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HISTORICAL PERSPECTIVES
The developing understanding of Human Health and Fitness: 9. The Post-Modern Era

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Abstract

This final segment in this history of health and fitness looks at the Post-Modern Era, through to 2012. New technology (such as the metabolic cart, signal averagers, isokinetic torque recorders, needle biopsy, automated cell sorting and counting and gene sequencers) now speed research in many areas of Exercise Science, Kinesiology, Exercise Biochemistry and Exercise Immunology. Recent politicians have shown a varying personal interest in physical fitness. Several recent American leaders have played team sports, but in Canada some of our leaders have shown a greater interest in outdoor recreation than in sport. The increasing longevity of Western populations speaks to their better overall health. An earlier epidemic of cardiovascular disease has now been partially contained, but it has given place to a growing prevalence of obesity and diabetes. The Lalonde Report, the Romanow Commission, the Ottawa Charter and a series of consensus conferences have clarified many of the relationships between physical activity and disease prevention, and several North American journals now examine details of these relationships. Occupational health and cardiac rehabilitation programmes have attracted growing interest, and the U.S. finally has introduced a scheme for Nation-wide health insurance coverage. Canadian contributions to the study of fitness over the past 50 years have included the standardization of exercise test methodology, and coordination of the physiologic work capacity component of the International Biological Programme Human Adaptability Project. Exercise scientists have underlined the safety of appropriately prescribed physical activity for most of the world's population, and they have begun the difficult task of defining optimal dose-response relationships for individuals with various types of clinical disorder. Other recent initiatives of Canadian Exercise Scientists have included the development of tools for population screening and the field testing of physical fitness, the conduct of representative National fitness surveys, quasi-experimental evaluations of the benefits of enhanced physical education for school children, a detailed analysis of the costs and benefits of worksite fitness programmes, and the demonstration that conservation of a hunter-gatherer lifestyle is associated with a high level of physical fitness. Fitness awards and advertising have attempted to enhance the level of physical activity in the general population, with only limited success. Many Canadian universities now offer doctoral programmes in Exercise Sciences and Kinesiology, and the emphasis in School Physical Education programmes is shifting from the promotion of sports teams to the teaching of physical activities that will carry over into adult life. Minimum fitness needs in physically demanding occupations have been defined in the context of human rights legislation, and Kinesiologists have increasingly demonstrated the beneficial impact of regular physical activity upon various facets of the aging process. International-level sports programmes have received growing support from governments and commercial sponsors, with a multiplication of the corresponding professional associations. High-risk activities such as mountain biking, Himalayan trekking, snow- and skate-boarding, windsurfing, parachuting, hang-gliding and rock-climbing have become popular with many young men. Mass participation events such as marathon runs have also involved large segments of the general population. Outward Bound and trail walking programmes have offered other interesting possibilities for outdoor activity. Olympic and Masters Games now cater to women, para-athletes and the elderly, but athletic competition has lost much of its earlier idealism. Back-room laboratories are pitted against one another in a search for legal or illegal means to enhance the performance. of contestants. Sex and age scandals, physical attacks on opponents and biased judging further sully top-level competition, and cheating is a concern even in the Paralympic Games. The costs of international competition (including associated security measures) have become enormous, and claims that such expenses are offset by a beneficial impact upon public interest in physical activity seem highly doubtful.
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Introduction

Previous articles in this series have examined our developing knowledge of health and fitness from early Neolithic communities through to *homo sedentarius*, living in the pampered, sedentary comfort of the modern era (Shephard, 2011; 2012a; 2012b, 2012c; 2012d; 2013a; 2013b; 2013c). The final segment of this review explores developments during what many historians term the Post-Modern Era.

The term "*Post-Modernism*" was coined in part as a reaction against the growing certainty of experimental scientists, as they pursued with seeming success an objective description of reality. The stereotypical *Post-Modernist* maintains a healthy scepticism towards "*scientific*" explanations of phenomena that claim to be valid for all groups, societies, cultures, traditions, and races. The ardent *Post-Modernist* focuses instead on the relative truths encountered by a given individual, insisting that the way a person perceives the world is inherently subjective. Further, thinkers from this school argue that language, power relations, and motivations play a crucial role in the shaping of ideas and beliefs and the way in which we describe them.

Although I accept the overall validity of this critique, I have a semantic dislike for the term "*Post-Modernism*." According to the *Oxford English Dictionary*, the word "*modern*" is derived from the Latin *modo* ('*just now*"), and it is difficult to conceive any historical era that we can describe or discuss as being subsequent to "*just now*," Nevertheless, the term *Post-Modernism* seems deeply entrenched in the vocabulary of historians and social scientists, and for many people it has come to describe the era in which we now live.

The date when the *Post-Modern era* began is in itself controversial (Anderson, 1998). The historian Arthur Toynbee wrote in 1939:

"Our own Post-Modern Age has been inaugurated by the general war of 1914-1918."

But this time-frame is not universally accepted. Rather, the suggested advent of the Post-Modern Era seems to vary with social discipline. Already, in the 1870s, artists were discussing *Post-Modernism* as a move beyond Impressionist painting. Theologians began talking about *Post-Modernism* during World War I, but the term did not become common among architects until the 1950s. From the viewpoint of health and physical fitness in Canada, the current era was probably initiated by a speech that the Duke of Edinburgh made to the *Canadian Medical Association* in 1959. This was followed by passage of *Bill C-131* and formation of the Federal *Directorate of Fitness & Amateur Sport* in 1961. On the world stage, also, the early 1960s became a turning point for Exercise Scientists, as the sophisticated apparatus previously available only to a few privileged medically-staffed laboratories became available to Kinesiologists and Physical Educators. The Post-Modern Era that we shall discuss in this article thus extends from the early 1960s through to the present day.

As in previous sections of this review, we look first at the impact of new technology upon our scientific understanding of health and fitness. We then explore the attitudes of key politicians in Canada and the U.S., discuss issues in health and fitness that are specific to the Post-Modern Era, and

explore the impact of new types of sport and major international competitions upon the activity patterns and fitness of the general population. Finally, we examine briefly what lessons our historical review offers to those who carry forward the study of health and fitness to future generations.

New technology and resulting scientific discoveries.

Much (but not all) of the new knowledge of health and fitness garnered during the Post-Modern Era reflects access to new laboratory technology. The respiratory physiologist can now use an automated metabolic cart to follow the details of exercise metabolism on a breath-by-breath basis, The Cardiologist profits from the availability of electronic signal averagers and echocardiograms to examine the ECG and movement of the heart wall during vigorous physical activity. The Muscle Physiologist has access to isokinetic machines that record muscle torque accurately throughout the full range of joint movements, and data from needle biopsies clarify the type and metabolic characteristics of individual muscle fibres. The scope of the Exercise Immunologist has also expanded greatly with the advent of automated devices for leukocyte cell sorting and counting, while the human genome project has clarified relationships between inheritance, health and fitness. Finally, a continued study of reactions to environmental extremes has pointed to methods of enhancing human performance and reducing the dangers of exercise under a variety of adverse conditions.

Respiratory Physiology. The last few decades have seen replacement of the traditional Douglas bag technique by metabolic carts equipped with electronic flow meters and electronic gas analysers. Moreover, miniaturization has allowed use of this automated equipment in field studies of athletes. However, controversy has continued over the interpretation and practical value of maximal oxygen intake measurements.

Douglas bag technique. When evaluating exercise responses, the traditional approach of the Respiratory Physiologist was to collect several samples of expired gas in large rubberized canvas or neoprene bags at 30-60 sec intervals. This required very precisely timed turning of valves; a one-breath difference in sample collection could immediately cause an error of 2-3% in estimates of an individual's oxygen consumption. Then, the contents of the bags had to be sampled, using an evacuated glass tube or syringe. The gas composition was determined by tedious chemical analyses, and the volume of gas that had been collected was measured by emptying the bag through a dry gas meter. Thus, up to 30 minutes was required in order to complete a single measurement of oxygen consumption.

Automated flow and gas analysis measurements. The measurement of respiratory gas flow was greatly facilitated around 1950, when the Swiss physiologist Alfred Fleisch [1892-1973 CE) devised an electronic instrument that he called a *pneumotachograph* (Fleisch, 1952; Fleisch, 1954; Shephard, 1955); it measured pressure differentials across a fine gauze mesh. During the late 1950s, the British biomedical engineer Basil Martin Wright (1910-2001 CE) also applied a small turbine flow meter to the measurement of human respiratory air flow (Wright, 2001). Nevertheless, some problems remained with both types of

instrument. Pneumotachograph calibration curves became non-linear at high flow rates, due to turbulence across the screen, and pressure differentials were further distorted by the accumulation of water droplets. Turbine flow-meter data were also compromised by inertia of the rotors at low flow rates and slippage of gas at high respiratory minute volumes.

The electronic measurement of expired gas concentrations began soon after World War I, with the introduction of the katharometer. This device exploited the fact that heat loss (and thus electrical resistance) in one arm of a Wheatstone bridge could be modulated by the carbon dioxide content of the air that was passing around the resistor (Daynes and Shakespear, 1920). Other early methods of electronic gas analysis included interferometry and mass spectrometry. During the 1950s, the non-dispersive infra-red analyzer was developed by the High Altitude Physiologist Ulrich Cameron Luft (1910-1991 CE). This device quickly became the option of choice for the determination of respiratory carbon dioxide concentrations (Dubois et al., 1952; Fowler, 1949), and the paramagnetic analyzer of Linus Pauling (1901-1994 CE) became the preferred method for oxygen analyses. However, both of these devices had rather slow response times, making them unsuitable for breath-by-breath analyses, and the infra-red monitor had the further disadvantage of requiring a gas sample of at least 100 ml per measurement.

Thus, when rapid response metabolic carts came onto the scene during the 1970s (McFarlane, 2001), the methodology of gas analysis changed. Carbon dioxide concentrations were determined using a CO_2 electrode, and a polarographic electrode (originally conceived for blood gas analysis) was commonly used for determinations of oxygen concentrations (Clark et al., 1953; Severinghaus and Bradley, 1958). Other occasionally used oxygen sensors now include a high temperature Zirconia fuel cell (Roe et al., 1987), and a mass spectrometer (Hunter et al., 1949).

Miniaturization. Progressive miniaturization of metabolic cart components has enabled analysers to be incorporated into the outflow tube of a standard face-mask. The information is then transmitted by radio-telemeter to a nearby recording system or stored on a memory stick (Crouter et al., 2008; Hausswirth et al., 1997). This new approach has greatly facilitated the measurement of oxygen consumption in exercising athletes. Previously, an assistant or a vehicle had to carry Douglas bags (or more recently, to push a metabolic cart) alongside a competitor.

Value and interpretation of metabolic cart data. Clinical testing was greatly facilitated by the introduction of metabolic carts, but the contribution of such equipment to new scientific knowledge is more debatable. Breath-by-breath analysis of oxygen consumption has certainly become possible. This allows the investigator to make a more precise definition of an individual's ventilatory threshold (the oxygen consumption associated with a disproportionate increase in ventilation), (Davis et al., 1980). It has also become easy to visualize attainment of an oxygen consumption plateau (the classic criterion of all-out aerobic effort, where oxygen consumption increases by less than 2 mL/[kg.min] in response to a further increase in the rate of working). However,

it is worth underlining that both the standardization of fitness test methodology that was conducted by the International Working Party (below) (Shephard et al., 1968a; 1968b: 1969), and research on the oxygen conductance theorem (which identified the circulatory system as the primary bottleneck to oxygen transport during vigorous exercise, (Shephard, 1970)) were completed using the classical Douglas bag approach.

A concept foreshadowed by the findings of the International Working Party was that the magnitude of an individual's peak oxygen intake would depend on the volume of muscle activated by the exercise test equipment. Thus, the Working Party demonstrated that in most ordinary people, a treadmill test yielded a somewhat larger maximal oxygen transport than cycle ergometry (Shephard et al., 1968a). I was able to explore this issue further in 1984-1985, when working with Henri Vandewalle and Hugues Monod at the Pitié Salpetrière Hospital in Paris. We compared the peak oxygen consumption developed when exercising with one or two legs, the arms and the forearms, and we were able to correlate the respective figures with anthropometric estimates of the muscle volume that had been activated (Shephard et al., 1988b).

Sports Scientists have shown more than two-fold difference of maximal aerobic power (expressed in ml/[kg.min]) between several classes of endurance athlete and the ordinary healthy young adult (Shephard and Âstrand, 2000). Nevertheless, Tim Noakes (1949-), the controversial Professor of Physiology at the University of Cape Town, has recently challenged the usefulness of measuring maximal oxygen intake in athletes (Noakes, 2008). Most other exercise scientists are firmly convinced that one of the important factors limiting an individual's endurance performance is the ability of the heart and circulation to transport oxygen from the lungs to the working tissues (Shephard, 2009a). However, Noakes has drawn upon an idea advanced by C.V. Ulmer (Ulmer, 1996), arguing that endurance performance is limited rather by an ill-defined "*Central Governor*." In his view, this governor operates a feed-forward control system that protects the competitor from exercising to a level that could cause tissue damage through either hypoxia or hyperthermia (Noakes and Marino, 2009; Noakes et al., 2001).

Cardiology. The post-modern era has seen considerable advances in electrocardiography, the use of ultrasound, and techniques for detecting an injury of myocardial tissue, allowing a clearer understanding of cardiac reactions to both acute and chronic exercise.

Use of the ECG. Until the early 1960s, a combination of a "wandering baseline," electrical signals from muscles underlying the surface electrodes, and electrical noise from other laboratory equipment such as motor-driven treadmills made the interpretation of exercise ECG records very difficult. However, a combination of better skin preparation, grounding of ancillary equipment, shielding of cables and the development of electronic averaging and filtering devices now allows cardiologists to make quite precise measurements of average heart rates and the extent of ST segmental depression during exercise (Jonson et al., 1976). Appearance of more than 0.2 mV of ST depression during a progressive exercise test has proven a useful warning that the

myocardium is developing an excessive degree of hypoxia during a progressive exercise test.

It was thought initially that quantitation of an exercise-induced ST depression might identify those apparently healthy individuals who were at particular risk of a heart attack, but a better understanding of Bayes theorem and the principles of biological screening quickly dashed such hopes. Bayes theorem itself was described many years ago by Thomas Bayes (1702-1761 CE), a Presbyterian minister living in Tunbridge Wells, Kent. However, during the 1970s, clinical investigators began to apply this mathematical concept to a critical evaluation of various biological screening procedures (Andermann et al., 2008; Wilson and Jungner, 1968). This led to an appreciation that in a healthy population with a low prevalence of cardiac disease, the sensitivity and specificity of most exercise stress tests was such that an unacceptable proportion of patients developed false positive responses. These apparently abnormal findings required further evaluation, and had the potential to cause long-lasting cardiac neuroses in the individuals who were misdiagnosed (Shephard, 1981).

Unfortunately, not all sports physicians have yet recognized the difficulties of screening healthy athletes that are implicit in Bayes theorem. For example, a European movement centred in Northern Italy has argued strongly over the last 30 years that all athletes should receive an annual resting ECG in the hope of avoiding the very rare sudden and exercise-related deaths that have occasionally occurred in young competitors (Corrado et al., 2006). In 1982, the Italian parliament enacted legislation making such evaluations mandatory, and in consequence a substantial proportion of quite healthy Italian athletes with what were wrongly judged as "ECG abnormalities" were advised against taking any further vigorous exercise. Moreover, many other competitors faced the expense and anxiety of secondary clearance by such techniques such as echocardiography in an attempt to clarify their false positive ECG test results.

Italian Cardiologists claim that as a result of this legislation, there has been a small reduction in the number of sudden exercise-related deaths among Italian athletes, although critics have pointed out that the incidence of such episodes is still no lower in Italy than in North America (where preliminary ECG screening is not mandatory). Many of the early diagnoses of supposedly abnormal ECGs in Italian competitors were based upon increased voltages of the QRS complex (an almost inevitable consequence of a larger heart and a thinner overlying layer of subcutaneous fat). ECG criteria of normality specific to the athlete were not introduced until 2010 (Corrado et al., 2010), and unfortunately, recognition of the need for altered, athletic-specific criteria has cast additional doubt upon earlier claims for the efficacy of an ECG screening process that Italian cardiologists now admit used inappropriate norms. Vigorous debate continues, but North American cardiologists still reject the idea of universal ECG screening of athletes, largely because it inevitably produces so many worrying and costly false positive test results (Maron et al., 2007; Shephard, 2011a; 2011c).

Echocardiograpy. The Italian priest and physiologist Lazarro Spallanzani (1729-1799 CE) was apparently aware of the use

of sonar by bats, and ever since an Austrian physician, Josef Leopold Auenbrugger (1722-1809 CE), introduced the technique of thoracic percussion, clinicians have exploited the reflection of sound waves by the heart wall as a means of approximating cardiac dimensions.

During the late 1940s, a German physicist, W.D. Keidel, attempted to measure the attenuation of sound waves by the heart, but he was apparently unsuccessful in determining cardiac volumes. The first practical form of echocardiography was developed in 1953 (Krishnamoorthy et al., 2007). Working at the University of Lund, Sweden, Inge Edler (1911-2001 CE) and his physicist colleague Carl Hellmuth Hertz (1920-1990 CE) designed an ultrasound device that they termed a *reflectoscope*, and they used this equipment to assess cardiac dimensions in patients with mitral valve disease (Edler and Lunstorm, 1954).

The standard clinical M-mode echocardiogram was popularized by Harvey Feigenbaum during the 1960s. He showed that echocardiographic estimates of heart volume compared closely with the values obtained by the more invasive technique of angiography (Feigenbaum, 1996). Dekker and colleagues (Dekker et al., 1974) introduced the refinement of a 3-dimensional echocardiogram. Sports Physicians quickly began to exploit echocardiography, both to evaluate the health of the heart in athletes with supposedly abnormal ECGs, and to search for evidence of hypertrophic cardiomyopathy, which some authors claimed was the commonest cause of sudden exercise-induced death in young athletes. However, the setting of appropriate goal-posts for diagnosing a pathological ventricular hypertrophy (such as the ratio of inter-septal to posterior wall thickness or end-systolic diameter) has remained a thorny problem. Upper limits for the dimensions of interest have undergone frequent adjustment (Shephard, 1996) and as with other screening tests, it has been difficult to establish clear norms that are effective in distinguishing the normal physiological hypertrophy seen in all endurance athletes from the pathological changes associated with hypertrophic cardiomyopathy (Pelliccia et al., 2012). A recent ultra-sound study of 114 Olympic athletes, spanning their participation in 2 to 5 Olympic Games, emphasized that top endurance competitors normally showed no cardiovascular symptoms, and little change of left ventricular morphology or function as their sport participation continued (Pelliccia et al., 2012a).

Often, the only recourse of those suspecting a pathological enlargement of the heart has been to forbid exercise, and to watch whether the size of the myocardium then decreased to what seemed "normal" values. In the future, a new technique that may help to differentiate physiological from pathological hypertrophy is the use of ultrasound speckle tracking; this calculates the global longitudinal strain in the ventricular muscle (Butz et al., 2011). Differentiation of transient from long-term pathologies may also emerge from ultrasound and magnetic resonance imaging of right ventricular and atrial dimensions before and after endurance competition (Neilan et al., 2006).

The use of ultra-sound continues to expand in the clinical laboratory, with applications that now include the diagnosis and treatment of musculo-skeletal injuries, the diagnosis of splenomegaly, and the estimation of bone density (Yim and Corrado, 2012).

Identification of myocardial injury. The detection and quantification of myocardial injury has been greatly facilitated as exercise biochemists have developed an ability to distinguish the release of a myocardial protein (cardiac troponin) from similar proteins that are released by the injury of skeletal muscle (Roth et al., 2007), Such data have been very helpful when managing cardiac patients, but controversy continues over the clinical significance of the small quantities of cardiac troponin that are sometimes detected in the blood of healthy individuals following participation in ultra-marathon and triathlon contests. Some investigators have argued that a small leakage of myocardial protein is a normal component of the process of cardiac hypertrophy (Shave and Oxbrough, 2012) and that magnetic resonance and echocardiographic techniques show no associated deterioration of myocardial function following a bout of prolonged endurance exercise (Wilson et al., 2011). Others have insisted that if there is release of cardiac troponin, there is some injury to heart muscle; they have linked their findings to small immediate changes in ventricular function that resolve within a week or so following endurance competition (LaGerche et al., 2008). This debate has yet to be resolved.

Muscle physiology. New techniques that have facilitated the description of muscle function during the post-modern era include the development of isokinetic dynamometers and needle biopsy.

Isokinetic dynamometers. The isokinetic dynamometer was first developed by H.G. Thistle, a physician interested in muscular rehabilitation (Thistle et al., 1967). Several forms of isokinetic dynamometer became commercially available during the 1980s, and use of such equipment has become an important component of assessments undertaken in well-equipped strength testing laboratories.

Some historians trace the origins of isokinetic equipment back to the mechanical exercise machines of Gustav Zander that appeared during the 19th century (Shephard, 2013b). Because of the high retail cost and large profit margins associated with modern isokinetic equipment, various civil court actions have debated patent rights to the underlying concepts. Machines such as the *KinCom*, *Cybex* and *Biodex* allow subjects to exercise at computer-controlled speeds throughout a pre-determined range of motion, with measurements made most easily at the knee joint. One immediate objection to the isokinetic testing of a single joint is that the results may not be representative of muscle strength in other body regions. Thus, one study of Australian football players found little relationship between the isokinetic strength of the quadriceps and their likelihood of developing hamstring injuries (Bennell et al., 1998).

Other current methods of assessing muscle function are the Wingate test and the calculation of force-velocity curves. Use of the Wingate test as a simple measure of the anaerobic power and capacity of the leg muscles was discussed in a previous segment of this review (Shephard, 2013c). The force-velocity ergometer test developed by Henri Vandewalle and Hugues Monod during the 1980s allows the determination of both the peak power and the peak velocity that an individual can develop using either the legs or the arms (Vandevalle et al., 1987).

Needle biopsy. Needle biopsies of muscle have given new insights into both fibre types and muscle metabolism, with implications for both athletic selection and sports nutrition. Throughout the 1950s, muscle fibres were classified as either fast or slow twitch, basing the distinction simply on their myoglobin content (Lawrie, 1953). However, in the 1960s, classification began to be based on the enzyme profile of the fibre, basing fibre typing upon the content of either myosin vs. actomyosin ATPase (Engel, 1962) or oxidative vs. glycolytic enzymes (Barnard et al., 1971).

For a while, there was considerable debate as to whether humans had an intermediate fibre type, but advances in muscle protein chemistry during the 1990s allowed resolution of this question; fibre types I, II and IIx were defined very precisely in terms of their main protein constituents (Moss et al., 1995). Bengt Saltin of the Copenhagen Muscle Research Centre began studies of muscle glycogen content in 1967. He demonstrated that intramuscular glycogen reserves could be boosted by a specific dietary regimen that comprised a heavy, glycogen-depleting bout of work and three days of a fat and protein diet, followed by three days of a high carbohydrate intake (Saltin and Hermansen, 1967). With minor variations and simplifications, this dietary technique has become very popular as a means of boosting intramuscular glycogen reserves and thus the performance of endurance athletes.

