have included demonstration of the potential to make direct measurements of maximal oxygen intake in this age group, linking threshold values of aerobic power to an ability to

undertake the activities of daily living, organization of the first Masters Games, and longitudinal studies showing the continuing linkages between specific levels of objectively measured physical activity and health.



Figure 37: The late Oded Bar-Or directed the Chedoke-McMaster Children's Exercise and Nutrition Centre, known world-wide for its research on relationships between obesity and physical activity in children.

Maximal oxygen intake. It is often argued that elderly individuals are unable to continue a progressive treadmill or cycle ergometer test to a plateau of oxygen consumption. However, Ken Sidney (Figure 38), then a doctoral student in Toronto, found that three quarters of a sample of adults aged 65 -85 years were able to reach a plateau in their first treadmill test, and a half of the remainder were able to do so if allowed a second opportunity. The quality of the effort attained by adequate motivation of subjects was shown by a final heart rate averaging 172 beats/min, and an arterial blood lactate immediately after exercise that averaged 11.1 mM/L.

Activities of daily living. There has been general agreement world-wide about a progressive loss of both aerobic fitness and muscular strength with aging; the decrease of peak oxygen transport averages around 5 mL/(kg.min) per



Figure 38: Ken Sidney (on left) completed a wide-ranging doctorate on fitness in elderly individuals at the University of Toronto. Throughout his life he has been a keen exponent of cross-country skiing and orienteering.

decade. An important facet of this phenomenon, emphasized in Canadian research, has been a recognition that fitness eventually falls to a level where the individual can no longer undertake the activities of daily living. Institutionalization is required, with a dramatic decrease in the individual's quality of daily living. Depending on the living environment and the degree of available support the critical maximal oxygen intake is probably around 15 mL/[kg.min] (Shephard, 1987; Paterson and Stathokostas, 2001) and in a sedentary person this threshold is likely to be reached at an age of 85-90 years.

David Cunningham was the driving force behind establishment of the Canadian Centre for Activity and Aging at the University of Western Ontario, and in collaboration with Don Paterson (Figure 39) he has completed important longitudinal studies, showing the importance of regular physical activity to the maintenance of health and

independence in advanced old age. Their investigations and the research of Ken Sidney in Toronto have shown that regular physical activity can increase maximal oxygen intake by 5-10 mL/[kg.min], and in terms of oxygen transport this is equivalent to a 10-20 year rejuvenation. The critical threshold of 15 mL/[kg.min] is unlikely to be reached before the person is 105-110 years old, and institutionalization for loss of aerobic power thus becomes unlikely (Shephard, 1997).

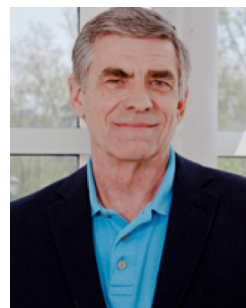


Figure 39: Don Paterson has directed a research programme in exercise and aging at the University of Western Ontario for many years, and he has underlined the impact of declining physical capacity upon loss of independence and a resulting deterioration in quality of life.

Masters' Games. John Sutton (Figure 40) of McMaster University and Robert Brock (an Ontario Sports Physician) played a prominent role in organizing the First World Masters Games, held in Toronto in 1985. This event attracted 8305 athletes from 61 countries, with competitions in 22 different sports, and there was an accompanying scientific symposium (Sutton and Brock, 1986).

The arrival of so many aging athletes in Toronto allowed an examination of many interesting themes, particularly the rate of aging of maximal oxygen intake as observed in cross-sectional samples



Figure 40: The late John Sutton, of McMaster University, is best known for his contributions to Environmental Exercise Physiology. However, he also organized the first Masters' Games, in Toronto, was an active investigator in the Multi-centre exercise-heart trial, and participated in the consensus conferences on exercise, fitness and health.

(Kavanagh et al., 1988). In general, the loss of oxygen transport per decade in the Masters group seemed similar to that observed in sedentary people, but because they began from a much higher level of fitness in middle age, the athletes were at a much smaller risk of reaching the point where an insufficient oxygen transport could compromise their independence.

Objective measures of activity and health. Yuki Aoyagi was able to examine relationships between physical activity (as measured objectively with a pedometer/accelerometer) and health in a large sample of elderly men and women (ages 65-85 years). Many earlier studies of this type had been content to record physical activity for only four to seven days and then to make cross-sectional comparisons with the prevalence of disease. However, Aoyagi and his associates showed that this duration of recording was inadequate, because there were reactive responses to the monitoring device and substantial seasonal effects. Many of his subjects who

initially were in good health wore the recording device for five years, and it was possible to establish longitudinal relationships between a low level of habitual physical activity and the risk of developing sarcopaenia (Shephard et al., 2013) and an adverse osteosonic index (Shephard et al., 2017).

Aoyagi also overturned the common assumption that the same volume of physical activity would reduce the risk of all forms of chronic disease; he demonstrated that at least in those aged 65-85 years, the physical activity threshold associated with improved health rose from 4000-5000 steps/day for a lesser risk of depression and greater mental health to 5000-7000 steps/day for a greater psychosocial health and an enhanced quality of life, to 7000-8000 steps/day for physical fitness, aerobic and muscular fitness, and to >8000 steps/day for metabolic health, and a reduced risk of hypertension and hyperglycaemia (Aoyagi and Shephard, 2009).