Immune function. Until the 1980s, few Exercise Science laboratories had the equipment to develop an interest in Immunology, although there were occasional epidemiological studies suggesting relationships between upper respiratory infections and either a single bout of heavy endurance exercise or a period of particularly arduous training (Shephard, 2013d). Proof even of this relationship was somewhat tenuous, since most studies were based upon reports of respiratory symptoms rather than clinically diagnosed and virologically proven episodes of rhinovirus infection (Shephard, 2000). Development of Exercise Immunology over the past 3 decades has been spurred by new technology, appreciation of the importance of leukocyte demargination, and discovery of a metabolic role for cytokines.

Technical developments. Progress in Exercise Immunology was greatly stimulated by several technical developments: introduction of the *Coulter Automated Cell Counter,* the *FACScan Cell Sorter* that has enabled identification of a wide variety of leukocyte sub-types, radioactive techniques to measure the cytotoxicity of leukocytes accurately, and application of the techniques of molecular biology to determine the quantities of cytokines secreted by immune cells. The idea of automated cell counting can be traced back to Moldovan, (1934), but a practical device for this purpose was only developed and patented by Wallace Coulter in 1953 (Coulter, 1953).

Dittrich and Gohde (1969) began measuring the fluorescence of particles in a fluid stream. Electronic devices that sorted cells by volume soon followed (Fulwyler, 1965), and dyes absorbed by the leucocytes were quickly replaced by fluorescent markers linked to monoclonal antibodies. The first Becton-Dickinson *Fluorescence Activated Cell Sorter* (FACScan ®) was introduced in the early 1970s (Gabriel and Kindermann, 1995).

Assessments of cytotoxicity became more precise as methods developed to isolate natural killer (NK) cells; it is now possible to express rates of lysis relative to both the NK cell count and to a unit volume of blood.

Determinations of cytokine concentrations continue to prove challenging, since plasma concentrations of these compounds are very low. Most cytokines also bind strongly to receptor molecules, have a short half-life, and are readily neutralized by circulating inhibitors. Assay methods have included radioimmunoassay, enzyme-linked immunosorbent assay (ELISA), competitive binding to a receptor molecule, and most recently the transcription of cytokine mRNAs, using the technique of reverse transcription polymerase chain reaction assay (Moldoveanu et al., 1995).

Demargination. Although substantial changes in the circulating leukocyte count have long been observed during and immediately following a bout of vigorous exercise, it has become appreciated that many of the changes in circulating cell numbers are due to a modulation of cell adhesion molecules and a resulting attachment or release of immune cells from extra-vascular storage sites (Weicker and Werle, 1991). This conclusion has spurred an extensive study of the modulation of the activity of adhesion molecules by hormones such as the catecholamines (Shephard et al., 2000).

Changes in the number and toxicity of circulating natural killer cells may contribute to an increased susceptibility to upper respiratory infections following a demanding bout of exercise, but in recent years, interest has shifted from the NK cells towards exercise-induced changes in the protective role of the mucosal immune system, where immunoglobulins offer the primary physical, biochemical and immunological barrier to most hostile micro-organisms (Tharp and Barnes, 1990).

Metabolic role of cytokines. One of the current leaders in Exercise Immunology, Bente Klarlund-Pedersen of Copenhagen opened up a new line of enquiry with the fascinating discovery that exercise activated the IL-6 gene in skeletal muscle. IL-6 was thus released into the blood as intramuscular glycogen stores became depleted. It appears that in addition to playing an important role in controlling responses to infection and injury, leukocyte secretions may make a significant contribution to metabolic regulation (Pedersen et al., 2004).

Genetics of health and fitness. Quantitative study of the genetics of physical fitness began in the early 1970s, with comparisons of fitness levels between similar and dissimilar twins who had been exposed either to similar or to dissimilar environments during their years of growth. Vassilis Klissouras, a Greek immigrant to Montreal, was an early pioneer in this area of research (Klissouras, 1972). Subsequently, more extensive investigations were undertaken at Laval University, where Claude Bouchard directed the *Quebec Family Study* and subsequently participated in the *Human Genome Project* (Bouchard et al., 1984; 1986; 2000).

The early efforts of Kinesiologists sought to partition the variance in both an individual's initial fitness and his or her response to training between genetic and environmental factors. Unfortunately, the repetition of apparently very similar observations yielded widely differing

verdicts on the partition of this variance. Nevertheless, there is little doubt that some individuals are born with a higher maximal oxygen intake than others; for instance, a group of investigators at York University in Toronto engaged in the screening of firefighters found that 6 of 1900 young men with no history of training had a maximal oxygen intake some 50% greater than that of their peers, apparently because they were endowed with a larger blood volume than others of their age (Martino et al., 2002).

One factor that encouraged a continued search for substantial genetically determined differences in the response to training was what seemed large inter-individual differences in the gains of maximal oxygen intake when apparently similar individuals followed an identical conditioning regimen. The conclusions drawn from these experiments had to be re-examined when it was pointed out that about a half of the apparent inter-individual differences in training response were simply an expression of laboratory errors in the measurement of maximal oxygen intake, with data following the well-known statistical principle of "*regression to the mean*" (Shephard, 2003a; 2004). However, it remained apparent that inheritance of a high initial aerobic power and an above-average response to training gave a few individuals a large advantage in athletic events requiring a large maximal oxygen intake.

The mapping of the human genome gave further impetus to the research of Sports Geneticists. Many attempts were made to link specific gene configurations to risks of disease and to fitness attributes such as maximal oxygen intake, muscle strength and the response to various types of training programme. Statistically significant linkages are indeed being discovered, but in most cases individual genes seem to account for only a very small fraction of the total variance in data. The discovery of substantial new information that can help the sports medicine practitioner currently remains a tantalizing dream. Further advances await a better understanding of possible interactions between individual genes, and clarification of epigenetic factors that activate and deactivate particular segments of the human genome. Nevertheless, one recent study of 324,611 single-nucleotide polymorphisms (SNPs) identified 21 SNPs which together appeared to account for about 49% of inter-individual differences in the trainability of maximal oxygen intake (Bouchard et al., 2011). There are fears that in the future, unscrupulous athletes may solicit deliberate genetic manipulation in order to give themselves a competitive advantage ("gene doping"), for example by boosting their endogenous production of erythropoietin or human growth hormone.

Environmental physiology. The hosting of the Olympic Games in Mexico City (1968) sparked interest in the speed with which athletes could adapt to low ambient pressures of oxygen. It was also appreciated that when a competitor returned to sea level, the increase of haemoglobin concentration that had developed in Mexico City allowed more oxygen to be carried with every litre of blood that was pumped by the heart, and that this physiological advantage persisted for several weeks as the haemoglobin concentration gradually reverted to its sea level norm. Some athletes thus attempted to gain an unfair competitive advantage by transfusion of

their own (autologous) blood or by the administration of the erythropoietin to stimulates their red cell production (erythropoietin was first identified and extracted from urine in 1977). Investigators at York University played an important role in demonstrating the potential impact of this abuse upon maximal oxygen intake, and thus the likely outcome of endurance competition (Buick et al., 1980; Spriet et al., 1980; 1986).

Anti-doping agencies are still struggling to regulate these abuses by such approaches as testing the blood or urine for evidence of exogenous erythropoietin, noting the ratio of reticulocytes to mature red cells in the blood, and requiring endurance athletes to keep a passport recording their haemoglobin levels on a regular basis (Bornø et al., 2010; Garvican et al., 2010). Some endurance competitors now boost their haemoglobin "legally" by living at high altitude for various periods. The most effective technique seems to live at altitude (or the simulated high altitude conditions of a tent where the partial pressure of oxygen is reduced), but to continue training at sea level (in order to avoid curtailing the normal vigour of conditioning programmes) (Levine and Stray-Gundersen, 1997).

Another environmental issue that has attracted considerable controversy in recent years has been the quantity of fluids that endurance athletes should ingest when competing under warm conditions. The basic principles of fluid replacement were established through our observations on marathon runners during the early 1970s. Fluid intake could usefully include a modest pre-event drink of 500 ml., and a further 150 ml. of fluid should be ingested in each subsequent 15 minutes of running, to match the likely rate of absorption from the gastro-intestinal tract during vigorous exercise (Shephard and Kavanagh, 1975). Water was shown to be as effective a replacement fluid as proprietary sports drinks during competition (Kavanagh and Shephard, 1977), and weighing offered a simple means of assessing final over- or under-dehydration, if due allowance was made for the water liberated from stored glycogen and produced by metabolism (a total of up to 2 litres).

However, some athletes and coaches ignored these simple guidelines, reasoning that if a little fluid was good, more would be even better for them. Thus, a proportion of participants in endurance races ended up with a biochemical hyponatremia (a plasma sodium concentration in the range 130-135 mE/L), and in a few instances endurance runners developed a symptomatic, clinical hyponatremia (<130 mE/L). Problems were particularly likely in the slowest runners and under cool conditions. World-wide, there have been at least 8 deaths from over-hydration of endurance competitors. Tim Noakes stirred up considerable controversy on this question, making the as yet unsubstantiated allegation that companies manufacturing sports drinks and scientific agencies that received grants from these companies were actively conspiring to suppress information on the dangers of hyponatraemia. In his view, hyponatraemia had become epidemic (Noakes and Speedy, 2007) (Noakes, 2011; Shephard, 2011b).

Attitudes of political leaders.

We will examine briefly the attitudes of some recent political leaders to issues of health and fitness, firstly in Canada and then in the United States, noting their personal lifestyles, and specific health and fitness initiatives that have been associated with their terms of office.

Daniel Roland Michener (1900-1991 CE). Rolly Michener was one of the fittest of Canada's *Governors General*. He served in this office from 1967-1974, and was a keen participant in several of the Ottawa fitness conferences of that era. Although he was then in his seventies, he would out-run most conference delegates in a 5 km lunch-time sprint along the banks of the Rideau Canal.

Lester Bowles Pearson (1897-1972 CE). Despite leading a minority government during his term of office (1963-1968), Pearson's government successfully introduced such important measures as *Universal Health Care*, *Student Loans*, and the *Canada Pension Plan*.

When attending the University of Toronto, Pearson himself had been an outstanding athlete, coaching the Varsity ice-hockey and football teams, and excelling in baseball, lacrosse, golf and tennis. He was inducted into the *University of Toronto's Sports Hall of Fame* in 1987 (Cohen, 2008). The award for the best national league hockey player was long known as the *Lester B. Pearson Award*, and Pearson was also inducted into *Baseball's Hall of Fame* in 1983.

Joseph Philippe Pierre Yves Elliott Trudeau (1919-2000 CE). Beneath his image as an astute politician and society playboy, Pierre Trudeau had quite a reputation as an athlete (Southam, 2005), with a strong personal commitment to such outdoor activities as long canoe trips in Canada's north. He was also a keen practitioner of judo, finally being promoted to *ni-dan* (second-degree black belt).

Trudeau supported the *Cooperative Commonwealth Federation (CCF*, the Canadian Democratic Socialist Party) throughout the 1950s. In consequence, Maurice Duplessis (the ultra-conservative Premier of Quebec) black-listed him for an academic position at the *Université de Montréal*, and Trudeau was also prohibited from entering the United States during the McCarthy communist witch-hunt. However, when Trudeau entered Federal politics in the 1960s, he chose to join the Liberal Party of Canada. He succeeded Lester Pearson in 1968, and continued as Prime Minister (with one brief interlude in opposition) through to 1984.

Trudeau vigorously defended the newly introduced *Universal Health Care System*, and expanded welfare programming for the aged, the young and the under-privileged. Other notable actions were invoking the *War Measures Act* to defuse the *October Crisis* of 1970, *Patriation of the Canadian Constitution* from the U.K., and policies of bilingualism and multiculturalism. In 1974, Marc Lalonde (1929-), a Québecois Federalist politician who was then Trudeau's *Minister of Health and National Welfare*, became concerned about the rapidly increasing costs of health care (Tulchinsky and Varavikova, 2009), and he produced a striking document entitled *A new perspective on the health of Canadians* (Lalonde, 1974). This identified several health-related objectives, including support of the health

care system, the prevention of health problems and the promotion of good health, with a strong emphasis upon the value of an active personal lifestyle. Many consider the report (Lemco, 1994):
"*the first modern government document in the Western world to acknowledge that our emphasis upon a biomedical health care system is wrong, and that we need to look beyond the traditional health care (sick care) system if we wish to improve the health of the public*."

Charles Joseph Clark (1939-). Joe Clark was Canada's youngest Prime Minister. He came to office in June 1979, at the age of 39 years, but was quickly ousted after a negative vote on Budget legislation that included an 18 cent hike in gasoline taxes (Humphreys, 1978). Although a member of the Conservative party, in terms of health and social policy, Clark was considered a "Red Tory," with left-leaning tendencies that included proposals for the decriminalization of marijuana and provision of a guaranteed minimum income to all Canadian citizens.

He has often been portrayed by cartoonists and biographers alike as a gangly individual (Nolan, 1978), "*not that well coordinated physically*" and with no particular interest in sport or athletics. His preferred pastimes have been reading, debating, and essay writing.

John Napier Wyndham Turner (1929-). John Turner was another ephemeral Prime Minister, serving in that office for a mere 79 days of 1984 (Litt, 2011). In contrast to Joe Clark, Turner was very athletic, and as a young man he had been an outstanding track sprinter, holding the Canadian 100 m record. However, a knee injury prevented him from participating in the London Olympics of 1948. While attending Oxford University, he found himself on the same track and field team as Roger Bannister. After returning to Montreal, Turner continued to enjoy squash, tennis, and skiing in the Laurentians. He was also a strong swimmer, and once rescued former Prime Minister John Diefenbaker when the latter was caught in an undertow on a Barbados beach. However, as a politician Turner's main appointments were in Justice and Finance, and he had no strong influence on Canadian health and fitness policies.

Martin Brian Mulroney (1939-). Early attempts by Mulroney to lead the Conservatives in 1975-76 were regarded by the rank and file of his party as too slick and over-financed. The lack of success of these efforts led him into a bout of alcoholism and depression. One biographer claimed that Mulroney sought professional help with his addiction to alcohol (Sawatzky, 1992). However, Mulroney stated bluntly (Newman, 2006):

"Never went to an Alcoholics Anonymous meeting in my life. I woke up one morning and thought... I'm drinking too much and I'm going to stop. I've never had a drink since. Same thing with smoking."

As Joe Clark became less popular, Mulroney initiated a successful back-room campaign to replace him. Mulroney quickly defeated John Turner, becoming Prime Minister in 1984 and continuing in office until 1993. Mulroney is best known for negotiating the *Free Trade Agreement* with the United States, introduction of a *Goods and Services Tax,* the doomed *Meech Lake Constitutional Accord*, and the East Coast ban on cod fishing. A close relationship with President Ronald Regan

helped in shaping an international agreement on acid rain.

Mulroney had been a heavy smoker until 1983, and was successfully treated for pulmonary cancer in 2005. His Minister of Health, Jake Epp, was successful in getting increased funding for medical research, apparently through the advocacy of Mulroney's wife Mila. However, Mulroney's own attitude to physical activity was epitomized during a 1989 visit to Moscow, when he waited 10 minutes for a limousine to drive him a distance of 200 m to a ceremony celebrating the importance of exercise and physical fitness (Newman, 2006).

Avril Phædra Douglas "Kim" Campbell (1947-). Kim Campbell succeeded Mulroney as Prime Minister in 1993. She was the first woman to hold this office, but her term lasted a brief 4 months, largely because when an election had to be called, Mulroney had already made the Conservative party extremely unpopular. Campbell is remembered particularly for her definition of sexual assault while Minister of Justice. She never sat in parliament during her period as Prime Minister, and thus no specific health and fitness legislation can be attributed to her government.

One of her most urgent concerns as a woman was the toll upon health caused by illegal back-street abortions. In her biography, Kim Campbell also speaks of taking a regular fitness walk with her friends (Campbell, 1997). Her interest in walking and jogging is highlighted by the fact that during her term as Prime Minister, she was dating Russian-born Gregory Lekhtman, inventor of the *Exerloper*, a patent type of exercise boot.

Joseph Jacques Jean Chrétien (1934-). Chrétien was Canada's 20th Prime Minister, serving the country in this role for more than 10 years (1993-2003) (Chretien, 1986). This was an era of national belt-tightening, as his Minister of Finance (Paul Martin) struggled to control the budgetary deficit and reduce the National debt that had accumulated during the 1970s and 1980s. Perhaps in part for this reason Chrétien's administration introduced no dramatic innovations in the fields of health and fitness. Indeed, the Provincial transfers of funding for health services were substantially reduced during his administration, and the possible restoration of a part of this funding was used as a bargaining chip in subsequent discussions with the Provinces.

Chrétien was personally quite fit, and likened politics to a sport. When physically confronted by a protestor during a walkabout in Hull, QC, he responded with a brisk choke-hold (a move that some reporters described as a "*Shawinigan handshake*"). He enjoyed swimming and was a keen golfer. He aroused some controversy when he lobbied the *Business Development Bank of Canada* to provide a multi-million dollar loan to a golf resort near to his home town of Shawnigan (the *Gran'-Mère Inn*) (Lawrence, 2003). Chrétien had previously held a substantial personal stake in the resort, and he was still owed money for the sale of his shares, but after investigating these transactions the Prime Minister's *Ethics Counsellor* ruled that Chrétien had not been guilty of any wrong-doing.

Justice Gomery, who in 2004 was charged with investigation of the *"Sponsorship Scandal,"* was less generous in his assessment of Chrétien's administration. Moneys earmarked to promote the Federalist cause in Quebec

had ended up in Liberal Party coffers, and Gomery criticized Chrétien specifically for distributing autographed golf balls that had been purchased using this fund. In Gomery's view, this was "*small town cheap*." Chrétien responded by pulling from his pocket golf balls that had been autographed by various U.S. Presidents, and he asked the Judge which of these Presidents was *small town cheap*.

In 2007, Chrétien complained of anginal pain while he was playing in a charity golf match in Montreal, and 2 days later he underwent successful quadruple by-pass surgery. He again complained of difficulty in walking in 2010, and on this occasion was admitted to hospital with a sub-dural haematoma.

His oldest son is a SCUBA instructor, and a pioneer in teaching SCUBA diving to the disabled. The younger son was adopted from an Inuvik orphanage with foetal alcohol syndrome, and he has had various unfortunate brushes with the law.

Paul Edgar Philippe Martin (1938-). Martin waited in the wings of the Liberal Party for several years, scheming to succeed Chrétien as leader, but when Chrétien did finally resign in 2003, Martin was perceived by many as too old for the job, "*yesterday's man*."

As a child of 8, Martin had sustained an attack of poliomyelitis. Full recovery took about a year, but on reaching high school, he was able to play on a championship football team. As a teenager, he was said to be more impressed when his politician father met with sports figures than when he talked to politicians or diplomats. As a politician, Martin junior found relaxation in weekend games of golf (Chodos et al., 1998).

Martin's policies while Minister of Finance had reduced Canada's debt to GDP ratio dramatically, from 70 to 50%, with a balancing of the Federal budget. However, this had been achieved at the cost of endangering social, health and infrastructure programmes. As Prime Minister, Martin reached a $41 billion dollar agreement with the Provinces to improve health care and reduce wait times for surgery. He also signed agreements with the Provinces to establish a National early learning and child care programme, and in the *Kelowna Accord* of 2005 he promised to eliminate inequalities of health care between aboriginals and non-aboriginals.

Stephen Joseph Harper (1959-). Canada's current Prime Minister, Stephen Harper, came to power in 2006. He led a minority government until 2012, when he gained a substantial majority.

Prior to gaining power, Harper had told the *Council for National Unity*, an American think-tank, that "*Canada is a Northern European welfare state in the worst sense of the term, and very proud of it*." In an editorial that was written in 2000, following the death of Pierre Trudeau, Harper accused Trudeau of "*unabashed socialism*," stating that Canada "*appears content to become a second-tier socialistic country*." These quotes seem to summarize the extreme conservatism of Harper's policies. In particular, he would like to see amendment of the Canada Health Act to allow the introduction of a second-tier private health care system, with shorter surgical-wait times available to the wealthier members of society.

A high-school photo shows Harper playing basketball, and he is still an avid follower of ice-hockey, although his current body build and perfectly styled hair suggests that he has an armchair rather than an active interest in sport. He

attends his son's hockey games when duties permit, and his hopes to publish a book on the history of hockey (Mackey, 2005) were realized in 2013 ("*A great game: the forgotten Leafs and the rise of professional hockey*", New York, NY, Simon & Schuster, 2013). Harper still writes occasionally on the subject, and appeared on *The Sports Network* (TSN) during the broadcast of the Canada–Russia final of the 2007 world junior ice-hockey championships. He also enjoys playing board games with his daughter, and is quite skilled as a pianist.

One small positive initiative of the Harper government was the establishment of a children's *Fitness Tax Credit* in 2007. This legislation allows parents to claim an income tax deduction of up to $500 for enrolling a child under 16 in any eligible physical activity programme. For children with disabilities, an additional tax credit of $500 can be claimed until the child is 18 years old.

John Fitzgerald "Jack" Kennedy (1917-1963 CE). John Kennedy brought a youthful and athletic image to the Oval Office when he became U.S. President in 1961. However, when at school he suffered from various bouts of illness, and lived under the shadow of his brother Joe, who was the local football star (Dallek, 2011). In 1936, JFK recuperated from one bout of illness by serving as a farm hand on a 40,000-acre Arizona ranch. He is said to have "*worked very hard*" during that summer.

At Harvard, Kennedy tried out for football, golf, and swimming, earning a spot on the varsity swim team. Despite medical disqualification for lower back problems, he used the powerful influence of his family to be allowed to serve as Captain of a torpedo boat during World War II. When his boat was rammed by a Japanese destroyer, he swam away, towing a badly burned crew member to the safety of a nearby island by clenching the man's life-jacket between his teeth. In 1947, Kennedy was diagnosed as suffering from Addison's disease. This condition together with severe back pain led to frequent use of a multiplicity of drugs, sudden mood swings, periods of impaired judgment and a plethora of extra-marital affairs.

An early positive contribution of the Kennedy administration was the creation of the *U.S. Peace Corps*, under the direction of his brother-in-law, Sargent Shriver. This programme allowed 10,000 volunteers to provide help in education, farming, health care, and construction to underdeveloped nations. On the domestic front, Kennedy's "*New Frontier*" promised free medical care for the elderly. U.S. attitudes towards fitness also became more positive under Kennedy. He was himself a major proponent of fitness in magazines such as *Sports Illustrated* (Shephard, 2013c).

Lyndon Baines Johnson (1908-1973 CE). Johnson grew up in a poor area of rural Texas. At high school he was known for his prowess in both debate and baseball. He came to the Presidency in 1963, following the assassination of Kennedy, and continued in this office through 1969.

As a politician, Johnson would often adjourn a meeting, insisting that all of those present needed to "exercise" in the White House swimming pool, whether they had a swimsuit with them or not (Parker, 2007). He also claimed to (Parker, 2007):

"*walk the grounds for exercise after lunch*."

"*can't beat a brisk daily walk for sound exercise...You should walk with me more often and lose some of that lard*."

However, he was not himself famous for a healthy lifestyle. He reputedly smoked 60 cigarettes per day and worked 18-20 hours per day with no obvious leisure pursuits, until he sustained a near-fatal heart attack in 1955. He then stopped smoking, but he became overweight, particularly after leaving office. He also resumed smoking heavily. He suffered further massive heart attacks in 1972 and 1973, the last proving fatal.