Special populations. In terms of physical activity and the health of special populations, Canadian contributions have included organizing the First Olympiad for the disabled, the hosting of the First International Conference on Sport and Training for the Disabled, development of appropriate methods of sub-maximal and maximal testing of the disabled, evaluation of responses to aerobic training, the relationship of aerobic power to quality of life and ability to undertake the activities of daily living, fitness levels in those with loss of sight, and emergence of evidence-based recommendations for daily physical activity in these population groups (below).

First Olympiad for the disabled. Robert Jackson, a surgeon at Toronto Western Hospital (Figure 41) took advantage of Canada's Olympic Year to help organize the first Olympiad for the disabled in Toronto, in 1976. A tremendous boost was given to disabled sport, as more than 1500 athletes with paraplegia, amputations or blindness from 38 countries engaged in international competition.



Figure 41: Robert Jackson, a surgeon at Toronto Western Hospital, organized the first Olympiad for disabled athletes in Toronto, in 1976.

First international conference on sport and training for the disabled. The first international conference on sport and training for the disabled was held in Edmonton, in 1978. This event was organized by Richard Steadward (Figure 42). It dealt largely with methods of classification of disabled individuals and wheelchair technique (Steadward, 1979). Partly in recognition of his work for the disabled, Steadward was later appointed Lieutenant-Governor of the Province of Alberta, and the outstanding research centre that he developed at the University of Alberta subsequently became the Rick Hansen Centre, named after the athlete who attempted to run across Canada on one leg.



Figure 42: Robert Steadward organized the first international conference on sport and training for the disabled in Edmonton in 1978.

Testing and training of the disabled. Peggy Kofsky and Glen Davis (Figure 43), working in Toronto, evaluated sub-maximal and maximal tests of aerobic power in the disabled (Davis et al., 1981; Kofsky et al., 1982). They found a fair correlation between the two data sets ($r = 0.67$). They were also able to predict isokinetic measurements of upper body strength relatively acutely from cable tensiometry and handgrip data ($r=0.82$). They found that active disabled individuals generally had higher values for both measures than those who were inactive, but regular wheelchair use had



Figure 43: While pursuing doctoral studies in Toronto, Glen Davis examined techniques for the sub-maximal and maximal testing of disabled individuals, as well as developing training techniques for maximizing their aerobic function.

limited effectiveness as a means of maintaining fitness. They also studied

training techniques to maximize function in people with disabilities, finding this had a substantial impact upon their ability to perform the activities of daily living and maintain a good quality of life.

Functional Status. Luc Noreau (Figure 44) and his colleagues at Laval University measured the maximal oxygen intake of individuals suffering spinal injuries as a result of motor vehicle accidents. They related their findings to the ability to undertake the activities of daily living (Fougeyrollas and Noreau, 2009), and they assessed how far people with spinal injuries were meeting the disability specific recommendations for daily physical activity (Rocchi et al, 2017).



Figure 44: Luc Noreau and his colleagues at Laval University examined the influence of quadriplegia on the social adaptation of affected individuals and determined how many were meeting the weekly recommended activity levels for those with this type of disability.

Physical capacity of individuals with visual impairments. In Toronto, Mary Lee and colleagues evaluated the physical capacity of sightless adolescents who were attending a residential school. This group was receiving four 45-minute adapted physical education lessons per week, and they had a physical capacity comparable with that of other Toronto youth. Moreover, an additional four

activity sessions/week for four months produced only minor gains, suggesting that their existing programme was adequate to maximize their health and fitness potential (Lee et al., 1985).

Genetics. Canadian interest in the genetic impact of inheritance upon fitness began early, with Vassilis Klissouras, who studied various aspects of fitness in small samples of monozygous and dizygous twin pairs. More substantial subsequent Canadian research has included the Quebec Family Study, trials of inter-individual differences in training response, and a major contribution to the human genome project.

Early twin studies. In 1971, Vassilis Klissouras (Figure 45), then at McGill University, studied maximal aerobic power in 15 monozygous and 10 dizygous twin pairs. He found respective inter-pair correlations of 0.91 and 0.44, and from this data he estimated a 93.4% heritability of maximal oxygen intake (Klissouras, 1971). Unfortunately, in part because small samples were used, subsequent estimates obtained by this approach proved highly variable, with heritability values ranging from zero to 90%.

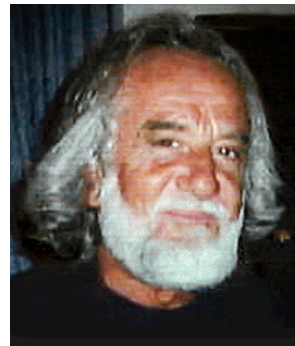


Figure 45: Vassilis Klissouras carried out twin-pair studies of fitness in 1971, while at McGill University.

Quebec Family Study. The Quebec family study was initiated by Claude Bouchard (Figure 46), and Louis Pérusse (Figure 47 at Laval University, beginning in 1978. They examined various facets of body build, obesity and fitness in a large sample of the local population (1,630 subjects, including 727 parents ranging in age from 30 to 59 years of age and 903 offspring, eight to 26 years old), and derived estimates of heritability for their various measures from differences in inter-individual variation, based on the degree of closeness of individual familial relationships (Bouchard, 1996).