During his term in office, Johnson set in motion the *Medicare* and *Medicaid* programmes which had been proposed by the Kennedy administration (Martin and Weaver, 2005). The *Medicare* programme offered low cost medical services to tens of millions of elderly Americans; Harry and Bess Truman received the first two *Medicare Cards* as the bill was signed into law at the Truman Library in Independence, Missouri. Low-income groups also began to receive government-sponsored medical coverage through the *Medicaid* programme.

Richard Milhous Nixon (1913-1994 CE). Nixon was raised by poor Quaker parents in Loma Linda, CA (Aitken, 1996). There was a family history of tuberculosis, and when a "spot" was found on Richard's lung at the age of 12, he was prohibited from playing any sports (although the lesion was later found to be a residue of pneumonia rather than tuberculosis) (Ambrose, 1987). Nixon enrolled in junior varsity football, but was rarely asked to play, because of his short stature. However, he was a member of his college basketball team.

His term in office ran from 1969 to 1974. He is perhaps best known for his impeachment, and he is the only American President to have resigned from office.

Positive contributions to health and fitness included wars on cancer and drugs, creation of the *Environmental Protection Agency* (EPA) (1970) and the *Occupational Safety & Health Organization* (OSHA), and enactment of the *Clean Air Act* (1970). However, in our present context, he was also the first President of the "*President's Council on Physical Fitness*."

In 1971, Senator Edward Kennedy was motivated by dramatic increases in the costs of medical treatment to propose a universal, federally-run health insurance scheme. Nixon responded with a health care plan that provided insurance for low-income families, and required that all employees be provided with health care. However, the Nixon plan still left some forty million people without coverage, and the democrats thus declined to support it. Congress did approve Nixon's proposal for increased use of *Health Maintenance Organizations* in 1973.

In terms of health research, Nixon's critics point out that although he called for increased spending on high-profile items such as cancer and sickle cell research, he sought to reduce overall spending at the *National Institutes of Health*.

Gerald Rudolph "Jerry" Ford (1913-2006 CE). Ford was the only unelected U.S. President. He came to office in 1974 with the enforced resignation of Nixon, and continued as President through 1977. His three-year term was marked by a depressed economy, inflation, and few

new policy initiatives. He died at the age of 93 years (Greene, 1885).

At high school and university, he was the star of the football team, and the team's football song was played during his funeral procession. He was also an avid golfer, shooting a hole in one during a Pro-Am competition, and he was a boxing coach while studying at Yale. During World War II, he coached all available 9 sports at the *U.S. Navy Pre-Flight School,* and he then became Athletics Officer on the aircraft carrier *Monterrey*. As an adult, he maintained a strong interest in the *Boy Scouts of America*, and he was the only U.S. president to attain the highest rank of *Eagle Scout*. Despite his athletic career, he tripped on one occasion when leaving the Presidential plane in Austria, and in consequence he was often lampooned as a klutz by cartoonists.

James Earl "Jimmy" Carter (1924-). Jimmy Carter was U.S. President from 1977 to 1981. Before entering politics, he had been first a Naval Officer and then a Georgia peanut farmer. As a Naval Officer, he had been seconded to Chalk River, ON, in 1952, following a partial melt-down of a Canadian nuclear reactor that spilled millions of litres of radioactive fluid into the Ottawa River.

Carter returned to Georgia to help with the family farm following the death of his father, and at this time he was sufficiently poor to qualify for subsidized public housing. No doubt, this experience stimulated his subsequent interest in the "*Habitat for Humanity*" project that continues to construct simple housing for the underprivileged in the U.S. and overseas. By applying scientific methods to his farming, he quickly became relatively wealthy.

During his Presidency, the Soviet invasion of Afghanistan precipitated an American boycott of the Moscow Olympic Games. After leaving office, Carter himself worked tirelessly to improve housing and eradicate disease in developing countries. The *Carter Center*, opened in 1982, has played a major role in the control and eradication of Guinea worm disease, river blindness, malaria, trachoma, lymphatic filariasis, and schistosomiasis (Gherman, 2003).

Carter's hobbies include painting, fly-fishing, woodworking, cycling, tennis, and skiing.

Ronald Wilson Reagan (1911-2004 CE). Regan served as U.S. President from 1981 to 1989. At school, he had been a member of the football team and captain of the swim team. He brought to the White House the skills of a radio, television and movie actor, mostly in the B-grade film unit and (notoriously) he was featured in commercials for Chesterfield cigarettes. Thus, in 1948:

"I'm sending Chesterfields to all my friends. That's the merriest Christmas any smoker can have- Chesterfield mildness, plus no unpleasant after-taste."

As President, he was the front-man for Reaganomics. He sought deregulation of the economy, a lowering of taxes, and the cutting of government services, with an implicit faith that the goodness of humanity would make the system work. His changes reduced *Medicaid*, food stamps, and funding of the *Environmental Protection Association*. In 1986, he also budgeted $1.7 billion for a *War on Drugs*, specifying mandatory minimum penalty for drug offences.

Reagan was formally diagnosed with Alzheimer's disease in 1994, five years after leaving office. However, many observers think that mental deterioration may have set in earlier, albeit masked by skilful assistance from his wife Nancy. Former CBS White House correspondent Lesley Stahl recounts a meeting in 1986 (Stahl, 1999):

"Reagan didn't seem to know who I was. ... I thought. I have to go out on the lawn tonight and tell my countrymen that the President of the United States is a doddering space cadet."

Reagan died at the age of 93.

George Herbert Walker Bush (1924-). While at school, George Bush Sr. captained both baseball and soccer teams. As a sports-minded boy, he thought that one of the advantages of going to heaven was to get a better overview of football plays (Gormley, 2000). He continued to use sports analogies in his speeches as a politician (Barilleaux and Rozell, 2004). At the age of 18, he decided to postpone his entry into university in order to serve as a pilot in the U.S. Navy. In the period following the attack on Pearl Harbor. he flew in 58 combat missions, on one occasion with his engine in flames. Attending Yale after demobilization, he again captained the baseball team, and in the summer of 1966 he worked at the Houston branch of Sears, selling sporting goods. However, he quickly left Sears for the Texas oilfields, where he became a millionaire.

Much of his Presidency (1989-1993) was haunted by pragmatic attempts to reduce the National deficit, which had tripled under President Reagan. This objective led to increased taxes and further reductions in government services. In the context of health and fitness, one positive piece of legislation was passage of the *Americans with Disabilities Act* (1990).

Bush maintained an active lifestyle during his Presidency, playing a doubles tennis match with the Emperor of Japan Akihito and his son the Crown Prince Naruhito during a 1992 visit to Japan (Barilleaux and Rozell, 2004).

William Jefferson "Bill" Clinton (1946-). Bill Clinton's father was an Arkansas travelling salesman who died 3 months prior to Bill's birth. His mother subsequently married a car dealer who proved to be an alcoholic and a gambler. Clinton developed an interest in Rugby Union football, playing at Oxford University, and later for the Little Rock Rugby club in Arkansas (Benson, 2004). However, he was also characterized as a McDonald's-and-junk-food-loving boy (Morrison, 1998). His term of office (1993-2001) saw a long period of economic expansion and prosperity, but his Presidency was marred by several allegations of sexual improprieties, most notably with his intern Monica Lewinsky.

He introduced the *Family and Medical Leave Act* in 1993. This legislation required large companies to allow employees to take unpaid leave for pregnancy or a serious medical condition. However, attempts at further reform of health care and provide universal coverage through a *National Health Care Plan* (brought forward in part at the urging of his wife Hilary) were thwarted by the combined opposition of congress Republicans, the *American Medical Association* and the health insurance industry (Harris, 2006). After his re-election, Clinton successfully enacted

some measures of welfare reform and instituted a *State Children's Health Insurance*.

After leaving office, he created the *William J. Clinton Foundation* to promote such causes as the prevention of AIDS.

George Walker Bush (1946-). George W. Bush is the eldest son of George Bush Sr. When at boarding school, George W. played baseball and was the head cheer-leader. As a young man, he enjoyed baseball, football and tennis. Before becoming U.S. President, he worked in the Texas oil business, and was a co-owner of the *Texas Rangers* baseball team. He supposedly had an adult "*conversion*" to evangelical Christianity in 1985, although seven years later the televangelist James Robison still dismissed him as fun-loving and sports-crazed.

He had been ticketed at least once for public drunkenness, but he had continued in the belief that a 3-mile run the "*morning after*" would overcome his hangover. One morning in 1986, it did not, and in response to pressure from his wife Laura, George W. decided to quit drinking. He attributes a fairly rapid overcoming of alcohol dependence to his religious faith (Mansfield, 2004). He continued regular running, and completed the Houston Marathon in 1993 in 3 h 45 minutes. He comments (Bush, 2010):

"*I felt ten years younger at the finish, and ten years older the next day."*

As U.S. President (2001-2009), his attention was largely engaged by the so-called "*War on Terror*" in Iraq and Afghanistan, and by the major financial and banking crises of 2008. These events led to a rapid decline in his popularity. However, early in his first term of office he had increased funding to the *National Science Foundation* and the *National Institutes of Health*. After his re-election, he also signed into law *Medicare* benefits for seniors that subsidized the purchase of prescription drugs, at a cost of some $40 B/yr. The *Medicare* plan covered some 25 million seniors, each with their own private account. An aide, John Goodman, explained gleefully that this made the plan almost impossible to Socialize. At the same time, the government lost any chance to negotiate wholesale prices for medications, or to import cheaper alternatives from overseas (Zelizer, 2010). George W. also opposed expansion of the *State Children's Health Insurance Program*, which would have provided medical care to an additional 4 million children from poor families. He supported adult stem cell research, but used his Presidential veto to oppose embryonic stem cell research. He committed $15 B to the fight against the global HIV/AIDS epidemic over the period 2003-2008.

Barack Hussein Obama (1961-). Obama is the first African American to have become President of the United States. He was born in Hawaii, and spent some of his childhood in Indonesia, following the remarriage of his mother. At high school, Obama played basketball, but also admits to using alcohol, marijuana, and cocaine as a part of the *Choom gang* (Maraniss, 2008). Later, he started jogging regularly, and gradually weaned himself from the drug culture. After several abortive attempts with nicotine patch therapy, he reportedly finally quit smoking in 2010.

Prior to entering politics, he was a civil rights attorney. He became U.S. President

in 2009. He inherited, and has yet to fully resolve the deep financial crisis that beset the second term of the George W. Bush administration. Unemployment is only now dropping from officially reported levels of around 10%, not seen since World War II.

Early in his mandate, Obama moved ahead with health care reforms. He proposed an expansion of health insurance that would cover the 30 million adults who were as yet uninsured, would cap premium increases, and would allow people to retain coverage if they left work or changed their jobs. In future, every American will be required to have health care coverage. However, this will still be arranged through private insurance companies. There was to have been a public option to keep rates competitive, but when the bill was finally approved by the Senate in 2010, the public option was deleted. Premiums are to be subsidized for everyone earning below 400% of the Federal poverty level (an annual income <$80,000 for a family of four). Measures to offset the costs of the new health plan include economies in other arms of government, new Medicare taxes for those in high-income brackets, taxes on indoor tanning, and fees imposed on pharmaceutical companies and manufacturers of medical devices. Obama has reversed Bush's stand on embryonic stem cell research.

Health

Life expectancy at birth has shown a continuing increase in most developed countries during the Post-Modern Era. This points to further improvements in the overall health of the population. A Canadian born in 2009 can expect to live a total of 81.2 years [10 years longer than in 1961 (Canada, 2012)], and despite the snide remarks that Americans sometimes make about the Canadian health care system, the current life expectancy of a Canadian child is now 3 years greater than that of a child born in the U.S. A large part of the increased longevity over the past 3 decades is attributable to a greatly reduced prevalence of cigarette smoking (which can shorten lifespan by as much as 8-10 years). Medical and Surgical advances have also made some contribution to these gains, although these benefits have been offset by an increase in metabolic risk factors.

The emergence of professional associations and journals concerned specifically with health and fitness and the hosting of a series of major consensus conferences have been major factors enhancing the professional development of health and fitness workers. Formal governmental recognition of the importance of Preventive Medicine came early to Canada, with publication of the landmark *Lalonde Report* (1974), appointment of the *Romanow Commission*, and promulgation of the *Ottawa Charter*. In many developed countries, the epidemic of cardiovascular disease has now been replaced by an obesity epidemic. Among other health programmes, both occupational health and rehabilitation have attracted growing interest.

Professional Associations and Journals. The *Canadian Public Health Association* (1910) and the *Canadian Association of Health, Physical Education and Recreation*, now known as *PHE Canada* (1933) both came into existence long before the Post-Modern Era, as did their primary house journals (the *Canadian Journal of Public Health, 1910* and the *CAHPERD Journal*, 1934).

However, both of these organizations have boosted their output of publications in more recent years, with launching of the *CPHA Health Digest* (beginning in 1977) and the on-line resource *PHEnex* (commenced in 2009). In 2008, Canada also saw publication of the first issues of the *Health & Fitness Journal of Canada*. In the United States, a growing array of journals that focus upon health and fitness now includes (with date of initiation) *Preventive Medicine (1959)*, the *American Journal of Preventive Medicine (1970)*, the *American Journal of Health Promotion (1987)*, *ACSM's Health & Fitness Journal (1997* and the *Journal of Physical Activity & Health (2004)).* Interest of the lay public was such that in 1950 the Rodale Press began publishing a specific magazine for the intelligent general reader (*Prevention*); this now boasts a world-wide circulation of 2.8 million. But perhaps the biggest boost to professional discussion and management of health and fitness issues came with the *Certification of Fitness Professionals* and their attendance at meetings of the *American College of Sports Medicine* (*ACSM)* and the *Canadian Society for Exercise Physiology* (*CSEP)*, beginning during the 1990s.

The Lalonde Report. A Federal governmental report entitled "*A new perspective on the Health of Canadians*" was published when Marc Lalonde (1929-) was the Canadian *Minister of National Health and Welfare* (Lalonde, 1974). This document recognized the heavy financial demands created by the 1965 system of universal health care, and it identified twin health objectives: improvement of the health care system itself and the prevention of health problems through the promotion of good health. It distinguished four "health fields:" *Human Biology*, *Environment*, *Lifestyle*, and *Health Care Organization.* It underlined that many of the determinants of good health lay outside traditional systems of medical care. As an American commentator noted (Lemco, 1994):

"our emphasis upon a biomedical health care system is wrong, and ....we need to look beyond the traditional health care (sick care) system if we wish to improve the health of the public…"

Romanow Commission. During the last decade, concern has been expressed about the ability of federal and provincial governments to sustain universal health care in the face of an aging population and the availability of ever more costly forms of treatment. Thus in 2005, the *Romanow Commission on The Future of Health Care in Canada* was appointed to address this issue*.* Among its findings, it estimated that in 1999, physical inactivity was costing the health care system $2.1 B per year, and that a 10% reduction in physical inactivity would save $150 million per year in direct health costs.

Ottawa Charter. In 1986, the *Canadian Public Health Association*, in association with *Health Canada* and the *World Health Organization* developed the *Ottawa Charter for Health Promotion,* and at an international meeting in Victoria, BC, Health Canada released *"Achieving Health for all: A framework for health promotion"* (NationalDepartmentofHealthandWelfare ., 1986). This document underlined the concept of active living, suggesting that people should incorporate much of the physical activity needed to maintain their health into the daily routine. The *Charter* also emphasized the importance of

"*strengthening community action*" as a key to success.

***Consensus conferences*.** In recent years, several major international consensus conferences on physical activity and health have built upon the 1966 Toronto *International Symposium on Physical Activity and Cardiovascular Health*, doing much to clarify relationships between physical activity and health. New methodologies adopted for the more recent conferences have included the use of *Citation Indices* to select the most knowledgeable invitees and the employment of professional facilitators to develop a consensus from among a large group of experts with initially disparate views.

All of the consensus conferences were hosted in Canada. In 1988, Claude Bouchard of Laval University headed a team that organized a conference on *Exercise, Fitness and Health.* Over four and a half days of meetings, around 1000 scientists from many parts of the world gathered in Toronto to develop a consensus on the health benefits of regular exercise, The findings were subsequently published (Bouchard et al., 1990). A similar event (again chaired by Claude Bouchard) was held in Toronto in 1992. On this occasion, a computer search of the literature identified the best-informed international investigators to lead discussion on each of some 70 topics. After detailed review, editing and group approval, the final conclusions were published as a major scientific text (Bouchard et al., 1994). Since information was still lacking on the optimal dose of exercise, Dr. Bouchard and his colleagues embarked on a third consensus conference in October of 2000. This focused specifically on dose-response relationships. Unfortunately, evidence still proved insufficient to make clear dose-response statements for many of the clinical conditions that were considered at the gathering (Kesaniemi et al., 2001). The three consensus conferences were very helpful in clarifying the ideas of exercise scientists, but a need was recognized to transmit this information to front-line workers engaged in fitness testing and health promotion. Art Salmon of *Fitness Ontario* thus collaborated with *Health Canada* and the *U.S. Centers for Disease Control* to offer a "translation" of the findings into terms that would be helpful for front-line workers. They organized a 2001 Whistler conference entitled "*Communicating physical activity and health messages: science into practice*" (Shephard, 2002).

The definition of dose-response relationships of course remains critical to appropriate exercise prescription, and over the past 5-6 years Canadian investigators led by Norm Gledhill and Darren Warburton have held further international conferences weighing the evidence on safety and the appropriate doses of exercise to prescribe both for healthy individuals and for those with a wide variety of clinical conditions (Shephard, 2007; Warburton et al., 2011a).

Epidemics of heart disease and obesity. The post-modern era has seen a growing application of epidemiological techniques to large studies that have examined the relationships between physical activity and disease*.* Until recently, the exercise side of the equation relied mainly on self-reports concerning the intensity and volume of habitual physical activity, as obtained from questionnaires of varying complexity.

Such estimates proved adequate for a simple 2-3 level classification of habitual activity patterns, but major systematic errors in the estimation of active energy expenditures precluded the interpretation of responses in terms of dose-response relationships (Shephard and Aoyagi, 2012).

The development of accurate and inexpensive pedometer/accelerometers is now allowing the earlier epidemiological studies to be repeated, with much greater confidence in the patterns of activity that are identified (Aoyagi and Shephard, 2009). In one such investigation, several hundred elderly people in a small Japanese town have worn pedometer/accelerometers continuously for 6 or more years. Objective measures of changes in health status over the 6 years, including pulse-wave estimates of arterial stiffness, osteosonic determinations of bone health, and DXT figures for lean tissue mass are currently being correlated with habitual patterns of physical activity (Shephard et al., 2013), allowing a relatively precise definition of the minimal levels of daily physical activity associated with protection of the individual against arteriosclerosis, osteoporosis and sarcopenia. By knowing the levels of physical activity associated with a given prevalence of various chronic diseases and the costs of treating each of these conditions, it has also become possible to estimate the economic benefits likely from inducing a modest increase of physical activity in specified fractions of a population (Aoyagi and Shephard, 2011).

Epidemics of chronic disease related to low levels of physical inactivity have been a continuing concern during the Post-Modern Era. Dr. Terry Anderson, the first doctoral graduate from the University of Toronto's Exercise Sciences programme, established that the epidemic of cardiovascular deaths previously noted in Great Britain was replicated in Canada during the 1950s and 60s (Anderson and Le Riche, 1970). Physical inactivity was not the sole cause of this epidemic. Cigarette smoking also played an important role. The incidence of coronary deaths in North America began to decrease in the 1960s, and continued to decline more slowly through the 1990s, as smoking became less prevalent and hypertension was better controlled (Cooper et al., 2000), even though there was little evidence that the population had increased its physical activity. Thus, Canadian statistics show the rates of heart disease and stroke declining by 25% over a 10-year interval, 50% over 20 years, and 70% between 1956 and 2002 (Canadian Heart Foundation, 2006). Unfortunately, these impressive gains have been offset by a growing prevalence of cardiac disease in developing nations, as their populations have moved to cities and have adopted the adverse lifestyle found in much of Western Society.

There were concerns about an obesity epidemic in Canada in the early 1950s, and partly for this reason, a Nation-wide survey of heights, body masses and skinfold thicknesses was undertaken (Pett and Ogilvie, 1956). In fact, the survey found that the percentages of overweight and obese Canadians were relatively low during the 1950s. However, more recent evidence shows that Canada is now affected by what has become a global obesity epidemic (Shields, 2005; Starky, 2005). From 1978 to 2004, obesity rates among Canadians aged 18 and over increased from an initial level of 14% to a final figure of 23%, and among Canadians aged 2 to 17 years the

corresponding values increased from 3% to 8%.

Occupational health. Efforts to improve the health and safety of workers began in the Victorian era (Shephard, 1991, 2013b). In Germany, Chancellor Otto von Bismark introduced compulsory state-run accident compensation during the 1880s. In Canada, the *Meredith Report* of 1913 addressed the issue of worker compensation, and initiatives were also taken in several U.S. States between 1902 and 1914.

Long hours of overtime were frequently instituted in British armament factories during World War I, in the hope of boosting overall output, but such policies proved counter-productive. Poor health and injuries actually reduced production, and a "*Health of Munition Workers' Committee*" was thus established (Oborne, 1982). After the conclusion of hostilities, the committee was reconstituted as the *Industrial Fatigue Board*, and in 1929 as the *Industrial Health Research Board*. This organization monitored working conditions, and made recommendations on such issues as posture, load carriage, physique, rest pauses, lighting, heating and ventilation. In the U.S, the Harvard Fatigue Laboratory began to explore similar issues (Horvath and Horvath, 1973; Shephard, 2013c).

Beginning in the 1920s, the *London School of Hygiene* in England, the *School of Hygiene* in Toronto (founded with Rockefeller support in 1927), and counterpart institutions in the United States began to train occupational physicians. The first Director of the *University of Toronto School of Hygiene* (Dr. John G. Fitzgerald, 1882-1940 CE) was a keen proponent of worksite exercise, and he encouraged his staff to spend 45 minutes each lunch-time playing deck tennis on the roof of the Fitzgerald building. However, this was an unusual recommendation for his time. In the period before World-War II, Russian occupational hygienists argued that in many industries the demands of daily physical labour already imposed a dangerously heavy physiological load, and any added exercise might cause irreparable damage to the workers (Cantelon, 1982). In Western Europe, also, the typical attitude of the factory doctor was to determine the intensity of effort required by an industrial task, to set an upper limit to the duration of such activity, and then either to seek workers with a physique that would enable them to undertake the task (Āstrand, 1967; Bonjer, 1966), or to hire an Ergonomist to reduce the physical demands of the job.

During the inter-war years, *time-and-motion* and *work-study* experts tended to treat employees as robots, prescribing standard times and movement patterns for each action that was required on an assembly line (Barnes, 1963; DeJong, 1967; Mundel, 1950). Nevertheless, such close examination of work practices and resulting changes in the design of machinery often reduced the energy cost of heavy industrial tasks. Studies also began to show that quite brief "*relaxation breaks*" could enhance output. In heavy types of work, a rest interval gave the best results, but in many of the newer sedentary occupations the problem was boredom rather than physical fatigue, and in such situations performance was restored more readily by 5-10 minutes of exercise than by a corresponding period of passive relaxation (LaPorte, 1966; LaPorte, 1970).