Figure 46: Claude Bouchard is probably the most widely published of Canadian Exercise Physiologists. A few of his major contributions include the Québec Family Study at Laval University, the human genome project, research on obesity, the metabolic syndrome, and diabetes, and the organization of a series of landmark international consensus conferences on Physical activity, fitness and health.

Further studies were made after follow-up intervals of 12 and 17 years. The most detailed studies were of the heritability of body composition, and it was estimated that 45-55% of the variance in both body fat and fat-free mass was attributable to inheritance.

Heritage Study. Claude Bouchard also directed the Heritage study, in conjunction with a number of U.S. Laboratories. 130 families, each



Figure 47: The doctoral studies of Louis Pérusse, at Laval University, focused on the Quebec Family Study.

comprising two parents and three or more biological offspring were tested before and after an identical 20-week period of aerobic training. Despite the constant conditioning stimulus, the aerobic training response seemed to vary widely from one person to another. About a half of the apparent difference in trainability was attributable to test-retest errors in the measurement of maximal oxygen intake, but even after allowing for this factor, there remained a significant inter-individual difference in the training response (Shephard et al., 2004).

Immune Function. North American interest in interactions between exercise and immune function began with David Nieman, in the United States. However, epidemiological confirmation of an optimal weekly jogging distance was provided by studies of Masters' athletes in Toronto, and the reputation of Canadian research in exercise immunology was such that a seminar on exhausting exercise as a model of surgical sepsis attracted international investigators to the Defence and Civil Institute of Environmental Medicine in Toronto. The Exercise Immunology Review also made

its debut under Canadian editorship.

Epidemiology of distance running. A study of distance runners participating in the First Masters Games in Toronto found that 76% considered themselves less vulnerable to upper respiratory infections than their sedentary peers. However, 16% of the runners were conscious of a threshold training distance (typically 70-80 km/week) above which vulnerability to such infections increased (Shephard et al., 1995).

Exercise as a model of sepsis. The military interests of Pang Shek (Figure 48) at the Defence and Civil Institute of Environmental Medicine included not only a clear indication of the level of training that would optimize the immunological health of military personnel, but also an examination of how the threshold of such excessive effort was modified by exposure to various



Figure 48: Pang Shek directed the immunology laboratory at the Defence and Civil Institute of Environmental Medicine (Downsview, ON). He made an important contribution to exercise immunology by developing the thesis that excessive exercise could initiate a negative immunological reaction such as that seen in surgical sepsis.

environmental stressors. He also underlined the potential of using exhausting exercise as a model for the study of a major battlefield concern, surgical sepsis. Governmental interest in

this research was sufficient that highly sophisticated automated cell counters and FACscan were purchased, allowing rapid and accurate analysis of changes in the various leukocyte populations induced by various intensities of exercise and training. Leading international figures in exercise immunology were drawn to Toronto for a seminar on exercise as a model of surgical sepsis. The findings from this seminar were published as a special edition of the *Canadian Journal of Physiology and Pharmacology* (Hoffman-Goetz et al., 1998).

Exercise Immunology Review. A further recognition of Canadian achievements in exercise immunology came in 1995, when the International Society for Exercise and Immunology invited me to found and edit the *Exercise Immunology Review*.

Accelerometry. Canadian investigators have made a number of significant contributions in the field of accelerometry, particularly in terms of the long-term epidemiology of habitual physical activity, the standardization of measurement protocols, and an examination of the health significance of sedentary behaviour.

Long-term epidemiology. In collaboration with our Toronto laboratory, Yuki Aoyagi has made extensive and quite unique epidemiological studies of physical activity and health among elderly people (aged 65-85 years) in the community of Najanojo (Aoyagi and Shephard, 2009). His subjects (both men and women) have worn pedometer/accelerometers continually for periods of one to five years, and physical activity levels (measured both as average daily step

counts and time spent at an intensity greater than three METs) have been related to various measures of health status such as mood state, quality of life, fitness levels, arterial elasticity, muscle mass, osteosonic indices of bone health, and the presence of metabolic risk factors, using both cross-sectional and longitudinal designs. These investigations have been successful in defining both thresholds of physical activity for benefit in these various conditions, and also the intensities of effort above which the health benefit appears to plateau.

Standardization of measurement protocols. Catrine Tudor-Locke (Figure 49), who obtained her doctorate from the University of Waterloo, has made an important contribution to objective studies of physical activity by developing standard protocols for the collection, management, and treatment of accelerometer data, and she recently co-authored an authoritative text on this theme (Shephard and Tudor-Locke, 2015).



Health significance of sedentary behaviour. A new chapter in health and fitness research opened with the concept

that an accelerometry record of sedentary behaviour had implications for health. Mark Tremblay and his colleagues at the Eastern Ontario Children's Hospital in Ottawa have played a lead role in this area of research, founding the "Sedentary Behaviour Research Network." A meta-analysis found that watching television was the commonest form of sedentary behaviour for children; watching television more than two hours per day was associated with unfavourable body composition, decreased fitness, lowered scores for self-esteem and pro-social behaviour and decreased academic achievement (Tremblay et al., 2011).

Cardiac rehabilitation programmes. The interaction between habitual physical activity and health has been studied most extensively in relation to cardiovascular disease. Canadian investigators have played a significant role in exploring this topic, beginning with non-randomized trials but proceeding to a large multicentre randomized controlled trial, and offering new insights into both the risks of exercise in cardiac patients and their potential for endurance effort.

Non-randomized trials. The first non-randomized trials of exercise programmes for patients with coronary heart disease were conducted in Israel (Viktor Gottheiner, 1959, and Daniel Brunner, 1968) and the U.S. (Herman Hellerstein, 1968). However, shortly afterwards the results of some non-randomized trials were also reported from London, ON, and Toronto.

In London, ON, Peter Rechnitzer (Figure 50) and Michael Yuhasz had post-coronary patients undertake twice weekly sessions of progressive endurance activity, supplemented by daily home exercise, and he noted superior outcomes

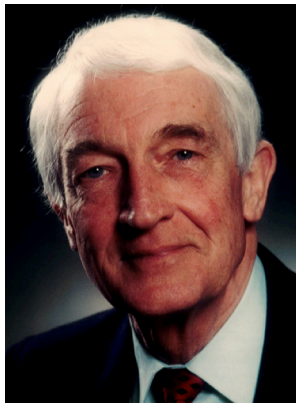


Figure 50: Peter Rechnitzer and colleagues carried out early non-randomized trials of endurance exercise for patients with coronary heart disease, and he was also lead investigator of the multi-centre cardiac trial in Southern Ontario.

to those of conservatively treated patients both in Toronto and at other hospitals in London, ON. (Rechnitzer et al., 1972).

In Toronto, Terence Kavanagh and his colleagues at the Toronto Rehabilitation Centre reported results for 690 patients who had attended the centre for an average of three years of rehabilitation following myocardial infarction. This data set was unusual with respect to the intensity of exercise prescribed, and the 100% follow-up that was achieved with respect to fatal and non-fatal reinfarctions. Eighty of the group received coronary by-pass operations, and these were excluded from the trial. In the remaining 610, the infarction recurrence rate in the first year was 3.11%, but it decreased progressively as rehabilitation continued (2.58% in year 2; 1.5% in years 3-5, and 0.81% in years 6-8) (Shephard et al., 1981).

Multicentre trial. Although the results from both London and Toronto were encouraging, it was thought that more conclusive evidence would be provided by organizing a large multicentre trial

with a randomized allocation of patients to exercise and control groups. This study involved the Universities of Western Ontario, Toronto, McMaster and Queen's. Peter Rechnitzer chaired this undertaking (Figure 51). A total of 379 patients were recruited to a high intensity exercise programme, and 354 were assigned to a control group that were to undertake only light exercise. After four years, the risk of a recurrence of myocardial infarction in the active group relative to controls was 1.09, with broad 95% confidence limits (0.61-1.96) (Rechnitzer et al., 1983). The incidence of fatal reinfarctions was also similar for exercise and control groups. This finding ran contrary to experience elsewhere in the world, and a *post-hoc* examination of the data suggested that one factor contributing to this surprising outcome was a limited compliance with the initial group assignment. In particular, many patients in the control group heard publicity favouring vigorous exercise, and they chose to undertake more than the mild activities prescribed by the investigators. When patients were classified not in terms of their initial group assignment, but rather in terms of changes in their level of aerobic fitness over the course of the study, the recurrence rate tended to be lower among those who had increased their level of aerobic fitness, although the difference was still not statistically significant (a revised odds ratio of 0.74, with 95% confidence limits of 0.20-2.6) (Cunningham et al., 1991).

Risks of exercise. Using data from the Toronto Rehabilitation Centre, we were able to form a unique estimate of the risks that vigorous exercise would induce a coronary attack in previously healthy middle-aged men. 203 individuals who had recently sustained a first heart attack



Figure 51: The multicentre Ontario Exercise-Heart Trial was a randomized controlled trial examining the value of exercise following myocardial infarction. Dr. Peter Rechnitzer, of the University of Western Ontario, organized this trial. Participants included:

Front Row: David Cunningham, Roy Shephard, Peter Rechnitzer, Norman Jones, Neil Lefcoe, John Sutton

Second Row: Robin Campbell, Neil Oldridge, Mike Yuhasz, Terry Kavanagh, George Andrew, Sasha Sangal (statistician)

were asked about the immediate antecedents of this event, and their responses were compared with those of their peers at the same place of employment (Kavanagh and Shephard, 1973; Shephard, 1974). The likelihood of reporting vigorous exercise immediately before the incident was about five times higher in the patients than in their peer group. Although introspection following infarction may have increased the reporting of exercise, an upper limit to risk was set in this way. Among patients who had already sustained a heart attack, vigorous exercise in the day preceding a recurrence was again reported five to six times more frequently than expected.