During the 1970s, Fitness Canada followed up on these observations, encouraging companies to replace the traditional mid-morning break for coffee and donuts by an 8-minute *fitness break*. The latter was usually taken at the employee's immediate work-station, with a volunteer leading a programme of exercises to the rhythm of taped music. There were suggestions from Eastern Europe that despite their brief duration, programmes of this type could reduce sickness and absenteeism (Pigalev, 1963 ; Uher, 1963). However, the main goal of the Canadian fitness breaks was to increase the worker's awareness of the need for regular exercise, rather than to provide the entire volume of daily physical activity that was needed to maintain good health.

Rehabilitation Programmes. The 1966 *International Conference on Physical Activity and Cardiovascular Disease* thrust Canada into the forefront of efforts in primary, secondary and tertiary rehabilitation, beginning with apparently healthy individuals and those with established myocardial infarction, but extending progressively to patients with a variety of other chronic illnesses.

Primary and secondary rehabilitation. The series of major consensus conferences on physical fitness and health that were held in Toronto placed Canada in a unique position to develop well-informed, evidence-based physical activity guidelines for rehabilitation of the sedentary but otherwise healthy individual. Over the past two decades, *Health Canada* (Sharratt and Hearst, 2007) has worked with various Canadian scientists (Janssen, 2007; Paterson et al., 2007; Timmins et al., 2007; Warburton et al., 2007) to develop and refine recommendations on an appropriate minimum weekly volume of exercise for people of various ages. Various groups in the U.S (US Department of Health and Human, 1996) and elsewhere have also developed recommendations, largely independently of each other. Inevitably, details of these recommendations have differed somewhat, and this has had the unfortunate effect of causing the general public to be skeptical about all of the advice that has been offered (Shephard, 2003b). Interestingly, the WHO (World Health, 1985) and Canadian experts have at times urged a weekly volume of physical activity greater than that being recommended in other countries such as the U.S., arguing that a substantially larger weekly volume than 150 minutes of moderate aerobic exercise was needed to counter one of North America's most urgent current health problems, the obesity epidemic.

Tertiary cardiac rehabilitation. Tertiary cardiac rehabilitation programmes began to appear during the 1950s (Shephard, 2013c). Soon after the *Toronto International Symposium on Physical Activity and Cardiovascular Disease*, the *Toronto Rehabilitation Centre* (TRC), in association with the University of Toronto, began its tertiary rehabilitation programme under the direction of Dr. Terence Kavanagh. This quickly progressed to become one of the world's leading cardiac rehabilitation programmes. Terry Kavanagh initially offered medically supervised programmes of progressive and vigorous aerobic rehabilitation to individuals who had sustained a myocardial infarction. He subsequently extended suitably adapted variants of this programme to individuals who had developed chronic cardiac

failure or who had received a cardiac transplant.

The Toronto programme incorporated several unique features. One was the collection of detailed physiological data on all patients, including direct measurements of peak oxygen intake, and accurate determinations of the ST depression induced by vigorous exercise, using an electrical signal-averaging device. The data thus obtained allowed Dr. Kavanagh to offer carefully individualized prescriptions of an appropriate intensity. Other cardiac rehabilitation facilities offered a brief (2-3 month) course of thrice-weekly classes, with supervision by a Nurse or Physiotherapist. However, the TRC recognized that poor compliance with such programmes reflected the large amount of time that was spent in travelling to and from the rehabilitation centre, and the limited guidance that the patient received on arrival. All TRC sessions were thus medically supervised, with detailed group discussion of exercise-induced symptoms and practical problems of rehabilitation prior to each class session. Patients attended the centre only once per week, to minimize driving time, but they also completed at least four more carefully prescribed home sessions each week, with compliance monitored by completion of a detailed daily "*exercise log*."

One measure of the success of the Toronto approach was seen in 1973, when eight post-coronary patients participated in the Boston Marathon under close medical supervision. The programme of progressive aerobic training had greatly increased the peak oxygen intake of the runners from their initial values of 24-27 mL/[kg.min]. Indeed, one patient had reached a peak maximal oxygen intake of 53 mL/[kg.min], and was able to complete the Boston Marathon in the very respectable time of 3 hours 17 minutes (Kavanagh et al., 1974). This feat not only gave new courage to post-coronary patients around the world, but it also provided valuable information on the best methods of maintaining fluid and mineral balance when performing prolonged exercise under warm conditions (see above).

Multi-centre trials of cardiac rehabilitation. The 1960s and 1970s saw many randomized controlled trials attempting to test the efficacy of cardiac rehabilitation in reducing subsequent recurrences of myocardial infarction and cardiac mortality. Meta-analyses across the various trials suggested that mortality was reduced by around 20% (Shephard, 1986b). However, the multi-centre trial that was conducted in Ontario showed no fewer recurrence rates in the exercised group than in controls who undertook a placebo programme of light physical activity (Rechnitzer et al., 1975; 1983).

One possible explanation of the aberrant Canadian finding was that whereas some patients assigned to the exercise group failed to persist with their prescribed programme of vigorous activity, by the 1970s, the publicity concerning the merits of daily exercise had persuaded a number of patients in the supposed placebo group to begin exercising vigorously on their own. Thus, when data were reanalyzed *post hoc*, in terms of those who had improved their physical condition versus those who had not, an advantage was seen in the more active of the two cohorts (Cunningham et al., 1990).

Rehabilitation in other chronic conditions. The experience gained with cardiac patients was progressively transferred to the rehabilitation of patients with other medical conditions. The Canadian international consensus conferences identified many diseases where exercise was beneficial in terms of both prevention and treatment. In particular, there was growing recognition of the value of exercise programmes in both the prevention of certain types of cancer and in rehabilitation following surgery or irradiation.

Fitness and Physical Education

The military demands of World War II stimulated the *American Association for Health, Physical Education & Recreation* to host a *National War Fitness Conference* in 1943, and the *U.S. War Department* published a manual of daily calisthenics, games and sports for aircrew (Karpovich, 1944). Two decades later, Kenneth Cooper (then a Colonel in the U.S. Air Force) introduced his aerobic test (the 12-minute run) and the associated *Aerobics* training programme in an attempt to enhance the fitness of U.S. Air Force personnel (Cooper, 1968). Physical Education Departments at many American high schools continued to focus upon the success of sports teams, but an appreciation of the importance of increasing the fitness of the general population developed through the efforts of the *President's Council on Fitness* and enthusiastic support from individual proponents such as Ken Cooper and Steve Blair.

Canadian interest in fitness was stimulated temporarily during World War II by the demands of military recruiting boards. One response was passage of the *National Physical Fitness Act* in 1943. More recently, the *5 BX plan* (Orban, 1961) offered personnel of the *Royal Canadian Air Force* an 11-minute daily exercise plan that could be completed "*beside your bed in the barracks*." However, the defining moment for health and fitness in Canada arrived in 1959, when HRH the Duke of Edinburgh addressed the *Canadian Medical Association* as its first lay President. He spoke with characteristic bluntness about a lack of fitness in the current generation of Canadians. His remarks were widely publicized, and they provoked a flurry of activity both in the Canadian legislature and in the general populace.

We will here discuss bureaucratic initiatives, the resulting establishment of *Fitness Research Units*, the standardization of fitness test procedures and the conduct of representative population surveys, attempts to motivate the general public through *Fitness Awards* and the Crown Corporation *ParticipACTION*, levels of habitual activity in urban Canada and in hunter-gatherer communities, trends in university courses, *Professional Certification,* school programmes of Physical Education, and attempts to extend fitness programmes to the worksite and to the elderly.

Bureaucratic Responses. An early response of the Canadian bureaucracy to new concerns about a poor level of National fitness was seen in 1963, with enactment of Bill C-131, *An Act to promote Fitness and Amateur Sport*. This legislation established a *Directorate of Fitness and Amateur Sport,* with a *Minister of State* under the general supervision of the *Minister of National Health and Welfare*.

Because the *Directorate* was a junior ministry, the incumbent was usually a

young and ambitious politician, who remained in this particular office for only 1-2 years before moving on to a more prestigious appointment elsewhere in the Federal cabinet. In order to make his or her mark, the emphasis of the *Directorate* was shifted with each new appointee. One incumbent thought it appropriate to focus upon the importance of sport programming, and the next emphasized the need to enhance the fitness of the general population.

As in most government departments, there were also frequent changes of name and administrative organization. In 1971, two directorates (*Sport Canada* and *Recreation Canada*) were created within the *Fitness and Amateur Sports Programme*. *Sport Canada* was supposed to concentrate its activities on competitive sport at the national and international levels, and *Recreation Canada* was charged with increasing the public's awareness of the importance of fitness and recreation in everyday life as it encouraged the average Canadian to engage in greater physical activity. *Recreation Canada* was renamed *Fitness and Recreation Canada* in 1977, and two additional Directorates (*Programme Operations* and *Administration, and Planning, Research and Evaluation)* were created. The responsibilities of *Recreation Canada* now included programming for National sport and recreation organizations, natives, and disabled persons, encouraging a healthy lifestyle through physical activity, and coordinating Federal fitness activities with those of the provinces. *Fitness Canada* was formed in 1979 from the fitness and recreation branches of the *Fitness and Amateur Sports Directorate*. In 1979 and 1980, responsibility oscillated with alarming rapidity between *National Health & Welfare*, the *Secretary of State* and the *Minister of Labour*. By 1993, *Fitness and Amateur Sport* comprised three divisions, entitled *Sport Canada*, *Fitness Canada*, and *International Relations and Major Games*.

A final reorganization occurred in 1993. This abolished the post of *Minister of State for Fitness and Amateur Sports,* and the functions of the programme were split between the *Minister of Health* (*Fitness*) and the *Minister of Canadian Heritage* (*Sports*). This arrangement was confirmed in 2003, with enactment of the new *Physical Activity and Sport Ac*t.

Fitness Research Units. An early annual budgetary allocation of $5 million allowed the *Fitness and Amateur Sport Directorate* to establish three *Fitness Research Units* in 1963-1964. Because of the regional realities of Canadian politics, it was decided to locate these units in Edmonton, Montreal and Toronto. Each unit received an annual grant of $50,000 for five years, at that time a budget that was judged sufficient to pay the salaries of two academic staff, two technicians and a secretary, and to cover the purchase of a limited quantity of equipment and supplies.

Despite fiscal constraints, Doctoral programmes in the Exercise Sciences were launched immediately in both Toronto and in Edmonton, with Dr. Terence Anderson becoming the first Canadian Ph.D. graduate in 1966. Another early initiative of the Toronto Fitness Research Unit was the hosting of the world's first *International Symposium on Physical Activity and Cardiovascular Disease*. This event took place in October of 1966 at Toronto's *Inn-on-the Park*. It attracted more than 600 delegates, and a well-edited conference proceedings appeared as two special issues of the

Canadian Medical Association Journal within 5 months of holding the symposium (Shephard, 1967).

Standardization of exercise test procedures. The newly publicized Canadian interest in health and fitness attracted an International Biological Programme/World Health Organisation *International Working Party* on the measurement of maximal oxygen intake and other aspects of fitness testing. This met in Toronto for 3 months during the summer of 1966 (Shephard et al., 1968a; 1968b; 1969).

Canadian interest in the standardization of laboratory testing continued in subsequent years, in part because Canadian athletes were being tested in various widely-separated parts of the country, and it was important that data did not show significant inter-laboratory differences. A Canadian Laboratory accreditation project was organized by Drs. Gledhill and Quinney (Quinney et al., 1986), and the accuracy of values obtained on a panel of subjects was reviewed before each participating laboratory was certified as an *Accredited Fitness Appraisal Centre.* Likewise, in preparation for the *Ontario Multi-Centre Exercise-Heart Trial, a* team of investigators from McMaster University took a torque generator to participating laboratories to ensure an accurate and agreed calibration of the cycle ergometers that were used in that study (Jones and Kane, 1979). A detailed laboratory test manual developed by Dr. Gledhill for the undergraduate programme at York University formed the basis for the protocol currently outlined in the *Canadian Physical Activity, Fitness & Lifestyle Approach (CPAFLA)* (Gledhill and Jamnik, 2003).

I was summoned to Geneva to serve as the *Rapporteur* of a *WHO Committee on the Fundamentals of Fitness Testing* (Andersen et al., 1971). Two years later, Dr. Joseph S. Weiner, the South African-born Physical Anthropologist and Director of the *Human Adaptability Project* of the *International Biological Programme* invited the Toronto Fitness Research Unit to coordinate that part of the IBP Human Adaptability Project that was dealing with world-wide comparisons of human physiological work capacity (Shephard, 1978).

Population Fitness Surveys. There was early pressure from the Canadian government to check on the physical condition of Canadians; the hope seemed to be that the newly created *Fitness Research Units* might somehow disprove the strictures of the Duke Of Edinburgh concerning the poor fitness levels of Canadians. I spent a fair part of 1966 making many measurements of maximal oxygen intake on the general population at such places as the *Canadian National Exhibition*, and I compared this data with published reports from around the world (Shephard, 1966). The values reported by the Åstrands for residents of Stockholm far exceeded those for people from other countries. Close examination of their publication suggested that the high Swedish figures were due at least in part to a selective sampling of the Stockholm population. However, in 1971 a crown corporation *(ParticipACTION)* had been established under Russ Kisby to act as a sophisticated marketing agency, "selling" the benefits of physical recreation to the Canadian public. Soon, *ParticipACTION* was airing TV cartoons showing a 60-year old Swede walking past a 20-year-old

Canadian jogger, a haunting image that has long challenged Canadian egos.

The scientific community had a strong interest in obtaining reliable and representative information on fitness trends within the Canadian population. This required a shift from earlier performance measures to more precise, laboratory-type tests that could be carried into the homes of the general public, and the establishment of an agency charged with monitoring the nation's fitness.

Critique of field testing. Until the mid 1960s, large-scale fitness surveys in Canada and the U.S, had relied upon the use of field performance tests. Some assessments, such as the *Kraus-Weber Test* (Kraus and Hirschland, 1954) and the *Canada Fitness Awards* (below), were criterion based; such instruments had a marked negative impact upon children who "failed" one or more items in the test battery. In response to this criticism, the *CAHPER* performance test (Canadian Association for Physical Education and Recreation, 1966) moved to the classification of an individual's scores in terms of age and sex-specific percentiles.

But during the late 1960s, it was demonstrated that even if the results of performance tests were reported as percentiles, the achievements on many measures still depended more upon an individual's body size than upon his or her physical fitness (Cumming and Keynes, 1967; Drake et al., 1968).

Screening prior to mass testing. Before mass exercise testing could be carried out on older people in the home environment, there was a need for some procedure to screen out high-risk individuals who required their exercise tests to be conducted under immediate medical supervision. Potential screening procedures were evaluated on a large sample of the Saskatoon population during the summer of 1974 (Bailey et al., 1976). Participants responded to a short list of questions about their health prior to undergoing a step test, and this approach seemed to provide a simple and relatively effective approach to exercise clearance.

This simple instrument was checked further relative to physician-based screening at the Pacific National Exhibition (Chisholm et al., 1975), and the *PAR-Q test* was born from this research. Over almost four decades of widespread use around the world, the *PAR-Q* has proven a very safe and effective screening procedure. The one drawback has been the referral of a rather high proportion of potential exercisers to their physician for final clearance. Minor rewordings of the questionnaire failed to correct this problem (Thomas et al., 1992), and Darren Warburton and his colleagues have now developed a new Physical Activity Readiness Questionnaire for Everyone (PAR-Q+) and an appropriately-branched electronic form of the questionnaire to introduce supplementary "probing" questions when the safety of testing is still unclear (Warburton et al., 2011b).

Home fitness testing. In 1967, *CAHPER* conducted a Nation-wide cluster survey of the fitness of Canadian children, taking cycle ergometers into selected schools (Howell and MacNab, 1968). However, it did not seem feasible to carry cycle ergometers to thousands of homes scattered widely across the country for a Nation-wide survey of fitness in adults. Thus, a simple step test was chosen as a

field measure of the individual's aerobic fitness.

The concept of estimating maximal oxygen intake from an individual's performance on a progressive, sub-maximal double nine-inch step test originated with the *Toronto International Working Party* on aerobic fitness measurement (Shephard, 1968b). When using this type of step-test in Igloolik, Nunavut, our attempts to explain the stepping procedure in a halting form of *Inuktituk* had limited success. However, I found that the Inuit quickly learned to climb and descend the steps at the correct cadence if I sang the rhythm to them on a rising followed by a descending scale, using the IUnuit words for 1, 2, 3.... I discussed this finding with *ParticipACTION* and *Fitness Canada*, and we decided to base a *Home Fitness Test Kit* around an LP recording of music that set stepping rhythms appropriate to a person's age and sex. The idea was generally well received, although a Winnipeg cardiologist (Gordon Cumming; Cumming and Glenn, 1977) questioned the ability of either health professionals or the general population to palpate heart rates with sufficient accuracy. He further commented that at least on his record player the speed of the music slowed as the centre of the LP disc was approached (this problem has since been overcome by the use of tapes and CDs to provide a standard musical cadence for the test).

Population testing. With appropriate screening and test procedures in place, in 1980 the Canadian Federal government created the *Canadian Fitness and Lifestyle Research Institute (CFLRI)*, under Cora Craig. In 1982, she directed a *National Fitness Survey*. To this point, most investigators had paid little attention to the issue of subject selection, but with the help of *Statistics Canada*, the *CFLRI* tested a large and representative sample of Canadians aged 7 to 65 years (Canada Fitness Survey., 1983; Shephard, 1986).

The first Canada Fitness Survey was completed in 1982 (Canada Fitness Survey, 1983; Shephard, 1986). The costs of sending health professionals to make on-site measurements of height, body mass, skin folds, grip strength, maximal oxygen intake, and back flexibility were high. Several subsequent CFLRI surveys such as the 1988 Campbell Survey on Well-Being in Canada thus used physical activity questionnaires rather than direct physiological measurements. However, all questionnaire estimates of physical activity are liable to large systematic errors, and in part for this reason pedometer estimates of habitual physical activity were included in the 2007-2009 *Canadian Health Measures Survey*, sponsored by *Statistics Canada* and the *Public Health Agency of Canada* (Colley et al., 2011; Prince et al., 2008).

Canada Fitness Awards. *Fitness and Amateur Sport* launched the *Canada Fitness Award Programme* in 1970. Participants were required to perform six tests: a 2400 m endurance run, a shuttle run (4 trips back and forth, picking up and dropping objects), push ups, curl-ups (the number performed in one minute), a standing long jump and a 50 m run. In order to win the highest award (*Excellence*), the criterion level of *excellent* had to be achieved in all six events.

By 1986, more than 16 million Canadian children had participated in the *Canada Fitness Awards* programme, and over 12 million Awards had been distributed. However, the programme

was discontinued in 1992. Critics argued that it discouraged those who failed to achieve even the minimum grade, yet these were the individuals who most needed encouragement to become more active.

The U.S. adopted a percentile-based award system in 1991. A *Presidential Award* was given to students scoring at or above the 85th percentile on all of five activities. A *National Physical Fitness Award* was presented to students scoring above the 50th percentile on all activities, and students who participated in all activities, but fell below the 50th percentile on one or more tests received a *Participant Physical Fitness Award*.

In 1997, the U.S. added a *Presidential Active Lifestyle Award*. For adults, the requirements were to undertake physical activity for 30 minutes a day, at least 5 days a week, during 6 out of 8 weeks, or to reach a pedometer count > 8,500 steps/day, as well as attaining a healthy eating goal. For children and adolescents (8-17 years of age) the requirements were somewhat more rigorous: to take 60 minutes of physical activity a day, for at least 5 days a week, during 6 out of 8 weeks, or to maintain a pedometer count of > 12,000 steps/day, plus attaining healthy eating goals.

ParticipACTION. Many countries have engaged in short-term local campaigns intended to boost the physical activity of the population, but *ParticipACTION* is unique in undertaking a long-term Nation-wide motivational programme. We will look briefly at the origins of ParticpACTION, some its major initiatives, its demise and its rebirth.

Origins. *Sport ParticipACTION Canada* was formed as a not-for-profit company in 1971, with Lester B. Pearson as its Chairman, and Philippe de Gaspé Beaubien, the Chair of the *Canadian Council for Physical Fitness & Amateur Sport,* as its President. The organization was later rechristened with the bilingual name of *ParticipACTION* (Lagarde, 2004). The new title was intended to avoid the connotations of hard work and inconvenience that some people found in the words "*exercise*" and "*fitness*," the notions of high performance that were evoked by the term "*sport*," and the distrust of government invoked by the word "*Canada*."

In discussion with the Prime Minister of the day (Pierre Trudeau), Beaubien pointed out that it would cost at least $5 M to launch a new design of automobile, and that a publicity campaign to increase physical activity could hardly be expected to cost any less. Trudeau thought this estimate was rather high, but nevertheless he agreed to contribute $2.5 M, provided that Beaubien could raise the remaining $2.5 M from the private sector. Thus, *ParticipACTION* was born (Beaubien, 2004).

In 1972, Russ Kisby (1940- 2007 CE), a Saskatoon native then working for the Canadian national YMCA was hired as its first Director-General. The job advertisement, as posted by marketing consultant Keith McKerracher, read as follows (Edwards, 2004):

"Wanted: A Chief Executive Officer to whip Canada into shape. Reward- a generous salary and the thanks of future generations."

Kisby remained as President of the organization from 1978 until his retirement in 2001. In 2000, he received the *World Sport for All Award* in Vienna,

Austria, for his "*international contribution to population health, quality of life through physical activity and sport*."

The discipline of Health Communication did not exist when plans for *ParticipACTION* were being developed. Health Education was certainly a recognized skill, but it was a "one-way street;" information was presented to the general public without anticipation of any active response (Edwards, 2004). This issue underlines the conflicting demands of Social Marketing and Health Communication that have dogged *ParticipACTION* over much of its history (Bauman et al., 2004).

Major initiatives. The nature of *ParticipACTION* and its commercial partnerships can be judged from a brief sketch of some its very diverse initiatives. During 1972, the first television and radio advertisements were launched, and through the local connections of Russ Kisby, a pilot fitness project was launched in the city of Saskatoon. This effort had modest success in mobilizing the local community and augmenting physical activity through the efforts of a board that included local decision makers such as a newspaper publisher, a prominent physician and a University President (Jackson, 1975). A similar campaign was focussed on the city of Peterborough, ON in 1974.

ParticipACTION's controversial "*60-year-old Swede*" advertisement appeared in 1973, accompanied by other memorable publicity slogans such as "*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*," The following year *ParticipACTION* launched its own newspaper. In 1976, the *Sun Life Assurance Company* and the *Kinsman Clubs of Canada* were persuaded to build activity trails (*Participarks*) in 100 Canadian communities. In 1979, a partnership with the *Canadian Association for Health, Physical Education, Recreation and Dance* produced the booklet "*What's the Matter with Kids*?" This highlighted the growing problems of lack of fitness and obesity among Canadian children. In 1980-81 an employee fitness campaign with the title "*Fitness: The facts*" was directed to 100,000 workers and their families, and media support for *ParticipACTION* was valued at $8M.