Potential for undertaking endurance exercise. Beginning in the mid-1960s, the Toronto Rehabilitation Centre under its Director, Terry Kavanagh (Figure 52), was the first institution in North America to

offer vigorous rehabilitation to patients who had sustained a myocardial infarction. Subsequently, those who had developed compensated cardiac failure or had received a cardiac transplant entered a similar training programme. One

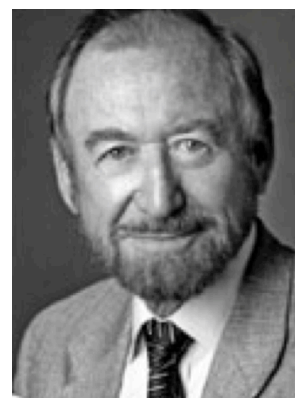


Figure 52: Terence Kavanagh, Medical Director of the Toronto Rehabilitation Centre had many firsts in the area of cardiac rehabilitation. In particular, he led a group of 8 men who had undergone rigorous training post-infarction in the 1973 Boston Marathon.

noteworthy episode was the participation (under close medical supervision) of eight of the post-coronary patients in the 1973 Boston Marathon. A carefully planned programme of aerobic training had increased the peak oxygen intake of participants from an initial 24-27 ml/[kg.min] to a peak of 53 ml/[kg.min] in one patient. This individual was able to complete the marathon in the very respectable time of three hours 17 minutes (Kavanagh et al., 1974).

Another early proponent of cardiac rehabilitation (Herman Hellerstein, of Cleveland, OH) was very upset to find himself upstaged in this way, declaring the involvement of cardiac patients in a marathon run as an act of “criminal folly.” Nevertheless, he rather undermined his condemnation of the Toronto group by claiming that he had persuaded one of his patients to run the marathon distance prior to the Canadian exploit! Terry Kavanagh's team made careful studies of fluid and mineral balance over the course of several marathons, and (at a time when proprietary drinks were becoming popular among runners), they established that from many points of view the best replacement fluid during an event was pure water (Kavanagh and Shephard, 1977).

Prevention and treatment of cancers. Kerry Courneya (Figure 53) and Christine Friedenreich (Figure 54) of the University of Alberta authored the first systematic text examining the role of physical activity in all phases of the prevention and treatment of breast and colon cancers, including reporting observations on primary prevention, recovery from treatment and resulting gains in longevity (Courneya and Friedenreich, 2011). Kerry Courneya was also a major contributor to an American College of Sports Medicine



Figure 53: Kerry Courneya has made major contributions to our understanding of the role of physical activity at various stages in the history of cancer, from primary prevention to recovery following treatment.

round-table on exercise guidelines for cancer survivors, and Christine Friedenreich conducted three case-control studies looking at relationships between life-time physical activity and the risk of cancer.

Canada was also at the forefront of



Figure 54: Christine Friedenreich conducted the first Canadian trial of exercise for the prevention of breast cancer, and has also made 3 case-control studies relating the risk of cancer to lifelong physical activity.

early studies of physical activity in animal models of cancer, with Laurie Hoffman-Goetz (Figure 55) of the University of Waterloo testing specified daily doses of exercise in various forms of experimental carcinogenesis. She has also exploited this approach to explore underlying



Figure 55: Laurie Hoffman-Goetz, of the University of Waterloo, has used innovative animal models to study mechanisms underlying the reasons why habitual physical activity reduces the risk of various cancers.

mechanisms in the immune system (Pervaiz and Hoffman-Goetz, 2012). Other important contributions have included innovative material on health-risk communication and health literacy, and a co-editing of the special issue of the *Canadian Journal of Physiology and Pharmacology* on exercise as a model of sepsis.

World-wide acceptance of the "Exercise is Medicine" concept. In the final segment of this story, Canada been involved in promoting the ACSM Exercise is Medicine initiative. Key initiatives were the Ottawa charter, the hosting of a series of international consensus conferences, and the development of evidence-based physical activity recommendations.

Ottawa Charter. The Ottawa Charter for Health Promotion (World Health Organisation, 1986) is an international agreement, developed at the First International Conference on Health Promotion, a meeting organized jointly by the World Health Organization, Health and Welfare Canada, and the Canadian Public Health Association (Figure 56). The event, which was held in Ottawa from

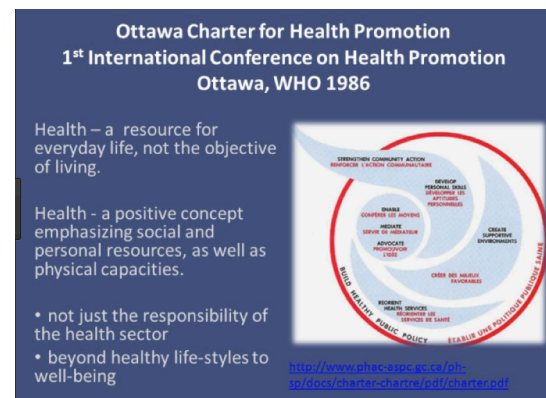


Figure 56: The Ottawa Charter for Health Promotion was signed in November of 1986.

17th to 21st November of 1986, attracted some 212 delegates from 38 countries, who met to exchange their experiences of health promotion.