In 1982, *PartcipACTION* Saskatoon challenged 100 towns across Canada to show a greater level of physical activity than the citizens of their community. In 1984, cooperation with *Fitness Ontario* and the *Milk Marketing Board* launched "*APEX*," an action programme focussed upon eating and exercise for elementary schools. The following year, *PartcipACTION* was collaborating with the *Department of National Defence* to develop training programmes, exercise prescription and promotional materials for the Military, and "*Health Saver*" pamphlets were being distributed to family physicians with the support of the *H.J. Heinz Company*. In 1988, *ParticipACTION* and *Petro-Canada* became involved in the *Olympic Torch Relay* across 1730 Canadian communities, and *Expres* (the training plan that *PartcipACTION* had developed for the Canadian Forces) was sold to the general public. In 1989, a partnership with *Health Canada* resulted in a healthy weight initiative, and *ParticipACTION* hosted the *TRIM* and *Fitness International Sport for All Conference* that brought together

similar organizations from 48 other countries around the globe.

Demise. Decreasing budgets caused *ParticipACTION* to switch to survival mode during the 1990s. Nevertheless, a series of computer-based interactions *InformACTION)* was launched in collaboration with *Fitness Ontario* as a health resource for the workplace. In 1992, the emphasis shifted to encouraging active living in the community; 50 community animation specialists encouraged up to a million volunteers in 20,000 community initiatives, with a strong emphasis upon the involvement of older adults. An ambitious bilingual interactive web-site was launched in 1998, and in that year *ParticipACTION* cooperated with *Health Canada* in launching *Canada's Physical Activity Guide to Healthy Living.*

Despite the long-term nature and the wide variety of these initiatives, the Board of *ParticipACTION* recognized that by the turn of the 21st century, funding had shrunk to a level where they lacked the resources to mount a National publicity campaign. The media environment was becoming ever more competitive. and the initial mainstay of free "*public service announcements"* had become a rarity. Moreover, two of the organization's strongest supporters had died, and many people were beginning to question the effectiveness of *ParticipACTION* in terms of its ability to alter human behaviour (Marcus et al., 1998). Although a high proportion of the Canadian population were aware of the existence of *ParticipACTION*, the number of Canadians who were themselves regular exercisers seemed to be diminishing rather than increasing. Thus, with the retirement of Russ Kisby, *ParticipACTION* officially ceased its operations in December of 2000.

Rebirth. The hiatus created by the demise of *ParticipACTION* was quickly perceived by those who were concerned with Health Promotion, and the organization was revived in 2007, under the direction of Kelly Murumets. She is placing increased emphasis upon social media as a means of raising the public's awareness of the need for physical activity, and she is now active in connecting funding partners with grassroots organizations that can spread the message of the need for greater exercise and implement community programming. However, the challenge remains to document the extent to which health behaviour can be changed by a given fiscal investment. Those intimately involved in the process insist that greater physical activity is a long-term goal, and that the immediate benefit must be assessed in terms of such intermediate measures as awareness and state of change (Bauman, 2000), but their critics remain skeptical of such evidence.

Habitual Physical Activity. In recent years, contentious issues concerning habitual activity have included methods of assessing large populations, current trends in population behaviour and the extent of physical demands imposed by a traditional hunter-gatherer lifestyle.

Measurement of physical activity. When assessing physical activity, one critical issue is the number of days of observation that are needed to provide a representative measure of a person's habitual behaviour. In the early 1960s, the *International Biological Programme* had recommended recording physical activity patterns on two weekdays and

two week-end days (Weiner and Lourie, 1969). However, recent studies that have extended over an entire year have demonstrated that substantially longer periods of observation are necessary to obtain reliable information, particularly on the behaviour of single individuals. Not only is there a strong likelihood that the wearing of a physical activity monitor may have an immediate reactive effect, encouraging an abnormally high level of exercise for a week or more, but there are also substantial variations in activity patterns attributable to seasonal changes in temperature, periods of adverse weather and other variables (Shephard and Aoyagi, 2010).

Pedometer/accelerometers now allow the collection of information about the physical activity patterns of quite large populations, and the findings have greater reliability and validity than questionnaire data, but most pedometer/ accelerometers still under-estimate some types of energy expenditure such as cycling and walking uphill. New methods of personal monitoring that combine information from heart rates, respiration rates and sweat rates are currently being explored, although to date they do not seem to provide more accurate estimates of daily physical activity than the current generation of pedometer/accelerometers (Shephard and Aoyagi, 2012). In the future, global positioning systems (GPS) may help investigators to draw the important distinction between counts arising from active locomotion and those due to incidental, random movements or artifacts arising from travel in a vehicle over rough terrain.

Current levels of physical activity in the general population. Most indicators currently point to a widespread prevalence of low levels of physical activity in all age groups, at least in developed societies. The daily duration of housework has greatly decreased for most women (although there has been a small increase in the time that men allocate to household tasks) (Brownson et al., 2005). Likewise, *Canada's Physical Activity Guides for Children and Youth* reported that over half of Canadian children and youth aged five to seventeen were not active enough for optimal growth and development (Statistics Canada, 2007-2009) and that the vast majority of the children and youth surveyed did not accumulate a sufficient number of steps per day to meet the minimum criterion associated with maintenance of a healthy body mass index.

The *U.S. Bureau of Labor Statistics* has commented upon the decreasing physical demands imposed upon adults by private industry (which accounts for about a half of the total labour force in the U.S.). Their analysis is based upon the changing distribution of employment in the U.S., but does not take account of a second important factor: the progressive decrease of energy expenditure within a given category of employment. In the early 1970s, almost a half of the jobs that were reported to the Bureau required at least a moderate intensity of physical activity, but now this is true for less than 20% of private-sector workers (Church et al., 2011). Based on such calculations, the average energy expenditure of a U.S. worker has decreased by at least 400 kJ/day over the past 40 years, with a roughly commensurate increase in body mass.

A similar analysis by (Brownson et al., 2005) noted that agricultural employment in the U.S. (typically a high

energy cost activity) accounted for 12.2% of the labour force in 1950, but less than 2% in 2000 (migrant workers being excluded from this comparison). In all, the proportion of high energy cost jobs decreased from 30% to less than 20% of the U.S. labour force during the period that they examined.

Those responsible for the promotion of physical activity, such as *ParticipACTION*, have claimed to detect some increase of leisure activity during the period of their advocacy. A comparison of 6 Canadian surveys from 1981 to 2000 (Craig et al., 2004) suggested that adults were 1.6 times as likely to develop sufficient leisure activity in 1988 as in 1981, and 1.2 times as likely to be sufficiently active in 2000 as in 1995. However, a critical examination of these claims shows that they are based upon questionnaire self-reports, which are unreliable at the best of times, and are liable to distortion of responses as expectations change. Moreover, interpretation of secular trends in the Canadian data is complicated by changes in methodology and questionnaire wording.

Information on physical activity patterns in the United States has been obtained repeatedly by the *Behavioral Risk-Factor Surveillance System*. This organization has applied a standard and consistent telephone interview format to make repeated examinations of the leisure-time activities of very large population samples, beginning in 1986. Such data do indeed show small improvements in the percentages of men and women claiming to meet the recommended minimum levels of weekly *leisure* activity (gains of 2.4% in men and 1.4% in women) between 1990 and 2000 (Brownson et al., 2005). Unfortunately, this promising trend is more than negated by adverse changes in other components of the total daily energy expenditure. Over the period from 1950 to 2000, employment demanding a high level of physical activity decreased from 30% to 22.6% of the U.S. labour force, while low activity jobs grew from 23.3% to 41.0%. There was also an increase in the proportion of the population living in outlying suburbs, particularly between 1950 and 1980, leading to a 7.4% decrease in active commuting, and daily television viewing increased steadily by 36 minutes per decade between.1950 and 2000.

Most developed nations have experienced similar adverse trends. Thus, in Finland, a study of 59,028 men and women showed that between 1972 and 2002, there was some increase in the prevalence of those reporting leisure activity (from 66 to 77% in men, and from 49% to 78% in women), but active employment declined from 60% to 38% in men and from 47% to 25% in women, and reports of active commuting dropped from 30% jn 10% in men, and from 34% to 22% in women (Borodulin et al., 2007). Likewise, a cross-sectional retrospective Swedish survey suggested a decrease in the total physical activity of men in all age groups between 1970 and 2000 (Norman et al., 2003). The proportion of men in England and Wales who were active for at least 30 minutes per week declined from 1994 to 1998 (Prior, 1999). In Catalonia (Southern Spain), residents showed decreases in both active employment and active commuting from 1992 to 2002, although they also reported a small increase in leisure activity (Román-Viñas et al., 2007). Even in China, the proportion of people with heavy jobs decreased from 64.6% in 1989 to 50.7% in the year 2000 (Food and Agriculture

Organisation, 2009), and urbanization reduced the average total energy expenditure by 1.2-1.6 MJ/day (James, 2008).

Physical demands of a hunter-gatherer lifestyle. A number of Exercise Scientists have long argued that the health problems of modern society have arisen because humans have abandoned the lifestyle to which they are genetically adapted, that of a hunter-gatherer society (Shephard, 2011). The *IBP Human Adaptability Programme* that was initiated in 1964-1965 (Weiner, 1964), provided an opportunity to examine both fitness levels and habitual physical activity in a number of isolated communities where the hunter-gatherer lifestyle persisted.

A North American and Scandinavian contribution to the IBP project was a study of energy expenditures, health and fitness in the indigenous populations of 3 Arctic communities with differing degrees of adaptation to a "modern" lifestyle. The U.S. were assigned responsibility for the village of Wainwright, Alaska, the Scandinavians investigated some small coastal settlements in Greenland, and our Toronto laboratory evaluated the Inuit community of Igloolik, near the tip of the Melville Peninsula. For various reasons, the American and Scandinavian investigators obtained rather limited data sets. However, we were able to establish and operate a field station in the village of Igloolik for some 20 years (1970-1990), repeatedly collecting extensive data on all willing villagers from primary school to old age. When our observations began, in 1969/70, the fitness levels of the Inuit population were high. Data collected during summer and winter hunting expeditions also documented the very high energy expenditures that were required when undertaking many of the community's traditional activities.

However, over the ensuing 20 years, we saw a progressive deterioration of fitness in the Igloolik community, as most of the local population made a transition from their traditional hunter-gatherer lifestyle to the sedentary habits of Southern Canada (Shephard and Rode, 1996). By 1989/90, the fitness of most of the Inuit villagers had dropped to levels that would be anticipated in Toronto, with a parallel increase in subcutaneous fat thicknesses. Nevertheless, a small group of adults who had replaced their lost hunting activity by regular visits to the local school gymnasium were able to conserve the levels of fitness that we had seen in 1969/70 (Rode and Shephard, 1993). This longitudinal study thus provided an important practical demonstration of both the health value of the traditional Neolithic lifestyle and the adverse consequences of shifting to a "modern" sedentary pattern of living.

University programmes. Beginning with some of Canada's newer Universities, such as Simon Fraser and the University of Waterloo, many Canadian Schools of Physical Education underwent a name change during the 1960s and 1970s. Commonly, they became known as Faculties of Kinesiology or Kinanthropology. This reflected a shift in the underlying curricular philosophy. Course-content shifted from material that was directed to the practical preparation of coaches, trainers and physical education teachers to a much broader curriculum that explored the multi-faceted sciences of health, fitness and human performance. The new philosophy and nomenclature encouraged the

recognition of Kinesiology as an academic discipline, worthy of Doctoral study within the university setting.

Early Canadian leaders in the Physical Activity Sciences, such as Bill Orban, had found it necessary to travel to the United States (frequently to the laboratory of Tom Cureton, at the University of Champaign-Urbana, Illinois, and more recently to the programme of a Canadian ex-patriate, Dr. Jerry Dempsey, at the University of Wisconsin in Madison) in order to obtain their doctoral training. However, with establishment of the *Fitness Research Units*, Canada began to develop its own Ph.D. programmes in the Exercise Sciences during the 1960s. The emphasis of these new programmes was rigorously physiological, with laboratory facilities and curriculae that were sometimes superior to what had previously been available through U.S. Physical Education-centred programmes.

Some Scandinavian countries had also developed good Doctoral programmes in Clinical Exercise Physiology by the 1960s, but in other European countries such as the United Kingdom, ventures into "Applied Science" were still held in low regard.

Many schools in the United States have changed their names and emphasis in recent years, although the transition from a performance-oriented to a biophysical emphasis has sometimes occurred less readily than in Canada, because of pressure from University Governors to maintain the excellence of sports teams and thus assure Alumnal support.

Professional Certification. Until recently, those operating fitness programmes lacked the professional regulation long required in Medicine, Nursing and Physiotherapy. The introduction of Professional Certification, both in Canada and in the U.S., has had twin objectives: the setting of appropriate minimum standards of education and experience for fitness professionals, and the provision of appropriate recognition to those who have acquired appropriate advanced qualifications.

The *ACSM Certification Programme* began in 1975. It now offers three levels of certification [the *Certified Personal Trainer*® (CPT), the *Certified Health Fitness SpecialistSM* (HFS) who works with those affected by medically controlled diseases, and the *Certified Group Exercise InstructorSM* (GEI)]. ACSM also offers two forms of Clinical Certification [the *ACSM Certified Clinical Exercise SpecialistSM* (CES) who works with clients having or at risk of developing, cardiovascular, pulmonary or metabolic disease, and the *Registered Clinical Exercise Physiologist*® (RCEP) who assists clients who are being treated by a physician for cardiovascular, pulmonary, metabolic, orthopedic, neuromuscular or immunological disease. Finally, *ACSM* has introduced three Specialty Certifications: the *ACSM/ACS Certified Cancer Exercise Trainer (CET),* the *ACSM/NCPAD Certified Inclusive Fitness Trainer (CIFT)* who leads individuals with physical, sensory or cognitive disabilities, and the *ACSM/NSPAPPH Physical Activity in Public Health Specialist (PAPHS)* who promotes physical activity in public health agencies at the national, state or local level.

One legislative initiative in Ontario was the establishment in 2007 of the College of Kinesiologists, designed to regulate the profession of Kinesiology in accordance with the Regulated Health Professions Act of 1991 and the Kinesiology Act, of 2007. *CSEP* had initiated Professional

Certification through its *Health and Fitness Programme* in 1981. This programme was created and led by Dr. Norman Gledhill based on his curricula and resources (e.g., the CPAFLA) developed at York University. It currently recognizes two levels of certification: the *CSEP Certified Exercise Physiologist®* (*CSEP-CEP)* and the *CSEP-Certified Personal Trainer*.

The *British Association of Sport and Exercise Science* has also introduced a form of Accreditation; they recognize *Certified Exercise Practitioners* and *High Performance Accreditation*.

Physical Education Programmes. In Canada, physical education instructors have replaced the rote gymnastics of an earlier era by classes that include information about health and nutrition. There has also been a growing emphasis upon the teaching of activities that are likely to create long-lasting and positive attitudes towards physical activity, with the learning of recreational skills that can be carried forward into adult life. Sophisticated path analyses have examined the main psycho-social factors contributing to a child's interest in physical activity, in order to focus promotional efforts upon the primary motivators (Godin and Shephard, 1990).

One major area of continuing discussion in Canada, as in other countries, has been the impact of required physical education upon a child's academic attainment. Physical Education teachers frequently argue that the usual time allocated for their classes is insufficient to bring sedentary pupils to an adequate level of health and fitness. They have thus demanded the inclusion an hour per day of quality physical education into the normal school curriculum. However, those teaching in other disciplines counter that devoting more time to physical education will inevitably have a negative impact on a child's academic grades.

The initial phase of the Trois Rivières regional study, led by Dr. Hugues Lavallée over the period 1969-1977, made a unique scientific evaluation of the effects upon both health and academic attainment of incorporating five hours per week of professionally taught physical education into the primary school curriculum. Similar experiments in the United States lasted for only one or two years, but the Trois Rivières intervention continued throughout the child's six years of enrolment in primary school. Unlike most other studies, a quasi-experimental design was also adopted, with students in preceding and succeeding classes at the same schools serving as control subjects. Telemetric monitoring of the intervention further ensured that the 5 hours of weekly exercise were of an adequate intensity and duration to enhance health and fitness, and questionnaires checked that there had been no compensatory reductions in the leisure activity of participant children outside of school hours. The total sample of children was large (546 students), and all participants in both experimental and control groups attended the University laboratory annually for a sophisticated range of clinical and physiological tests. Not only was the fitness of the experimental students boosted relative to that of the controls, but their levels of academic attainment were at least as good as the control subjects, even though they spent 14 percent less time learning academic material. It remains to be determined whether physical education had a direct

positive effect upon the learning of academic material, whether it stimulated the production of neutrotrophins, or whether the observed benefits arose less directly (through such mechanisms as enhancement of a child's self-image, greater attention and better behaviour on the part of the active pupils, or a shortening of teaching time and thus less exhaustion of the academic teachers following introduction of the new programme).

Because population mobility is low in the Trois Rivières area, Dr. François Trudeau and his associates were able to collect important data on the long-term effects of physical education. Their follow-up observations continued on the same group of subjects until they reached the age of 40-45 years. Their data showed at least a modest persistence into adulthood of health benefits derived from the enhanced primary school physical education programme, including a greater continuing involvement in physical activity and avoidance of cigarette smoking as adults (Shephard and Trudeau, 2005).

Many secondary schools in the U.S. still maintain a strong emphasis upon elitist sport programmes. In England and Wales, the pattern of education in state schools underwent a dramatic change in 1965. The move to "*comprehensive*" schools greatly increased both athletic and academic opportunities for pupils who had previously attended poorly equipped "*secondary"* schools, although even today educationalists still vigorously debate the academic merits of the new system. Prior to 1965, pupils were divided between academic ("*Grammar School*") and trade ("*Secondary*") streams, based on a standardized test that was written at the age of 11 years. The Labour Government abolished this policy in 1965 (although *de facto* there is still some socio-economic selection of students within state schools, based on the high cost of housing in areas that surround the better-equipped schools). Since 1988, such social selection has been exacerbated, as parents have gained the right to send their children to a school other than the one nearest to their home.

Economics and Health Benefits of Industrial Fitness Programmes. Both the United States and Canada introduced work-site fitness programmes during the 1970s. We will examine motivations in the U.S. and Canada, problems of assessment, a quasi-experimental evaluation of a large work-site programme, and a shift of orientation from fitness to broadly-based health programming.

Motivations. In the U.S., many employers saw industrial fitness programmes as a response to the first oil crisis (1973-74), which had brought a sudden halt to two decades of rapidly expanding production. Russian reports had suggested that "worker-athletes" enrolled in the *GTO Organization* (Shephard, 2013c) had a high level of productivity relative to their sedentary peers (Pravosudov, 1978). Likewise, during the 1970s the economic challenge posed to North America by the greater productivity of Japanese industry was thought to result in part from massed work-site exercise programmes that many Japanese employers were offering to their staff (Okada and Iseki, 1990).

One expression of the new interest in employee fitness was formation of the *American Association of Fitness Directors in Business and Industry*. This organization was subsequently renamed

the *Association for Worksite Health Promotion*, reflecting a shift of objectives from simple fitness programming to more broadly-based worker wellness initiatives. By the early 1990s, the U.S. group boasted a membership of some 2500, but then a critical corporate reappraisal of the loudly touted fiscal benefits of worksite wellness led to its rapid demise. A worksite health promotion "interest group" continued at the *American College of Sports Medicine,* and in 2009 an *International Association for Worksite Health Promotion* made its début. The *U.S. Centers for Disease Control* (Centers for Disease Control and Prevention, 2009) and the *National Institute for Occupational Safety and Health* (National Institute for Occupational Safety and Health., 2012) have also continued to promote worksite health promotion.

The 1972 *ParticipACTION* trial in Saskatoon (Jackson, 1975) demonstrated that community-wide programmes were both expensive and relatively ineffective in augmenting the physical activity of the population. The Canadian government of the 1970s thus welcomed work-site fitness initiatives as a low-cost and focussed alternative that could address the fitness needs of the working population. A conference on *Employee Fitness* was convened in Ottawa in 1974 (Collis, 1976). It seemed likely that the costs of such work-site programmes would usually be borne by the employer and/or the worker rather than the government, but, it was suggested that sponsoring companies might reap such dividends as an enhanced corporate image, the recruitment of premium employees, greater productivity, a lesser absenteeism, and reduced health insurance costs.

Problems of programme assessment. It proved difficult to provide convincing evidence of the postulated economic benefits, in part because of problems in organizing appropriate control groups in an industrial setting, and in part because the person charged with collecting subjective data was usually the individual the company had hired to run its fitness programme. Most "investigations" were simple "before and after" comparisons, devoid of any control groups. Even if the reporting of findings was dispassionate, responses were thus vulnerable to fallacious "Hawthorne" effects. But often the observers, anxious to keep their own jobs, made over-optimistic reports of programme success. I recall visiting one factory in Holland with supposedly the best work-site fitness programme in that country. I was shown a beautiful gymnasium, but at what I supposed was the peak hour for exercise (around 12 noon), there were just two exercisers in the facility!

A quasi-experimental evaluation of a work-site initiative. In 1977-78, the University of Toronto initiated a controlled, quasi-experimental study of work-site fitness programming at the *Canada Life Assurance Company*, with the enthusiastic support of Art Salmon and his colleagues at *Fitness Ontario*. Findings at the experimental site (the head office of the *Canada Life Company*) before and after initiation of the work-site fitness programme were compared with those at a well-matched control site (the nearby *North American Life Assurance Company*). Minor economic benefits were documented at the experimental site: increased productivity, reduced absenteeism, and reduced employee turnover. One particularly unique feature of the *Canada Life Study* was a direct

comparison of *Ontario Health Insurance Plan (OHIP)* Medicare billings (both the nature of diagnoses and the dollar payments disbursed to hospitals and physicians) for employees of experimental and control companies before and after institution of the programme (Shephard, 1986a). Some skeptics had argued that a fitness programme would have the effect of increasing immediate medical costs, particularly for the treatment of musculo-skeletal injuries and for cardiac problems. However, the OHIP data demonstrated that far from increasing demands for medical services, employees at the experimental work-site showed small decreases in doctor and hospital visits once the programme was in operation. Not only were overall medical consultations reduced, but there were also fewer claims for such specific diagnoses as musculo-skeletal injuries and cardiac problems.

The *Canada Life* head office payroll was sufficiently large to assess the overall success of a work-site fitness programme, at least in a white/pink collar employment. Despite the vigorous publicity that one would anticipate with an experimental study, only about a third of employees were initially recruited to the programme, and the participation of many of these individuals flagged over the year of observation. One major problem, probably generic to large cities, was that long commuting distances limited the involvement of many employees in exercise programmes that were arranged before or after work. From the viewpoint of population health, the work-site also could not cater either to the families of employees or to the growing number of people who work at home.

In the U.S. it became evident that sometimes work-site fitness facilities were only open to upper echelon employees. Even if admission was technically open to all classes of worker, programmes usually failed to attract the blue-collar segment of the labour force. The *Canadian Public Health Association* thus initiated a project with a specific focus on the blue collar employee (Canadian Public Health Association., 1979), and in the U.S. the *American Heart Association* convened a meeting to examine the needs of hourly workers (Meyers, 1987). One suggestion emerging from the latter conference was that the blue-collar group might be attracted more by team sports than by light aerobic-type gymnastics. In terms of enhancing National fitness, a further limitation of work-site initiatives is that for logistic reasons, programmes tend to be restricted to companies with more than 100 employees (Linnan et al., 2008), and such companies are in the minority, particularly in Canada.

Changing orientation of work-site programmes. During the 1980s, careful economic analyses suggested that many of the supposed gains from work-site programmes were at best marginal (Goetzel and Ozminkowski, 2008; Shephard, 1986a). In many operations, productivity had become a function of advanced technology rather than a reflection of human physical input. Partly for this reason, the emphasis of many work-site programmes shifted from the development of physical fitness to the enhancement of overall employee health. Some altruistic companies have seen the provision of a broadly-based health service as a worthy goal in its own right, and others in the U.S. have hoped that

such an emphasis might counter the ever-rising costs of medical insurance premiums that are still included in many union contracts.

Occupational fitness. Many professions, particularly those concerned with public safety, have historically demanded certain minimum standards of physical fitness from their employees. In 1893, a recruiting poster for the *North-West Mounted Police* specified the need for (Bonneau, 2001):

"applicants between the ages of 22-40, active, able-bodied men of thoroughly sound constitution."

And in a less formal sense, the hiring of a day worker outside the dock-gates or at the local labour exchange during the 1930s was often determined by the candidate's physical appearance of strength and stamina. However, in recent years, the issue of denying employment on the basis of inadequate physical fitness has become a human rights concern.

The *Canadian Human Rights Commission* was established in 1977, and in 1982, two Etobicoke, ON, firefighters fought their then mandatory retirement age of 60 years. They argued that Section 4(1) of the *Ontario Human Rights Code* prohibited their employer from discriminating in the hiring or firing of workers, based on their race, creed, colour, age, sex, marital status, nationality, ancestry or place of origin. However, the Borough of Etobicoke pointed out that Section 4(1) does not apply where age is a *bona fide* occupational requirement (BFOR). In other words, if age affects your ability to be a good firefighter, then you can indeed lose your job because of your age. The issue was appealed to the Canadian Supreme Court. In 1999, the ruling was made that a BFOR must be "*objectively reasonable*," and the Supreme Court set specific guidelines to evaluate BFOR tests and standards.

This legal ruling prompted extensive research by Occupational Physiologists, particularly the group at York University led by Dr. Norm. Gledhill. Their mission was to determine the physical demands of various occupations where public safety was at stake, and to design appropriate, job-related tests of physical fitness for employees who wished to continue working beyond the normal retirement age (Gledhill et al., 2001). The legislation still only regulates employment for those between the ages of 18 and 65 years. The *Equity in Employment Act* also became law in 1986; it forced an equally careful consideration of the fitness capabilities of female employees.

Other countries have enacted very similar laws. In the United States, the *Equal Employment Opportunity Commission* was established in 1965. It ensures that neither age nor sex is considered when determining a person's suitability for employment. Occupations that have been the subject of detailed physiological scrutiny include not only the military, the police, and jail workers (Shephard, 1990; 1991a), but also postal carriers (Shephard, 1982), bus drivers (Shephard et al., 1988a), and marine surveyors (Shephard, 1983).

Much of the discussion of methodology in occupational fitness testing has centred around the use of criterion-based testing, which has sometimes had the effect of selectively excluding women and minority populations with a short stature. In a 1999 decision (Meiorin), the Canadian Supreme Court called upon

employers to ensure that any fitness standards that were applied accommodated individual and group differences to the extent that was reasonably possible (Eid, 2001). Another hotly debated issue has been the relative merits of task simulation vs. fitness-based testing (Bonneau, 2001). In the Canadian Armed Forces, there has been a frequent shift of criteria. Normative referencing prevailed during the 1960s, first with an emphasis upon performance on the 5BX and 10 BX tests (1960s and 1970s), then on achievements in the 1.5 mile (2.1 km) run (1972-1980), the BFOR (1978), and a fitness test battery (1984). An *Occupational Physical Selection Standard* was adopted from 1980 to1984, followed by the *Battle Efficiency Test* (1985), an indoor obstacle course (1986), the *Land Force Command Physical Fitness Standard* (1991) and the *Basic Military Qualification* (2002). Specific additional qualifications are now required for tasks such as parachuting or diving.

Fitness and aging. As the proportion of older citizens has increased in developed societies, there has been a growing interest in the design of fitness programmes adapted to the needs of the elderly, Such programmes prevent many of the chronic diseases where benefit has been observed in younger individuals, but for the elderly an enhanced quality of life and an extended period of independent living are more important objectives than simply preventing disease. A 20% increase in maximal oxygen intake or muscular strength in some instances can reduce a person's biological age by 10-20 years, with a corresponding delay in the age at institutionalization (Shephard, 1997). Indeed, many physically active individuals seem likely to die without the need for a long period of institutional care.

A further major concern of Geriatricians is the progressive mental deterioration that is typically associated with aging. In recent years, evidence has accumulated that regular physical activity can slow the aging of a person's mental faculties. It is not clear whether benefit arises simply from the greater range of social contacts and experiences enjoyed by an active older person, or whether physical activity has a direct effect in stimulating the production of neurotrophins and/or reducing the formation of Alzheimer plaques in the brain (Radak et al., 2010).

Interest of the Canadian government in fitness of the elderly was signalled by the hosting of a *National Conference on Fitness in the Third Age* at the Government Conference Centre in Ottawa in 1982 (Canadian Public Health Association., 1983). On the world stage, the *International Coalition for Aging and Physical Activity* now promotes the study of active aging; the enhanced delivery of services to older adults; and the collection, dissemination, and discussion of information on active aging. This coalition coordinates the *World Congresses on Physical Activity and Aging*, gatherings that were initiated by Raymond and Sarah Harris from the *Center for the Study of Aging* in Albany, NY during the early 1980s. Congresses are held approximately every 4 years, the most recent (8th) Conference being held in Glasgow (2012). The *Journal of Physical Activity & Aging,* now in its 22nd year, has become the official organ of this coalition.

Sport and Leisure.

Recent decades have seen an increasing involvement of many

governments in the support of both sports associations and individual athletes. There has also been a progressive multiplication of professional associations and forms of professional certification, and an ever-increasing range of professional journals. New sports have often brought danger to participants, and there has been dramatic changes in the nature of major international competitions such as the Olympic Games.

Governmental involvement. In Canada, involvement of the federal government in sport began during the 1960s, in part because of concern about low levels of fitness in the population (above), but also because of political embarrassment about the poor showing of Canadian competitors at international competitions. In 1969, a *Task Force on Sport for Canadians* made numerous recommendations to the Federal government. One important consequence was the establishment of a *National Centre for Sport and Recreation*, in 1974. All of Canada's sporting organizations were encouraged to establish their National offices in a single building in Gloucester, ON,, and in return they were offered financial support for technical, executive and programme staff, office expenses, secretarial help, and use of the centre's services at a low cost. This largesse was plainly going to cost the Canadian government a significant amount of money.

The *Olympic Trust of Canada* was formed in 1970, with the responsibility of raising funds to meet the objectives of the *Canadian Olympic Committee*. In 1973, *Loto Canada* was also established as a Crown Corporation; they reported to the Federal parliament through the *Minister of State for Fitness, and Amateur Sport*, and their revenues were applied to the funding of public events such as the 1978 Commonwealth Games, as well as specific projects in *Fitness & Amateur Sport*. The minting of Olympic coins and postage stamps carrying an Olympic surcharge were further sources of revenue authorized by the same legislation.

With the improved communication made possible via the internet, centralization of sports associations became less critical to the coordination of government efforts, and by the beginning of the 21st century, sport centres for both high performance athletes and those with disabilities had developed in Victoria, Vancouver, Calgary, Winnipeg, Toronto, Montréal and Halifax.

The Provincial and Territorial governments also became involved in sports development during the late 1960s, and in the 1970s Federal-Provincial partnerships led to programmes such as the *Canada Games* and the *National Coaching Certification Programme*. In 1987, a *National Recreation Statement* attributed primary responsibility for such activities to the Provinces and Territories, although it also noted that there was "*a clear and necessary role*" for the Federal government in the field of recreation (recreation here being defined to include sport).

A key concern in many regional and National consultations was evidence showing an insufficient participation of school students in physical education and sports programmes. A discussion paper entitled *"Towards a Canadian Sport Policy"* distributed at the *National Summit on Sport* in April 2001 stated:

"*There was consensus.... action must be taken to improve the state of school sport*

and physical education.... This is critically important since schools present one of the best opportunities for broad and barrier-free access to sport."

After a series of Federal-Provincial consultations, a *Canadian Sports Policy* emerged in 2002. The four goals of this policy were: enhanced participation, enhanced excellence, enhanced capacity and enhanced interaction between the two levels of government. The goal was set that by 2012, a significantly higher proportion of Canadians from all segments of society would be involved in all forms of quality sport activities at all levels.

In 2003, the Federal government enacted a new *Physical Activity and Sport Act*, to replace the legislation of 1961. The area of sport participation was passed from the *Minister of National Health and Welfare* to the *Minister of National Heritage*, with an assistant who was designated in a series of cabinet reshuffles as a *Minister of State for Sport, Minister for Sport or Minister for Amateur Sport*. Objectives that were set for the new agency were increased participation in sport, support for the pursuit of excellence and building capacity in the Canadian Sports system. The long time-course of athletic preparation was acknowledged, and there was acceptance of the notion that a well-rounded education should include the learning of a wide spectrum of physical skills by children and youth. This conclusion spurred the development of generic *Long-Term Athlete Development* (LTAD) models both for mainstream athletes and participants and for athletes and participants with a disability, as described respectively in *Canadian Sport for Life* and *No Accidental Champions.*

Broad benefits were anticipated from increased public involvement in sport. *A Canada Fit for Children* (2004), Canada's follow-up to the United Nations special session on children, states:

"*Physical activity, sports and recreation programs provide considerable physical benefits for children and can also serve as tools to teach important values and life skills, including self-confidence, teamwork, communication, inclusion, discipline, respect and fair-play.*"

The *2005 General Social Survey* estimated that 7.3 million Canadians 15 years of age and older were active participants in sport, and millions more were involved as volunteers and as spectators (Canada, 2005). Nevertheless, the last two decades have seen a drastic decline of sport participation among those >15 years of age, from 45.1% cent in 1992 to 34.2 % in 1998 and only 28% in 2005. Aging might explain some of the decreased participation by adults, but even in teenagers aged 15 to 18 years, the participation rate declined from 77% in 1992 to 59% in 2005.

As in many countries, certain segments of the Canadian population remain under-represented in sport: only 21% of participants are women, as compared to 36% of men. Only 9.4% of those >15 years of age are from households with incomes under $30,000, compared with 23.9% of those with incomes > $80,000, and only a small proportion of those with disabilities, aboriginals and people from visible minorities engage in sport.

Sport Canada is now working with the Provinces, Territories and various sport organizations to supplement National coaching, strengthening community sport leadership through initiatives aimed at

instructors, coaches, officials and grassroots volunteer leaders. It is also supporting efforts to promote the benefits of sport participation for all Canadians, in cooperation with other stakeholders. It claims commitment to supporting research and knowledge mobilization, data gathering, monitoring activities related to sport, information sharing through conferences, database support and the publication of surveys and other information.

Professional Associations. In many countries, professional associations associated with sport and exercise science had already been established during the Modern Era (Shephard, 2013c). However, in Britain a growing tension developed between Medically-qualified Sports Physicians and physiologically oriented Sports Scientists; this tension caused the *British Association of Sports Sciences* (BASS) to split from the *British Association for Sports Medicine (BASM)* in 1984. BASS became the *British Association of Sport and Exercise Sciences (BASES)* in 1993, and BASM followed suit by becoming the *British Association for Sport and Exercise Medicine (BASEM)*.

For a long time, the progress of professional associations in Canada was hampered by a small and widely scattered population. Until the mid-1960s, exchange of scientific ideas occurred largely through attendance at professional meetings in the United States. However, as Canadian universities grew in size and stature, a need was felt to develop specific Canadian organizations dedicated to the discussion of health and fitness. In 1963, the *Canadian Association for Health, Physical Education, and Recreation* (CAHPER) hosted its first fitness seminar in Saskatoon, and the *Canadian Athletic Therapists' Association* was founded in 1965. The *Canadian Association of Sport Sciences* (*CASS*) was inaugurated at a scientific meeting held in conjunction with the Winnipeg *Pan American Games* of 1967. Formation of *CASS* followed long discussions between the *Canadian Medical Association* and the *Canadian Association for Health, Physical Education and Recreation.*

Two of the first three Presidents of *CASS* were Sports Physicians (Sam Landa, and Max Avren), and early meetings of *CASS* had a strong medical emphasis. However, a stronger physiological orientation emerged when I became President (1970-1971) and I chaired the only joint meeting between *CASS* and the *American College of Sports Medicine*. Because of trans-continental travel costs, attendance at some early meetings of *CASS* was sparse, and the economics of its conferences was further compromised by simultaneous translation of most of sessions into French. The initial mandate of *CASS* had been to bridge the gap between Physical Educators and Physicians, but by 1969 the Physicians were busy organizing an independent *Canadian Academy of Sport Medicine* (*CASM*), now the *Canadian Academy of Sport and Exercise Medicine (CASEM).* This allowed achievement of what for them was a major goal, a Canadian Medical Association-recognized specialty certification in Sports Medicine. Those members of *CASS* with interests in biomechanics, sociology, psychology, and psychomotor learning also began to organize their own specialized conferences. The issue of "scientific separatism" was debated vigorously at several annual meetings of *CASS*, and some expressed the hope that *CASS* could still function as an umbrella organization

for the disparate factions. But reluctantly, it was eventually recognized that only the exercise physiologists were strongly committed to *CASS* and in 1993 the *Canadian Society for Exercise Physiology* was created. Currently, the annual meeting includes 2-3 days of scientific papers, and a final day with topics of interest to *Certified Exercise Professionals*. In 1978, the provision of medical and sports science support to Canadian athletic teams by the CASEM, the Athletic Therapists Association and the Sports Physiotherapy section of the Canadian Physiotherapy Association of Canada became organized and coordinated through foundation of the Sports Medicine Council of Canada.

Interest in the athletic performance of children stimulated formation of the *Pediatric Work Physiology Group.* This organization was founded in 1968, by Josef Rutenfranz, a Physiologist at the Max Planck Institute in Dortmund. The name of the group underlines an orientation towards the interests of European Clinical Physiologists. Meetings are held biennially, usually in Europe and at low cost locations such as monasteries, although Hugues Lavallée and I did persuade the group to convene its 1978 meeting in Trois Rivières, QC. Since 1985, the *North American Society for Pediatric Exercise Medicine (NASPEM*) has fulfilled a similar role in North America.

The appearance of specialist organizations interested in fitness and aging has been noted above. Another recently formed group is the *International Society of Exercise and Immunology,* It has held biennial international conferences, beginning in Paderborn, Germany, in 1993.

Journals. Journals in Sports Medicine and Exercise Science began to appear in many countries towards the end of the Modern Era, although the number and quality of such publications have expanded rapidly in the Post-Modern period, particularly since the advent of on-line publications. In addition to *Applied Physiology, Nutrition & Metabolism (below)*, we may note (with dates of first publication) such other journals with high citation indices as the *British Journal of Sports Medicine* (1964), the *Journal of Athletic Training* (1966), the *American Journal of Sports Medicine* (1972), the *International Journal of Sports Medicine* (1980), the *Journal of Sports Sciences* (1983), the *Clinical Journal of Sports Medicine* of CASM and the *Scandinavian Journal of Medicine & Science in Sports* (both 1991). On-line initiatives include the *International Journal of Behavioural Nutrition & Physical Activity* (1994), the Australian-based *Journal of Science & Medicine in Sport* (1998), and *PHEnex* (2009), launched by PHE Canada.

The increasing specialization of investigators in Kinesiology and Sports Medicine is high-lighted by the appearance of such journals as *Pediatric Exercise Science* (1989, the house journal of NASPEM), the *Journal of Physical Activity & Aging (1991), the Adapted Physical Activity Quarterly (1984,* the official journal of the *International Federation of Adapted Physical Activity),* and the *Exercise Immunology Review* (1995) published by the *International Society of Exercise and Immunology*.

There has also been a proliferation of journals focussing on relationships between health and fitness, such as *ACSM's Health & Fitness Journal* (1997) and the *Health & Fitness Journal of Canada*

(2008). *Exercise and Sports Science Reviews* began to offer in-depth reviews in 1973, and from 1979 to its final edition in 2013 the *Year Book of Sports Medicine* has offered critical commentary on some 250 of each year's top papers. *Sports Medicine* has also offered systematic reviews and meta-analyses since 1984.

Canadian sports scientists were for some time content with reading journals published in other countries, but in 1976 CASS introduced what was at first termed the *Canadian Journal of Applied Sport Sciences*. This title was later shortened to the *Canadian Journal of Sport Sciences*, and (with the decision of CSEP to focus upon Exercise Physiology) it was rebranded under the title *Applied Physiology Nutrition and Metabolism*. It has published some important *Position Stands* on key issues in Exercise Physiology. A number of special supplements have summarized current evidence on both the appropriate dosage and the safety of therapeutic exercise, both those who are healthy and those with chronic conditions.

***Specific sports*.** During recent years, the tendency among the younger segment of the population has been to engage in ever more dangerous extreme sports. Their high risk has apparently been a part of the motivation to participate, as a reaction against what seems an ever safer urban environment (Caine, 2012). Examples of such dangerous leisure activities include mountain biking, Himalayan trekking, snow- and skate-boarding, surfing and wind-surfing, parachuting, hang-gliding, rock-climbing, and the use of mechanized off-road vehicles. There has also been a growing interest in mass participation events such as marathon and fun runs, mass cycle rides, and triathlon competitions. Trail walking and the Outward Bound organization have opened up other new possibilities for outdoor physical activity.

Mountain biking. Many ski facilities now permit mountain bikers to take their bicycles up the mountain-side during the summer months, using the gondola or ski lift. Riders then follow extremely rugged trails back to base at breath-taking speeds.

The *Whistler Mountain Bike Park* in BC is one such facility. Here, physicians serving the local health clinic have evaluated injury statistics for the mountain bikers. Over a five-month season, a total of 898 cyclists presented to the clinic (others with more serious injuries were likely transported to hospitals in Squamish and Vancouver). The toll of locally-treated injuries included 420 fractures and 101 cases of traumatic brain injury (Ashwell et al., 2012). Unfortunately, the authors were not able to obtain details on the number of tickets sold to cyclists over the 5 months, but the injury rate appears to be very high, particularly as the park is served by only a single gondola. Mountain biking accounted for 5% of all visits to the Whistler Health Centre. A general rule of thumb at the clinic currently is that one in 1,000 skiers will be injured, compared with one in 100 snowboarders, and one in 10 downhill cyclists. Many of the cyclists even want the nurse to take photographs of their gory injuries, so that they can post them on their *Face Book* site.

Himalayan trekking. As many as 100 million people now explore high peaks such as the Himalayas every year, and the number of commercial mountain trekking

expeditions seems to be ever increasing (Weinbruch and Nordby, 2010). The total of climbers visiting Nepal grew by 450% between 1994 and 2000. A recent estimate of risk for those climbing Nepalese peaks >8000 m (based on an exposure of 30 days per climb) put deaths at 544 per million days of climbing. This figure may be compared with the risk for the much older outdoor adventure of downhill skiing in the Alps, with only 1.1 death per million days of exposure (Burtscher, 2012).

Snowboarding. Boys have for long slid down steep snow-covered slopes with their feet tied to wooden boards. In 1965, a Michigan engineer named Sherman Poppen improvised a toy for his daughter, fastening two skis together and attaching a rope to one end to give her some control of the device as she stood on it and glided downhill. The toy proved so popular that Poppen licensed the idea to a local manufacturer, and over a million "*snurfers*" were sold during the next decade. Competitions began at a Michigan ski resort in the 1970s, a World Cup was held at Zurs, Austria, in 1985, and snowboarding became a Winter Olympic Sport in 1998.

Ski resorts were slow to accept snowboarders, fearing that the boards would wipe snow from their slopes. In 1985, boarders were accepted at only 7% of U.S. ski resorts. However, by 2004 the sport claimed over 6 million participants. The injury rate remains high, particularly for those who opt to perform acrobatic manouevres. The commonest site of injury is the wrist, with around 100,000 fractures per year. Head injuries are also 2-8 times more common in snowboarding than in downhill skiing (Nowak et al., 2009).

Skateboarding. Ocean surfers are thought to have begun skateboarding during the 1950s, finding it a useful alternative form of recreation when sea conditions were unfavourable. The first skateboards were simply planks fixed to roller skates. By 1965, an International Championship was being held. Rapid expansion of the sport began when steel wheels were replaced by polyurethane rollers (Hunter 2012). By 2002, there were reputedly 18.5 million skateboarders, 85% of this number being under the age of 18 years. Municipalities have constructed a substantial number of skateboard rinks in public parks. Many skateboarders are now interested in performing acrobatic tricks, and this has exacerbated their risk of injury (Hunter 2012).

Some teenagers are also using skateboards as a form of active transportation. Irregularities in the road or sidewalk surface frequently lead to spills, although except in hilly terrain injuries from such episodes are usually only minor scrapes, cuts, bruises and sprains (Keilani et al., 2010).

Wind-surfing and kite-surfing. Newman Darby claims to have begun the sport of wind-surfing on the Susquehanna River, PA, in 1948. He began selling sailboards commercially in 1964. However, this did not initially prove a very profitable venture. In the 1970s, a Californian (Hoyle Schweitzer) began mass-producing similar sailboards, and the sport became much more popular. Manufacturers also appeared in Europe, and it was claimed that in some European countries, one in 3 families had a sailboard, with 20 million people engaging in the sport world-wide (Hart, 2004).

A professional *World Cup Wind-surfing Tour* began in the early 1980s, and the sport was granted Olympic status for men in 1984 and for women in 1992. As with many recent sports, it has become progressively more dangerous with the introduction of extreme forms of wind-surfing.

Kite-surfing was first introduced in 1996. Using the vertical lift from the kite, a surfer has the potential to make high jumps, even without exploiting large waves (Pikora et al., 2012).

Parachuting, Bungee-Jumping and BASE-jumping. André-Jacques Garnerin (1769-1823 CE) parachuted from a hot air balloon as early as 1797. The procedure became an important component in the training of military pilots and airborne troops during the Modern Era, and competitions began during the 1930s. However, parachuting did not become an international sport until 1952. It is now performed both recreationally and competitively (Shea-Simonds, 1971). Depending on the altitude, the parachute may be deployed immediately, or there may be a preliminary period of free-fall from an aircraft.

National associations such as the *Canadian Sport Parachuting Association* (founded in 1956) and the *United States Parachute Association* are affiliated with the *Fédération Aéronautique Internationale,* There remains a significant mortality and morbidity associated with the sport, caused by a combination of parachute malfunction, mid-air collisions and landing problems. The year 2009 was hailed as especially safe for U.S. parachutists. During that year, there were about a half million jumps, and only 16 parachuting-related deaths. A minimum of 50 prior descents is now required before entering a competitive event (Shea-Simonds, 1971).

Bungee-jumping traces its origins to Vanatua, in the South Pacific, where young men proved their manhood by jumping from tall platforms with vines tied to their ankles. The first modern type of bungee-jumping dates from 1979, when university students jumped from the Clifton suspension bridge in Bristol, UK.