The Charter set as its ambitious target the achievement of "health for all" by the year 2000, through a greatly enhanced programme of health promotion that would build public health policy, create supportive environments, strengthen community action, develop appropriate personal skills, and above all reorient traditional health services towards prevention and health promotion. Doctors were urged always to assess the physical activity of their patients, to make exercise clearance and recommendations for regular physical activity a standard part of every medical visit, and to ensure referral to a qualified exercise professional where appropriate.

Many countries have since set up organisations to develop the idea that Exercise is Medicine. In Canada, Exercise is Medicine Canada is an initiative with an advisory council that guides the strategic direction of the programme; it offers a professional network that links the health professionals involved.

International consensus conferences.

A second vital step in this process of promoting Exercise as Medicine has been the hosting in Canada of several major international conferences on physical activity, fitness and health.

In 1988, Barry McPherson (Figure 57), as Chair of the Organizing Committee and Claude Bouchard as Chair of the Program Committee hosted a major conference in Toronto, with the unique objective of developing a consensus among attendees on the mechanisms linking exercise, fitness, and health, both in healthy individuals and those with a variety of clinical conditions. More than 60 topics were considered with special note given to the separation of health-related and performance-related fitness proposed by Norm Gledhill. A carefully selected panel of international experts had each circulated written preprints of their individual presentations. At the conclusion of each group of public presentations a panel of speakers and consultants vigorously debated the conclusions that should be drawn, and a final consensus statement on each topic was approved by the entire conference of some 1000 participants. The findings from the meeting (Figure 58) were quickly published as a major text

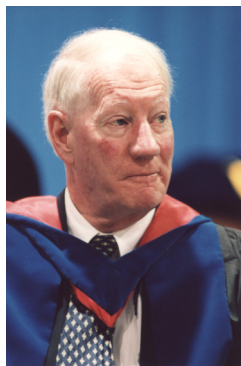


Figure 57: Dr. Barry McPherson played a key role in the leading Canadian and International Congresses related to health, fitness, and physical activity.

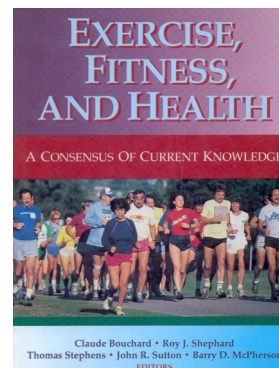


Figure 58: The 1988 International Consensus Conference Conference on Exercise, Fitness and Health was held in Toronto, and the proceedings were published by Human Kinetics in 1990.

(Bouchard et al., 1990).

Based on this experience, a somewhat similar event (again headed by Barry McPherson and Claude Bouchard) was held at Toronto's Skydome Hotel in 1992. Prior to the second conference, a computer search of major databases identified the most widely published investigators for each of some 70 topics. The participants prepared a draft consensus statement on their assigned issue, and they submitted this, along with a detailed supporting document, three months prior to the conference. This input was vigorously debated by the three editors and a panel of seven international advisors. Thus, conference delegates were able to review a carefully revised consensus statement that was already near to its final format. In 1994, the conclusions were again published as a major scientific text (Bouchard et al., 1994, Figure 59).

Although a fair degree of consensus was reached on the merits of regular physical activity in the prevention and treatment of a multiplicity of chronic disorders, little was still known about the optimal dose of exercise to prescribe for various conditions. A third consensus

conference was thus organized to focus on a careful rating of “levels of evidence” concerning dose-response relationships between physical activity and the prevention and treatment of various diseases. The panel of experts selected for this third event met in October of 2000 at the Hockley Valley Resort, to the north of Toronto. A few of the less fit American delegates were disturbed to find that the meeting included an opportunity to enjoy the fall colours during a substantial hike along the physically demanding Bruce Trail!

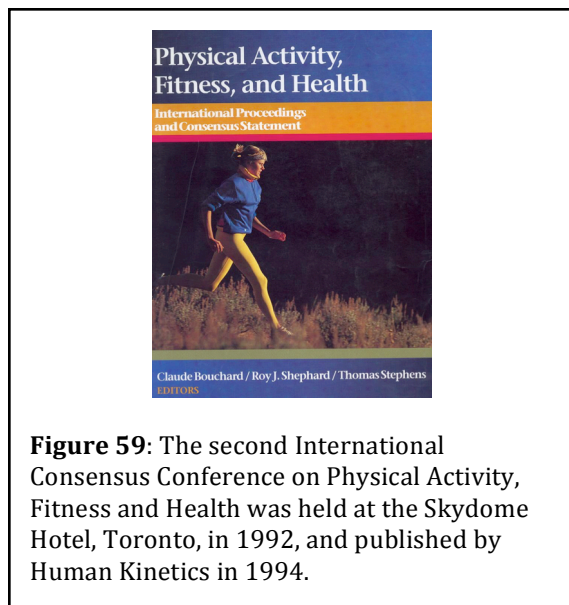


Figure 59: The second International Consensus Conference on Physical Activity, Fitness and Health was held at the Skydome Hotel, Toronto, in 1992, and published by Human Kinetics in 1994.

Although much new information was documented, unfortunately there was still insufficient evidence to develop clear dose-response statements for many of the conditions that had been considered. Nevertheless, the findings were published as a special supplement to *Medicine & Science in Sports & Exercise* (Kesaniemi et al., 2001).