BASE jumping is made from a building, antenna, span or earth. Because of the dangers of this sport, many public buildings such as the Eiffel Tower have banned BASE jumping (Søreide 2012).

Hang-gliding and para-gliding. The sport of hang-gliding began with the Americans Francis and Gertrude Rogollo (1912-2009 CE). They developed a predecessor of the hang glider (the flexible wing) in 1948. The construction of modern hang-gliders was greatly facilitated by the introduction of the synthetic fabric Mylar, in 1952. Paragliders are developed from parachutes, and are in essence foot-launched free-flying aircraft. One of the earliest designs was introduced by Domina Jalbert (1904-1991 CE) during the 1950s, and patented in 1963 (Rekand, 2012).

From around 1967, Australians began to use water-ski launching of hang-gliders, and this was soon followed by the foot-launching of paragliders. The *Hang-Glider Association of Canada* was formed in 1975, and the first National championship was held at Vernon, BC, in 1977. The International organization for this sport is known as the *Commission Internationale de Vol Libre.* In 2012, the record for the longest flight to a pre-declared goal was 557 km.

Those not content with the thrill of hang-gliding have now added acrobatic manoeuvres to their repertoire. The first *International Aerobatic Championships* were held near Montreux, Switzerland, in 2006.

Rock climbing. Some rock- and ice-climbing was inherent in Victorian alpine expeditions, but during the 20th century rock climbing gradually evolved into a more athletic activity, with extensive use of artificial hand- and foot-holds. This development has allowed ascents in the Yosemite Valley that previously would have been considered impossible. In 1991, a few countries participated in the first *World Sport-climbing Championship*, but by 2005 some 500 athletes from 55 countries were involved in this organization (Schöffl et al., 2012). Indoor climbing walls have also become a popular night-time and winter recreation, with risks somewhat lower than those for outdoor climbs. Great Britain listed 169 indoor climbing walls in 1996, and the number has undoubtedly grown since then (Wright et al., 2001).

Injuries due to falls are relatively uncommon among rock-climbers. The main clinical problem is an overuse injury affecting the fingers, the shoulders or the elbows (Doran and Reay, 2000; Wright et al., 2001).

Motorized off-road sports. Moto-cross has a relatively long history, evolving from "scrambles" organized in England during the early part of the 20th century, but popularity became more widespread as vehicle suspensions were improved. A World Championship was organized in 1957, and the sport reached North America in the 1960s, when Japanese motor cycles became widely available. The racing of all-terrain vehicles became common in the 1980s. During recreational use, the physical demands of the ATV are quite modest (an average oxygen consumption of 12 mL/[kg.min])), but energy expenditures are greater for off-road motor-cycling (21 mL/[kg.min]) (Burr et al., 2010).

Marathon Runs. The first Boston marathon run dates back to 1897. The course initially covered a distance of 24.5 miles, but it was adjusted to the full Olympic distance of 26 miles 385 yards beginning in 1927 (Derderian, 1996). The Boston event grew steadily from an initial field of 15 entrants to 210 runners in 1955. The number of participants then surged rapidly. By 1970, registrations had become so numerous that entrants were required to submit certification "*that he has trained sufficiently to finish the course in less than four hours*."

Women were allowed to participate officially beginning in 1972 (although a few women had unofficially completed the course previously). A wheelchair division was added in 1975. By the 100th anniversary run of 1996, there were 36,748 entrants, and 35,868 completing the run. The Boston marathon has now become one of the largest sporting events in the world, with some 500,000 spectators lining the route. In 2012, charities associated with the event raised a total of $11 M.

Vancouver hosted the first Canadian marathon (1972). The Toronto marathon (originally called the Canadian international marathon) began in 1977. The first Montreal marathon (other than the Olympic event of 1976) was held in 1979, with about 9000 runners; this event died out in 1990, but returned in 2004, boosted by the introduction of other options (including walking, cycling

and wheelchair events). Other major cities developed their own major marathon races during this same era, including New York (1970), Chicago (1977; Suozzo, 2006), and London (1981; Bryant, 2010).

Some runners, not content with 46 km, have participated in ultra-marathon runs. The oldest of these even more challenging events is the Comrades marathon (the 89 km run from Durban to Pietermaritzburg, RSA). This race began in 1921 with 48 runners. The number of starters increased to 1000 by 1971, 3000 in 1979, and 3961 by its 75th anniversary in 2000. Seven runners have died in attempting the Comrades marathon (Bateman, 2012).

Fun runs. Large-scale and less competitive walks and runs have become very popular over the last 30-40 years. In Canada, an early example was Hamilton's *Miles for Millions* march; this began in 1967, with 17,000 entrants and 10,000 people completing the 56 km course. Because of logistic problems such as road closures, the Hamilton event was only held for 6 years. Ottawa also organized a 64 km walk for OXFAM in 1968, with Lester Pearson as one of the participants. A similar event in Toronto attracted 40,000 adults and adolescents in its first year, but enthusiasm had faded away by 1984 (Myers, 2011).

In many Canadian cities, the successor event to *Miles for Millions* was the *Terry Fox Run*. This was named after Terry Fox (1958-1981 CE), the man who attempted to run across Canada in 1980 as a fund-raiser for cancer research, although one of his legs had been amputated for an osteosarcoma three years previously (Scrivener, 2010). Fox was forced to abandon his own run in Thunder Bay, about half way across Canada, because of a recurrence of the tumour, likely precipitated by his strenuous physical efforts. However, an annual *Terry Fox Run* of 5-15 km is now held in many cities, and it has raised a cumulative total of over $600 M for cancer research.

Other shorter runs also continue. In Vancouver, a 10 km fun run around Stanley Park began in 1985. It attracted over 60,000 entrants in 2011. In Sydney, the City-2-Surf fun run of 14 km began in 1971 with 2000 entrants, and it now draws up to 80,000 participants.

Mass cycling events. Mass cycling events have developed in part as a means of pressuring municipalities into making better provision for cycling commuters. The 50 km *Tour de l'Ile de Montréal* was first held in 1985. In 1999, this event expanded into a week-long bike fest; and by 2011 it boasted over 17,000 participants. On the west coast of Canada, the *Gran Fondo* began in 2010. This involved closing the recently rebuilt but hilly *Sea-to-Sky Highway* to motor traffic for an entire morning, thus allowing over 7000 cyclists to cover the 122 km distance between Vancouver and Whistler, BC.

Interest in such events has indeed had some effect on local authorities. In the town of Squamish, where I live, a one metre strip of pavement has been added on each side of a number of the busier roads, and in Vancouver a number of streets now have cycle lanes that are protected from cars by sturdy concrete barriers.

Triathlons. Triathlons vary in their rigour from the combination of a 750 m swim, a 20 km cycle ride and a 5 km run to the Ironman event, which comprises a 3.9 km swim, a 180 km ride and a 42 km run.

The modern version of the triathlon is said to have begun in France during the 1920s, as an event called *Les Trois Sports*. This was held near Joinville-le-Pont, the location of the French *School of Physical Education* (Tinley, 1998). The first North American triathlon was held at Mission Bay, San Diego, CA, in 1974, with 46 participants. The Hawaiian Ironman triathlon made its debut in 1978. An Olympic distance triathlon held at St. Petersburg, FL, now attracts 4000 participants, and a half-triathlon at Lake San Antonio, CA, has a typical entry of 8000.

Trail walking. Long-distance wilderness walking saw its North American debut with construction of the *Appalachian Trail*, a 3515 km path that extends from Mount Katahdin in Maine to Springer Mountain in Georgia. This trail was conceived by an American forester, Benton Mackaye. The first section was completed by 1923, and the trail was officially opened over its entire length by 1936. Some 30 hiking groups now maintain the trail, under the general supervision of the *U.S. National Park Service* and the *Appalachian Conservancy*. Two other major trails in the U.S. are the *Continental Divide Trail* (which will eventually run some 5000 km from Mexico to Canada, and is currently about 70% complete), and the *Pacific Crest Trail*, which runs 5000 km along the western coastal mountains from Mexico to Manning Provincial Park in British Columbia; it was officially completed in 1993.

The idea of the *Bruce Trail*, spanning the entire 740 km of the Niagara escarpment in Southern Ontario was developed in 1960 by Richard Lowes and the well-known naturalist and wild-life artist Robert Bateman (1930-). Seven years later, a cairn at the northern terminus of the trail, in Tobermory, ON, marked completion of the project. Sections of the Bruce Trail are now a popular weekend destination for active walkers from Toronto and Hamilton. The 75 km *West Coast Trail* runs along the foggy and treacherous south-western shore of Vancouver Island from Bamfield to Port Renfrew, It was first built in 1907 to facilitate the rescue of victims from the many ship-wrecks on that coastline, but it has now become a part of the *Pacific Rim National Park*. The *Trans-Canada Trail* is a much more ambitious project, currently under construction; parts of this journey will require use of a canoe or kayak.

In British Columbia, volunteers have constructed many shorter trails over Crown and private land for the pleasure of hikers and mountain bikers. Often, consent of the owner has been obtained, but when this has not been forthcoming, the sudden appearance of a trail has been blamed upon the youth from a neighbouring community- in the area where I live, a new trail is commonly attributed to "*the boys from Pemberton*."

Outward Bound. Outward Bound is an international, independent and non-profit, outdoor educational organization. It aims to foster the personal growth and social skills of participants (typically teenagers) by exposing them to challenging outdoor experiences. The four pillars of the programme are physical fitness; an expedition that provides challenge and adventure; a project that develops self-reliance and self-discipline; and fostering of a sense of compassion through service (for example in sea and mountain rescue) (Walsh and Golins, 1976).

The first Outward Bound School opened near Aberdovey, Wales, in 1941, under the direction of the exiled German educator Kurt Hahn. Hahn had founded the very Spartan *Gordonstoun School*, which was attended by the Duke of Edinburgh and Prince Charles. Hahn modelled it upon the *Schule Schloss Salem* that he had operated in Baden, Germany prior to his exile. The philosophy of Gordonstoun includes morning runs, cold showers, a variety of challenging outdoor activities and penalty drills based upon distance running for those falling afoul of the programme director.

The Outward Bound organization has expanded rapidly since its inception, and now has approximately 40 schools around the world, with some 200,000 participants each year. There are several schools of this type in Canada, and expeditions are organized to such locations as the *West Coast Trail* and the Yukon River.

Olympic Games and Competitive Sport.

One positive feature of the Post-Modern Era has been a gradual acceptance of women in all forms of major competitive sport. Against this must be set many negative trends. The ideal of the gifted amateur has been progressively eroded, and the concept of athletic prowess has given place to laboratory-based distortions of performance, biased judging, deceit regarding the age and gender of participants, deliberate injury of opponents, the doping of both competitors and horses, and unfair practices even in Paralympic competition. Despite the *Mitchell* and *Dubin* reports, success in the control of doping remains at best partial, and any stimulation of activity patterns in the general population is insignificant relative to the enormous costs of constructing present-day Olympic facilities and assuring their security. The traditional virtues of competitive sport can nevertheless still be found in less publicized events such as Masters competitions.

Female participation in competitive sport. The *Royal Commission on the Status of Canadian Women* (tabled in 1970) recognized that fewer women than men were involved in school physical activity programmes. In response to this information, *Fitness & Amateur Sport* held a *National Conference on Women and Sport* in Toronto in 1974, and a second conference (*The Female Athlete Conference*) was hosted at Simon Fraser University (Burnaby, BC) in 1980. That same year, the *Canadian Women's Programme* became an integral part of *Fitness & Amateur Sport* (Vail, 1983). It attempted to remove some of the traditional barriers to female participation and to involve more women in sport.

Specific initiatives of the Canadian women's programme included the provision of funding for female coaches and officials, an internship programme whereby female athletes could learn from retired competitors, liaison with other women's organizations, and the development of policies to curtail the support of sports organizations that were perceived to be sexist. The *Canadian Women's Programme* also sponsored several films encouraging female involvement in sport, including *Your Move* (1974), *Growing Together* (1981) and *Just for Me* (1982).

Female ice-hockey provides one example of changing attitudes towards the involvement of women. Throughout

the 1950s and 1960s, women's ice-hockey was regarded as little more than a curiosity. The ice rink was assumed to be the preserve of men and boys, an attitude seemingly confirmed in 1956, when the *Ontario Supreme Court* ruled against Abby Hoffman, a nine-year-old girl who had challenged the "*boys only"* policy in minor hockey. Hoffman had already played most of the season with a boy's team, disguising her sex by dressing at home and wearing her hair short.

A revival of Canadian female hockey clubs began in the 1960s. Most girls attempting to join boys' teams were still rejected. But women's hockey slowly gained ice-time, and as the new generation of players grew up they demanded a chance to play at colleges and universities. Canadian women's intercollegiate hockey began in the 1980s and the NCAA recognized the game in 1993. An international breakthrough came in 1990, when eight countries contested the first *Women's World Ice-Hockey Championship.* Participation grew exponentially in the following decade. Women's ice-hockey made its Olympic debut at the 1998 Winter Games in Nagano, Japan, and in 2002 the *Mission Bettys* of California became the first all-girls team to enter the *Quebec International Pee Wee Tournament,* one of the world's largest youth competitions.

The issue of female participation in sport attracted attention from the *United Nations World Conference on Women*. At the 4th Conference in this series, held in Beijing in 1995, a session on gender, development and sport, recognized that sport was a useful tool to promote gender equity and empower women. The *International Olympic Committee* has also hosted conferences on women in sport. The first such event was held at Brighton, U.K. in 1994. It established an *International Working Group on Women and Sport.* The 4th meeting in this series (2008) was held in Jordan. It covered such topics as sport as a vehicle for social change, the business advantages of increased female participation, the benefits women bring to sport, promoting equity of access within the community, and cultural barriers to female participation (International Olympic Committee, 2009). The 5th conference (in Los Angeles, CA, in 2012) called for a larger number of women to be given leadership roles in sport.

Loss of Amateur Idealism. The Post-Modern Era has seen a progressive erosion of the amateur ideal in competitive sport, particularly among Olympic contestants. Beginning in the 1950s, Eastern Bloc nations created sinecures for their top athletes that allowed them to train full-time, and if successful in international competition, the State also rewarded them with privileges such as apartments and cars that the general population could not hope to obtain without a wait of 10-15 years.

Now, most Western nations also provide selected top athletes with substantial funding. This not only pays for coaching and travel, but also reduces the need for the athlete to engage in other forms of gainful employment. With its "*Own the Podium*" programme, Canada spent $100M on the support of promising athletes during the 3-year period leading up to the London Games of 2012. Interestingly, the effect upon competitive outcomes seems to have been negligible: the total medal count (18) only matched that which had been won in Beijing, four years earlier, and fewer of the awards in

2012 were gold or silver medals. One argument in favour of providing cash support to athletes is the high cost of their equipment. At the Whistler Winter Olympics of 2010, the Canadian bob-sled team reportedly put the cost of their sled ($50,000) on the participants' credit cards, hoping for a win to pay off this considerable debt!

Many countries now offer cash prizes to competitors who win medals at the Olympics. In 2012, the amounts disbursed for a gold medal were - Italy $135,000, China $50,000, USA $25,000, and Canada $20,000, but Britain (who incidentally won 26 gold medals) gave out no such inducements. In contrast, Italy (with 8 gold medals) had to pay out a total of >$1M, despite the difficult current financial circumstances of that country. In the U.S., President Obama is now discussing the possibility of removing Olympic cash prizes from taxable income.

The final, and usually the most important challenge to loss of Amateur status is the growing extent of commercial sponsorship. Much thought is given to emblazoning commercial logos prominently on athletic equipment and clothing, and successful athletes in high profile sports are likely to net lucrative publicity contracts following their victories. The US swimmer, Michael Phelps, reputedly has an annual sponsorship income in excess of $4 M. The top players in professional baseball, American football and ice hockey also command salaries in this range.

Changing nature of athletic competition. Attempts to obtain an unfair advantage over fellow competitors have a long history, but unfortunately seem to have reached their apogee during the post-modern era. Now, apart from the ever-growing issue of doping, the outcome of events is heavily dependent on the back-room efforts of physicians, physiologists, biochemists, biomechanicians and psychologists rather than upon the innate abilities of the athlete (Waddington, 1996). Victory comes to the person who can assemble the largest and best-qualified support team. Efforts to prevent doping are also demanding Herculean efforts, and dishonest athletes are continually seeking new tactics to avoid the detection of doping agents.

Distortion of judging. All disciplines with subjective judging are plainly open to abuse, particularly collusion between judges from a particular regional bloc. This malpractice has become particularly evident in the judging of figure skating competitions. At the Salt Lake City Winter Olympics of 2002, few people could believe that the Russian team had out-performed the Canadians, and at a subsequent inquiry by the *International Skating Union Technical Committee*, the French judge, Marie-Reine Le Gougne reportedly broke down, admitting that she had favoured the Russians in return for support of the French team in an up-coming ice-dancing event (Lawler, 2012). The uproar over this blatant vote-swapping led to institution of a new international judging system.

In 2006, several top Italian soccer teams were implicated in a match-rigging scandal. Telephone transcripts showed managers had engaged in discussions with senior officials to ensure the appointment of referees favourable to their team. CBC Television recently reported wire-tap evidence from a German court-room that the Canadian Soccer League had also suffered from a

match-fixing incident; it was alleged that several semi-professional players from the *Toronto Croatia Football Club* received a total of $15,000 in order to lose a match against the Trois Rivières team *Attak* in September of 2009. The German trial suggested that a crime syndicate had manipulated domestic league games in many countries around the world, including Canada, Germany, Switzerland, Austria, Belgium, Turkey, Hungary, Slovenia and Croatia.

Cricket has also suffered from game-throwing abuses. In 2000, Delhi police accused the South African cricket captain Hansie Cronje of match-throwing, and subsequent investigations also implicated several Pakistani and Indian players in this malpractice.

Sometimes, individual athletes have themselves tried to manipulate scoring systems. In the 1976 Olympic Games, the Soviet modern pentathlete Boris Onischenko (1937-) used an épée with a push-button on the pommel. This fraudulent device caused the electronic scoring system to register a "hit" even when the épée had not actually made contact with the target area on his opponent. In consequence of this abuse, the entire male Soviet pentathlon team of 1976 was disqualified (Cooper, 2012).

In a unique incident at the London Olympics, a British diver was allowed a second attempt because he was distracted by flashes from the cameras of spectators. Although the use of such cameras is officially prohibited, there were frequent flashes during his first dive.

Deliberate injury of opponents and damage to equipment. The deliberate injury of opponents has become all-too common in ice-hockey and football games, but attacks upon opponents have occasionally sullied even Olympic competition.

Perhaps the most notorious example concerns the ice-skater Tonya Harding. Tonya Harding's ex-husband, Jeff Gillooly, was charged with attacking Nancy Kerrigan -- Harding's closest rival for a spot on the 1994 Olympic figure-skating team. The assault resulted in a bruised femur for Kerrigan, and jail time for Gillooly. Rumours that Harding had been involved in the attack were later confirmed by Gillooly. The *United States Figure Skating Association* was thus obliged to strip Harding of her national titles and it banned her from all future skating competitions, either as a skater or as a coach.

Another case involved the U.S. short-track speed-skater Simon Cho. He admitted tampering with the skates of a favoured Canadian opponent, Oliver Jean, allegedly at the behest of the head coach of the U.S. team, Jae Su Chun, during the 2011 *World Ice-skating Championships* in Poland. In consequence, Canada was only able to field 3 skaters for the 5000 m relay event.

Age categorization. The Romanian gymnast Nadia Comãneci (1961-) was only 14 when she won three Gold medals at the Montreal Olympic Games of 1976. This was entirely permissible in that era. However, in 1996 a new IOC rule specified that Olympic gymnasts must turn at least 16 during the year of their Olympic competition. There have been persistent rumours of several petite Chinese gymnasts flouting this rule. However, after enquiry, the IOC accepted the ages of the contestants, as shown on the passports, ID cards and family registers.

Deceit over gender. The earliest issue of deceit over gender occurred at the Los Angeles Games of 1932. The Polish athlete Stanislawa Walasiewicz won a Gold medal in the women's 100 m race, but after her death in 1980 she was discovered to have had partially developed male genitalia.

A 19-year-old Jewish high-jumper, Gretel Bergman, fled Nazi Germany in 1933, but she was forced to return for the Berlin Olympics of 1936, because the IOC were requiring Hitler to field Jewish athletes; the Nazis threatened reprisals against her family if she did not compete. At the last minute, Bergman was replaced by a team-mate, Dora Ratjen, and during the 1960s it transpired that "Dora" was really a man (Hermann Ratjen) disguised as a woman. Ratjen was placed fourth at the Olympics, but went on to set a high-jump record for women in 1938. Ratjen later claimed that the Nazis had forced him into competing "*for the sake of the honor and glory of Germany*."

Avery Brundage (IOC President from 1952 to 1972) called for an examination of female athletes following the Berlin Games, having watched the performance of a Czech runner Zdenka Koubkova and a British shot-putter and javelin thrower Mary Edith Louise Weston. Both of these individuals were apparently hermaphrodites, and later underwent surgery to change their gender.

The *International Association of Athletics Federations (IAAF)* began sex-testing in 1950, with athletes being examined in their home country prior to competition. The Dutch sprinter Foekje Dillema was expelled from the 1950 National team after she refused a mandatory physical examination; later DNA investigation revealed a 46,XX/46,XY chromosome anomaly, leading to hyperandrogenism (Ballantyne et al., 2012).

On-site sex testing at the *European Athletic Championships* began in 1966 as a reaction to a suspicion that some of the competitors from Eastern-Bloc states were really men. Specific rumours had swirled about the gender of the Russian Press sisters, Tamara and Irena. They had dominated field events, taking home several medals from both the Rome and the Tokyo Olympics. However, Tamara and Irena withdrew from competition when mandatory sex testing was introduced.

The IOC introduced mandatory sex testing at the Grenoble Winter Olympics of 1968. Poland's Ewa Klobukowska became the first woman to fail an Olympic 'gender' test; she had won a Gold medal at the Tokyo Games of 1964 as part of the women's 4×100 m relay, and a Bronze medal in the women's 100 m sprint. However, she was found to have the rare XX/XXY genetic mosaicism, and was subsequently banned from competition. Erik Schinegger, the 1966 female world champion in downhill skiing, was also banned from the 1968 Winter Games in Grenoble.

The buccal epithelial tests currently used to determine the sex of an athlete are unfortunately not infallible (Ballantyne et al., 2012; Simpson et al., 1993). Eight athletes failed these tests at the 1996 Atlanta Olympics, but all were cleared by subsequent physical examination. The *Journal of the American Medical Association* concluded (Simpson et al., 2000):

"Gender verification tests are difficult, expensive, and potentially inaccurate. Furthermore, these tests fail to exclude all potential impostors (e.g., some 46,XX

males), are discriminatory against women with disorders of sexual development, and may have shattering consequences for athletes who 'fail' a test."

The IAAF ceased gender testing in 1992, and the IOC voted to ban the practice in 1999, although both groups retained the right to test individuals if deemed necessary. This proved the case with Caster Semenya of South Africa, who won the 800 meters at the 2009 *World Athletic Championships* in Berlin. However, in 2010, the IAAF ruled that Semenya could continue to compete as a woman.