The organizing committee recognized that although the consensus conferences had been very helpful to the development of academic agreement, much of the information presented at these gatherings was not reaching those who were

working on the front lines of health promotion. Art Salmon of Fitness Ontario thus collaborated with Health Canada and the U.S. Centers for Disease Control in offering a more practically-oriented “translation” of the findings through a conference entitled “*Communicating physical activity and health messages: science into practice.*” The meeting was initially scheduled for Whistler, B.C. in September of 2001, but fears of air travel aroused by the attacks on the World Trade Center caused a postponement until December of 2001. On the designated day, a fleet of luxury coaches awaited delegates at Vancouver International Airport, but some participants from warmer climes elected to rent cars for the 130 km journey along the (subsequently much improved) mountain road to Whistler. Most of the rental vehicles were not equipped with snow tires, and by the time delegates had reached Squamish, a heavy snowfall persuaded many of them to make an ignominious return to Vancouver airport in search of the official transport! Art Salmon, always the consummate booster of things Canadian, arranged for two RCMP officers in full dress uniform to greet participants. A summary of the papers presented at this meeting appeared in the *American Journal of Preventive Medicine* (Shephard, 2002).

Canadians have also played a leading role in conferences related to the International Society for Physical Activity and Health. This includes the International Congress on Physical Activity and Public Health (ISPAH) (Toronto, May 2010) and the upcoming ISPAH Congress in 2020 (chaired by Drs. Darren Warburton and Shannon Bredin from the University of British Columbia).

Physical activity and sedentary behaviour recommendations for various specific groups. One important outcome of the consensus conferences, supplemented by meetings hosted by Darren Warburton and Norman Gledhill in Vancouver, was the specification of client-specific recommendations for daily minima of physical activity and a limitation of sedentary behaviour. The guideline development was informed throughout by the Appraisal of Guidelines for Research Evaluation (AGREE) II instrument and the evidence was assessed by applying the Grading of Recommendations Assessment, Development, and Evaluation (GRADE) system to evidence garnered from specifically commissioned systematic reviews that were evaluated by an international committee.

Early years (0-4 years). The lead authors of recommendations for the early years were Mark Tremblay (Tremblay et al., 2012) and Brian Timmons (Timmons et al., 2012, Figure 60). It was specified that infants aged less than one year should be physically active several times daily, particularly through interactive floor-based play, that toddlers (aged 1-2 years) and preschoolers (aged 3-4 years) should accumulate at least 180 min of physical



Figure 60: Brian Timmons of McMaster University was one of the prime movers in developing physical activity recommendations for children 0-5 years.

activity of any intensity throughout the day, including activities in different environments that fostered movement skills, with progression toward at least 60 min of energetic play by five years of age.

Children aged 5-11 years and adolescents 12-17 years. Ian Janssen of Queen's University (Figure 61) led the formulation of recommended levels of activity for both children aged five to 11 years (Janssen and Leblance, 2010) and adolescents aged 12-17 years (Janssen, 2007). His review examined seven health indicators: high blood cholesterol, high blood pressure, the metabolic syndrome, obesity, low bone density, depression, and injuries, with a literature search scouring six key databases. 11,088 potential papers were identified, with eligibility determined from a review of abstracts and full-text articles; data was abstracted for 113 outcomes from the 86 eligible papers. The report called for accumulating an average of at least 60 minutes and up to several hours of at least moderate intensity physical activity each day. More vigorous activities should be incorporated when possible, including exercises to strengthen muscle and bone; the majority of the activity should be aerobic, but there should also be muscle and bone strengthening activities on at least three days per week.



Figure 61: Ian Janssen of Queen's University led the development of physical activity recommendations for children aged 5-11 years.

Adults. The original physical activity guidelines for adults were based on relatively limited data. However, Warburton et al. (2007) undertook a systematic search for all relevant information. Their analysis supported the earlier recommendation of 30 minutes of moderate aerobic activity on most (and preferably all) days of the week as a means of reducing the risk of many chronic conditions, including coronary heart disease, stroke, type 2 diabetes mellitus, depression, breast cancer, colon cancer and osteoporosis. However, they cautioned that more research was needed to see if this volume of activity was adequate to address the current epidemic of obesity. Further, they underlined that there was scope for additional research to determine whether some benefits would accrue from lesser levels of physical activity.

Aging. Don Paterson (Paterson et al., 2007) headed the development of recommendations specific for older adults. In 2010, the analysis and Paterson and Warburton suggested the need for a combination of moderately vigorous cardiorespiratory activities such as brisk walking, strength and (or) power training for maintenance of muscle mass and specific muscle-group performance, "balance-mobility practice" and flexibility exercises.

Canadians with disabilities. Recommendations for Canadians with disabilities were addressed by Martin Ginis and Audrey Hicks (Ginis and Hicks, 2007; Ginis et al. 2011, Figure 62). Their article focused on the unique physiological and psychological needs of four specific groups of potential exercisers: individuals with arthritis, fibromyalgia, spinal cord injury and



Figure 62: Audrey Hicks, of McMaster University and Martin Ginis led the development of specific activity recommendations for people with disabilities.

multiple sclerosis.

Fitness Requirements for Workers in Physically Demanding Public Safety Occupations. A number of Canadian researchers including Roy Shephard, Stu Peterson, Dave Docherty, Joan Stevenson and Janice Deaken, have advanced the knowledge both within and outside Canada concerning fitness requirements for workers in physically demanding public safety occupations. However, Roni Jamnik of York University, in addition to co-authoring the CPAFLA with Norman Gledhill and being a member of the collaboration that coordinated the research and implementation of the PAR-Q+ and ePARmed-X+, has made a career commitment to researching the fitness requirements of structural firefighters, police officers, correctional officers, nuclear power emergency personnel and wildland fire fighters. Her publications, beginning with structural fire fighters (Jamnik et al CJSS 1992) and more recently with correctional officers (Jamnik 2010 APNM) plus "Developing Legally Defensible Physical Employment Standards for Prominent Public Safety Occupations (Jamnik, 2013 EJAP) are landmark publications.

Overall recommendations for exercise clearance. The group of investigators who had reached evidence-based recommendations for physical activity in various sub-groups of the population applied the same rigorous process to an assessment of the risks of exercise, allowing formulation of the latest electronic versions of the PAR-Q+ and the ePARmed-X+ forms (www.eparmedx.com; Warburton et al., 2011a, b).

Other Canadian health promotional initiatives. Governmental interest in health and fitness was symbolized by the appointment of a Minister of Health Promotion in Ontario in 2005, with the goal of encouraging Ontarians to make healthier choices at all ages and stages of life, to create healthy and supportive environments, to develop healthy public policy, and to assist with embedding behaviours that promote health. However, political interest did not survive a change of government, and in 2011 this initiative was absorbed into the Provincial Ministry of Health and Long-term Care.

In British Columbia, the framework for the *BC Coalition for Health Promotion* was established in 2002, in cooperation with Agri-Canada, as "a grassroots, voluntary non-profit society dedicated to the advancement of health promotion in British Columbia." Apparently independently of this coalition, the *BC Healthy Living Alliance* was also established in 2003. It claims 40,000 volunteers and 4300 health and recreation professionals, and it has received a \$25 million grant from the BC government to foster healthy eating habits, greater physical activity and a reduction of tobacco consumption.

The province of BC (under the

direction of Drs. Shannon Bredin and Darren Warburton and Shannon at the University of British Columbia) also have led the way in creating a novel free telehealth program that promotes the health benefits of physical activity (<https://www.healthlinkbc.ca/physical-activity>; Bredin and Warburton, 2013). This innovative

Future needs of health and fitness in Canada

Despite 50 years of enthusiastic research, there remain many important challenges to health and fitness in Canada, where further leadership can and will be contributed. There is still a need for more comprehensive information on the safety of exercise testing and prescription in health and in disease, and the development of reliable statistics would be greatly facilitated by the establishment of a Canada-wide registry where all critical incidents occurring during exercise testing and programming were fully recorded and evaluated.

Although Canadian investigators have taken the lead in seeking evidence-based exercise recommendations, there is still a need for further information on safety and dose-response relationships in various clinical conditions, and the PAR-Q+ clearance process (with its medical counterpart) needs continual updating to reflect this new knowledge. This will in turn require a progressive extension of the responsibilities of qualified exercise professionals, with a concurrent extension of their training. Hopefully, the next half-century will achieve that most elusive of goals, definition of the optimal frequency, intensity, and duration of physical activity not only for ostensibly healthy individuals, but also for all those clients with clinical conditions ameliorated by regular physical activity.

Investigators concerned with the promotion of health and fitness have consistently documented the benefits of regular physical activity in terms of enhanced overall mortality, but particularly from the viewpoint of the client, the critical issue is a major gain in the individual's quality of life. Analyses of costs and benefits will thus need repeating, with the quality-adjusted lifespan rather than overall mortality as the appropriate outcome measure. Finally, those on the front lines of health promotion will need to develop ever more effective ways of persuading the general public to accept and continue following recommendations for a healthy lifestyle.

Beyond these immediate and pragmatic goals, there remain many exciting new challenges. Global warming will force greater attention to the exercise responses that occur at high ambient temperatures; how far will exercise clearance and prescription need to be modified in the face of such developments? A growing desire to exploit the resources of the Canadian north will also encourage a re-examination of interactions between the cold of arctic winters and physical activity, with a possible need for adjustment of exercise prescriptions, particularly for those with cardiovascular disease. More fundamental studies of human health and fitness will need to move beyond simplistic surveys of the human genome, looking also at epigenetic determinants of body responses. Finally, as the average age of the population continues to increase, more attention will be directed to the biological causes of aging, and the ways in which what seem inevitable processes can be slowed or halted by regular appropriate doses of physical activity.

Conclusions

A brief account is given of the course of the health and fitness movement in Canada during its first half century from the perspective of an active contributor, looking at the reasons that spurred Canadian interest in this area of research, noting important landmarks on the journey where Canada has made major contributions to international understanding, summarizing the current health and fitness picture in Canada and looking to challenges that remain to be resolved in the next half century.

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Author's qualifications.

The author's qualifications are as follows: Roy J. Shephard, C.M.; Ph.D., M.B.B.S., M.D. [Lond.], D.P.E., LL.D., D.Sc, FACSM, FFIMS.

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