Trans-sexual individuals who have undergone a sex-change operation and 2 years of hormonal therapy are now allowed to compete in their new gender category.

Doping. Canada's first doping control programme was initiated and chaired by Dr. Norm Gledhill. He was succeeded by an Ottawa physician, Dr. Andrew Pipe, who was appointed as Chair of the Canadian Doping Control Review Board in 2000. The latter has devoted many years to this task, and continues as Chair of the Board for the period 2013-2017.

Despite the efforts of control groups in Canada and other nations, a Sports Illustrated interview of elite Olympic athletes in 1997 gave disturbing responses to two relevant questions (Bamberger and Yaeger, 1997):

"If you were given a performance enhancing substance and you would not be caught and win, would you take it?".

98% responded "*Yes*". Even more seriously:

"*If you were given a performance enhancing substance and you would not be caught, win all competitions for 5 years, then die, would you take it*?"

More than 50% still said "Yes." In 1999, the IOC organized a world conference on doping in sport because French police had discovered massive amounts of performance enhancing drugs at the 1998 *Tour de France*. One outcome of the conference was the formation of the *World Anti-Doping Agency* (WADA), with the mandate of fighting against doping in sports,

Among notable cases of doping during recent history, we may mention the cases of Ben Johnson, Marion Jones and Lance Armstrong. All of these individuals appear to have used multiple banned substances, to have achieved suspiciously good results in competition, to have gained very lucrative fees for product endorsements, and to have repeatedly denied their misconduct, although finally losing both their medals and their commercial sponsors. Official responses to these scandals have included the *Dubin Commission* in Canada, and the *Mitchell Report* in the U.S. The latter focussed specifically upon doping in baseball.

The abuse of steroids has now spread to high school athletes (Buckley et al., 1988; Pope et al., 1988), and despite the *Anabolic Steroid Enforcement Act* of 1990, it is estimated that in the U.S. the black market in anabolic steroids now nets $100 M annually. A trade also continues in human growth hormone derived from cadavers (Sonksen, 2001), a form of treatment that can lead to *Creutzfeldt-Jakob Degenerative Brain Disease*,

Benjamin Sinclair Johnson (1961-). Ben Johnson was a Jamaican-born sprinter. He began training under the notorious

Canadian coach Charlie Francis, and he competed for Canada in the 1980s. Johnson won two silver medals at the 1982 Commonwealth Games in Brisbane, Australia, and two bronze medals at the Los Angeles Olympics of 1984. In 1985, he succeeded in beating his American rival Carl Lewis, and in 1986 he covered the 100 m sprint in 9.95 sec. He was invested as a *Member of the Order of Canada*, and was soon receiving $400,000 a month in commercial endorsements. At the 1988 Olympic Games in Seoul, he set a world record of 9.79 sec for the 100 m distance, but his gold medal was rescinded when his urine tested positive for the steroid *stanozol.*

After at first denying the charge of doping, both Johnson and Francis complained that they had been forced to use drugs in order to keep up with the other competitors; Johnson just had the bad luck to get caught. Certainly, five of the other finalists in the 100 m event, including Carl Lewis, were also implicated in drug scandals at some point in their careers.

Johnson attempted a comeback in 1991, but at a race in Montreal in January of 1993, he was again convicted of doping, the finding on this occasion being an excess of testosterone in his urine. The *Federal Amateur Sports Minister* at that time (Pierre Cadieux) called Johnson a "*National disgrace*," and recommended that he move back to Jamaica. The *International Amateur Athletic Federation* imposed a lifetime ban upon Johnson, but because of technical errors in the process this decision was rescinded in 1999. Nevertheless, no other athlete was willing to run against him, and at one event in Kitchener, ON, Johnson was forced to run a lone race against the clock. In late 1999, his urine again tested positive, this time containing hydrochlorothiazide, a banned substance used to mask the administration of steroids. Johnson then went to Libya, to coach Al-Saadi Ghaddafi, the son of the former Libyan Dictator Muammar Gaddafi. Al-Saadi hoped to join a professional soccer team. The Libyan soon found a place on an Italian football team, but was quickly dismissed when he also was found to be using steroids.

In a 2006 interview, Johnson claImed that 40% of athletes were still using drugs (Johnson, 2010).

Marion Lois Jones (1975-). In 2007, the former world track and field sprint athlete Marion Jones admitted that she had taken the undetectable performance enhancing steroid *tetrahydrogestrinone*, developed by Victor Conte and the *Bay Area Laboratory Cooperative (BALCO)* since the year 2000, and that she had lied about this matter to a grand jury. Rumours and accusations had indeed begun while she was still in high school, when Jones had missed a random drug test, and despite repeated denials, allegations of doping continued to follow her through two Olympiads and several championship meets. Opponents noted that she chose to train in the company of athletes and coaches who were dogged by accusations of doping. In 2004, Conte appeared on ABC television, and admitted giving Jones five different illegal performance-enhancing drugs before, during and after the 2000 Sydney Olympic Games. Investigative reporters also obtained testimony from Jones' ex-husband that he had seen her injecting steroids into her stomach (Fort and Stevens, 2010). On 2006, one of her two urine samples taken at an American Track and Field meet tested positive for erythropoietin.

Jones was given a 6-month prison term for lying to the grand jury, and the US Anti-Doping Agency required:

"*disqualification of all her competitive results obtained after September 1, 2000, and forfeiture of all medals, results, points and prizes*."

Jones had made multi-million dollar endorsement deals, but by 2006 she was in financial trouble, and a bank foreclosed on her $2.5 M mansion at Chapel Hill, NC. The *BALCO* scandal eventually implicated 20 top U.S. athletes, including Jones' ex-husband, the shot-putter C.J. Hunter and the father of her first child, the sprinter Tim Montgomery.

Lance Edward Armstrong (1971-). Lance Armstrong is a former U.S. road-racing cyclist who won the *Tour de France* on 7 occasions. One laboratory test showed a maximal oxygen intake of 83.8 ml/[kg.min], less than the reputed values of 92-94 ml/[kg.min] for Miguel Indurain and Greg LeMond. Armstrong's first *Tour de France* victory was in 1993. However, a testicular cancer was detected in 1996, after it had metastasized to his brain, abdomen and lungs. He chose an unusual chemotherapeutic cocktail to avoid the toxic effects of the normally used medication, *belomycin*. His cancer went into complete remission, and by 1998 Armstrong was able to undertake serious race training once more. He won the *Tour de France* again in 1999, continued to compete until 2005, and had a further period of competition 2009-2011, finally retiring from road-racing in 2011.

He was accused by 10 of his team-mates of using testosterone, human growth hormone, erythropoietin and blood doping. Blood tests conducted in 2009 and 2010 appeared to support these various accusations. He also had repeated contacts with Michel Ferrari, a trainer who had been banned by the Italian Cycling Federation because of doping. In August of 2012, Armstrong declared that he had never engaged in any such practices, but that he had become tired of battling the issue. The U.S. Anti-doping agency (USADA) proceeded to erase all of the records that he had established in the previous 14 years, and imposed a lifetime ban upon his further competition in cycling or triathlon events.

Both Armstrong and the *Union Cycliste Internationale (UCI)* are still questioning the authority of the *USADA* in this regard, and the *UCI* is asking to review the relevant evidence. Their intervention is in itself suspect, as Floyd Landis, also convicted of using drugs, alleges that Armstrong tested positive for erythropoietin at the *Tour de Switzerland* in 2001, but that the *UCI* chose to suppress this information, although accepting Armstrong's donation of $100,000 towards the purchase of anti-doping equipment. The retrieval of Armstrong's prize monies and an appropriate redistribution of awards will present a major challenge, as 5 of his 7 runners-up have also been banned for drug offences.

The widespread doping of professional cyclists has been highlighted by several police and customs raids over the past 15 years. At the 1998 *Tour de France*, customs officers arrested Willy Voet, a physiotherapist attached to the *Festina* cycling team, for possession of needles, syringes and over 400 bottles of erythropoietin, human growth hormone, steroids, amphetamines, narcotics and stimulants. The Spanish police raided a Madrid doping clinic in May 2006. Here,

professional athletes were receiving medically-supervised injections, and a clear paper trail pointed to treatment of at least 50 professional cyclists, 23 of whom were subsequently disqualified (Baron et al., 2007). The same year, a Paris court sentenced 23 individuals to 4 years in jail for selling an amphetamine cocktail to professional cyclists. Some of the competitors were reputedly also taking Viagra in an attempt to enhance their performance at altitude (Hsu et al., 2006).

Some people have suggested that the sudden emergence of the Canadian Ryder Hesjedal as victor in the *Giro d'Italia* of 2012 may reflect an elimination from the competition of those using banned substances.

Dubin Commission. Following the drug scandal that stripped Johnson of his Olympic gold medal, the Canadian Federal Government established a *Commission of Inquiry Into the Use of Drugs and Banned Practices Intended to Increase Athletic Performance*. Ontario Appeal Court Chief Justice Charles Dubin chaired the inquiry. Several months of shocking testimony revealed the rampant use of performance-enhancing substances among athletes. Ben Johnson eventually admitted using steroids since 1981. In Dubin's report, released in June 1990, the Chief Justice criticized the testing policies and procedures of both the Federal government and amateur sports associations

As a result, in April of 1991 Canada strengthened its drug-testing programme, with the creation of an independent, non-profit *Canadian Anti-Doping Organization*. This organization is now responsible for Canadian drug-testing policy, practice and implementation, and it has become an internationally recognized leader in the fight against performance-enhancing substances.

Some countries have ignored the recommendations of the Dubin Commission, but the scope and effectiveness of doping control have increased progressively over the post-modern era. The British laboratory that tested 6000 urine and blood samples from athletes participating in the 2012 Olympic Games reportedly had a size "larger than 7 tennis courts," with a $10 M operating budget spread over 5 years (O'Dowd, 2012).

Mitchell Report. As early as 1998, when the American baseball player Mark McGuire set a new home run record, it was revealed that he had been taking a precursor of the steroid *nandrolone*. Drug testing of baseball players was instituted early in 2006, but sampling was not scheduled on a random basis.

The *Mitchell Report* was established by baseball commissioner Bud Selig later in 2006, following investigative reporting that suggested many of the top players were still abusing steroids and growth hormones, and that the honesty of drug testing in major league baseball was open to serious question. The report was prepared after a 21-month investigation (Rosen, 2008). Many active players were uncooperative, but information was obtained from a ball-boy with the New York Mets who had been involved in drug distribution, and Brian McNamee, a personal trainer who had administered steroids to many of the big names in baseball.

After mandatory testing was introduced in 2004, many of the players switched from steroid use (which was detectable) to human growth hormone (which was not then detectable). The

report named specifically 89 top players who had been abusing drugs, but as with many athletes in other disciplines, denials continued despite clear evidence. Roger Clemens stated through his agent:

"I want to state clearly and without qualification: I did not take steroids, human growth hormone or any other banned substances at any time in my baseball career or, in fact, my entire life."

It is also noteworthy that the report named no abuses among the *Boston Red Sox* (where Mitchell was a director) or the *Milwaukee Brewers* (once owned by Bud Selig), although both teams were later shown to have included players that had used steroids.

By the 2012 season, the league had become more serious about preventing doping, and players abusing banned drugs were suspended for 50 games following a first offence. However, in October of 2012, the Director-General of the World Anti-Doping Agency, Dr. David Howman, still singled out the NBA for gaps in its testing programme.

Doping of horses. The doping of horses at racetracks has long been a significant problem, but doping was also identified in Olympic show-jumping in 2004. In consequence, the German show-jumping team and an Irish show-jumper were stripped of their gold medals.

Six of the 20 Olympic doping cases in Beijing involved horses. A Norwegian rider lost his medal and several others were ejected from the Games. Four of the show-jumpers at the Beijing Olympics had administered capsaicin to their steeds. Capsaicin is derived from chili peppers, and is commonly used in riot control. In the context of show-jumping, it may hyper-sensitize the horse, or serve as a form of pain relief, in both cases potentially enhancing performance. The drug may have been used in earlier competitions, but it was not until 2008 that an appropriate test became available.

Unfair practices in Paralympic competition.. Unfortunately, attempts to gain an unfair advantage over fellow competitors have now spread to Paralympic sport. Two of the most common practices have been attempts to be included in a category not merited by the extent of the athlete's disability, and the boosting of blood pressure immediately prior to competing.

Following the 2000 Sydney Games, a Spanish basketball player alleged that only 2 of the 12-person "*intellectually-disabled*" Spanish basketball team met the required criteria. This was confirmed by an investigating committee from the *International Paralympic Committee*, and all intellectually disabled competitors were excluded from the 2004 and 2088 Games, although they were readmitted under tighter rules in 2012.

Some competitors have sought an advantage in paraplegic sport by inducing a rise of blood pressure. The measures adopted have included the deliberate retention of urine and sitting on the scrotum or a sharp object (Webborn, 1999). In sports such as cross-country skiing, such "boosting" can augment performance by 15%, and an advantage of 9.7% has been observed in simulated wheelchair races. The growing prevalence of the practice caused the *International Paralympic Committee* to ban it officially in 1994. Unfortunately, it is difficult to prove that the blood pressure has been artificially increased. The main control measure so far has been a threat

(apparently not enforced) of excluding athletes from events if they have an abnormally high pre-event blood pressure. A study at the Beijing Paralympics of 2008 estimated that 17% of competitors still engaged in blood pressure "boosting," and at the London Games of 2012 a figure of 30% was estimated.

The use of steroids has also become a concern in Paraplegic Games. Prior to the 2004 competition in Athens, Greece, Canada's best-known disabled athlete, single-amputee sprinter Earle Connor, received a 2-year suspension after testing positive for both *testosterone* and *nandrolone* (Collier, 2008), and at the Beijing Games of 2008 three power lifters and a basketball player were banned after their urine tested positive for steroids.

Munich and the costs of Olympic security. The Munich Olympics of 1972 were well-prepared, but were designed as a carefree event, in an attempt to reverse the militaristic image of the Berlin Games of 1936. It was alleged that many people avoided entry check-points at the Munich athletes' village, simply by climbing over a 2-metre-high chain-link fence.

The Games themselves were heavily over-shadowed by the fact that members of the Israeli team were taken hostage by a Palestinian group called *Black September*, with the assistance of some Neo-Nazis (Reeve, 2011). The group of hostage takers was dressed in athletic clothing, and their climb over the perimeter fence was apparently helped by some unwitting Canadian competitors. After capturing the Israelis, the demands of *Black September* included the release of not only 234 Palestinian prisoners held in Israeli jails, but also Andreas Baader and Ulrike Meinhof, leaders of the *German Red Army Faction* who were currently held in German prisons. The action of the Palestinians was widely condemned, with King Hussein of Jordan calling it (Cooley, 1973):

"a *savage crime against civilization ... perpetrated by sick minds*"

The German government, anxious to atone for its anti-Semitism during the 1930s, offered the kidnappers unlimited funds, and replacement of the Israeli hostages by top-ranking German officials, but at the request of the Israeli government, there were no negotiations with the hostage-takers.

Eventually, 11 of the Israeli athletes and coaches, plus one German police officer were killed. Five of the Palestinian kidnappers were also killed, and the remaining 3 were captured but later released following the hijacking of a *Lufthansa* airliner. The immediate effect of the massacre was a halting of the Games and the organization of a memorial service attended by 3000 athletes and 80,000 spectators. The Munich organizing committee suggested cancelling the remainder of the Games, but Avery Brundage insisted:

"The games must go on, ...and we must continue our efforts to keep them clean, pure and honest."

This decision was endorsed by the Israeli government and the Israeli *Chef de Mission.* However, the American Jewish swimmer Mark Spitz decided it was safer to leave Germany, as did the Egyptian team (who feared reprisals). The families of some victims asked the IOC to establish a permanent memorial to the athletes. The IOC declined this request, saying that

to introduce a specific reference to the victims could "*alienate other members of the Olympic community*,"

Golda Meier subsequently authorized the launching of what was termed *Operation Wrath of God.* Israeli planes bombed both Syria and Lebanon, killing some 200 people, and *Mossad* began a ruthless 20-year-long world-wide tracking and slaying of all Palestinians suspected of any involvement in the hostage-taking incident. Israeli agents killed one innocent person in Norway and four by-standers in Lebanon, also injuring 18 people during the killing of Ali Hassan Salameh, the leader of the *Black September* movement.

A more long-term impact of the events in Munich has been an almost paranoid concern about security at subsequent Olympic events. At the Whistler Winter Olympics of 2010, expenditures on security precautions exceeded $2 billion, with Canadian and U.S. jet fighters threatening to shoot down any aircraft that had the bad luck to wander into a large exclusion zone; apparently little concern was to be shown for either the hapless aircrew or the civilians such as myself who were living below.

At the London Summer Olympics of 2012, the proposed number of security personnel was so large that even the world's largest security company fell 3600 personnel short of requirements in a 20,000-person recruitment drive. A large naval combat vessel was stationed in the River Thames, four fighter jets were ready for instant take-off at an inner London air-base, and six surface-to-air missiles were installed on tall buildings surrounding the main stadium. The total cost of the security precautions in London was estimated at $15B, although Britain was at this time struggling with a deep recession and a high rate of unemployment. At the Sochi Winter Games of 2014, costs had risen to $51 B, much of this attributable to rigid security precautions.

Even the Paralympic Games that followed the main 2012 Games was monitored by a security force of more than 20,000.

Impact of the Olympic Games upon the general public. Attempts are often made to justify vast Olympic expenditures in terms of the new facilities that are created and the positive impact of the Games upon motivation of the general population to engage in physical activity.

In the 2010 Winter Games, the most impressive structure was the vast ice-skating oval constructed in Richmond, BC. However, far from being available to the general public, political discussion between sporting organizations and various levels of government led to a rigid agreement that the ice-rink at the facility would be dismantled immediately following the Games, apparently because it was feared that the new skating area would offer too much competition for another skating facility in Calgary, AL, more than 1000 km to the east. The oval has been converted to a multi-purpose sports facility, but it remains a financial albatross, saddling the City of Richmond with large annual costs, to the point that some city councillors are now agitating for it to be converted to a convention centre. The sports interest of volunteers who assisted at the 2010 Games was undoubtedly stimulated, at least transiently. However, the impact on the general population was essentially negative, as they saw ticket prices far outside the budget of the typical family, and the only road through the entire

Vancouver/Whistler corridor closed in order to allow senior Olympic officials to be whisked to the various venues in luxury limousines.

Sebastian Coe made ambitious claims for the London Olympics of 2012 (Campbell, 2012):

"…London's vision is to reach young people all around the world. To connect them with the inspirational power of the Games. So they are inspired to choose sport."

In a 2008 policy document, the *UK Department of Culture, Media and Sport* was more specific (Campbell, 2012):

"We hope to see people becoming increasingly active, with a goal of seeing two million people more active by 2012 through focussed investment in our sporting infrastructure and better support and information for people wanting to be active."

However, an analysis that was made following the Manchester Commonwealth Games of 2002 found that this event had a very limited impact on the membership of local sports clubs (Coalter, 2004), and in 2007 a select committee of the British House of Commons concluded (House of Commons Select Committee on Culture, 2007):

"No host country has yet been able to demonstrate a direct benefit from the Olympic Games in the form of a lasting increase in participation"

In Greece, sport participation rates for 2009 were actually lower than in 2004 (Pappous, 2011):

"What is evident from the statistics is that the Games in Greece had at best only a temporary impact on participation in sport and physical activity."

Other Competitive Games. The World Masters Games were inaugurated in Toronto, ON, in 1985. The initial event attracted 8305 participants from 61 countries, with competition in 22 types of sport (Kavanagh et al., 1988; Shephard et al., 1995). The Masters Games is now regulated by the *International Masters Games Association*, based in Lausanne, Switzerland, and under the patronage of the *International Olympic Committee*.

Since the Toronto Games, other major cities have hosted the Masters Games at 3-4 year intervals, attracting some 25,000 participants in Brisbane (1994) and Melbourne (2002) and nearly 29,000 in Sydney (2009). In Sydney, the largest overseas delegation came from Canada (2242 competitors). The total number of Masters participants is large relative to the Beijing Olympics of 2008 (10,500 athletes) and the Beijing Paralympics (4200 participants), although the number of countries involved in the Masters Games (about 100) is as yet smaller than that for the Olympics (around 205 nations) (Shephard, 2009b).

As yet, the Masters events have attracted relatively little public support. The organizers of the Sydney event received a grant of only $100,000 from the government of New South Wales, in contrast with the billions of dollars now poured into Olympic competitions. Nevertheless, the 2009 Masters Games was estimated to contribute $60.2 M to the New South Wales economy.

The Masters events are open to competitors at all levels of ability, and some events such as lawn bowling hardly

make for exciting television! Nevertheless, it has been argued that the example of Masters athletes can change the overall attitude of seniors towards physical activity (Shephard, 2009b). How far were older Canadians influenced by Jack Rabbit Johansson (1875-1987 CE), who was still actively involved in cross-country skiing on his hundredth birthday? Do seniors see Masters competition as something that they can emulate, or are they intimidated by people such as Johansson (Ory et al., 2003)? The impact of Masters competition upon population health is a question that remains to be explored.

The Sydney Games set a good example in terms of "Green" principles, with use of energy- and water-efficient facilities, free public transportation included in the registration fee, 90% of correspondence handled on-line, back-packs made largely from recycled material, and provision of reusable water bottles (Australian Government., 2010).

Other lower level Canadian events include the *Arctic Winter Games* (initiated in Yellowknife1970 (Shephard, 2011)) and the *Canadian Maccabian Games Association* (formed in 1972, to promote participation in the Israeli event).

Future Directions and Conclusions

The history of health and fitness highlights some fascinating themes. One commonality over the centuries has been a strong association between military demands and governmental encouragement of physical fitness. With active warfare now waged largely by drones and cyber-specialists and most industrial processes automated, this particular imperative is fast disappearing. Diplomats may continue to perceive some "cold war" advantage from athletic victories, but in general those seeking governmental support for fitness research or programming will in future need to justify their requests by demonstrating that their activities lead to improvements in health and thus reduced demands upon medical services.

Although the estimates of the costs of physical inactivity in Canada have received attention (Katzmarzyk, 2011; Katzmarzyk et al., 2000; Shephard, 1986a), to date most assessments of the costs and benefits of regular physical activity have focussed upon overall mortality, but from the viewpoint of the client, a more critical issue is the resulting quality of life. Existing cost- benefit analyses will thus need repeating, using the individual's quality-adjusted lifespan as the appropriate outcome measure.

Scientists have now elucidated much of the nature of aerobic and muscular fitness, and the inter-relationships between such fitness and health, but we still know very little about what will persuade a sedentary person to become more active. This will require more detailed examination of relationships between mood-state and various types of exercise, and a further exploration of the determinants of exercise behaviour. Tradition has prescribed a divide between body and soul, with the body needing exercise, and the soul seeking music and other "cultural" delights. However, it is increasingly recognized that a sound mind can only be found in a healthy body. Some present-day fitness programmes are seeking to harmonize the experience, with music, television watching or operation of a computer becoming an integral component of the exercise process.

As yet, social progress is too often measured in terms of personal wealth,

entertainment, leisure and self-indulgence. History offers little insight as to how such hedonistic trends can be reversed. This remains a major challenge for health professionals in today's society. Fitness experts should focus on the elusive goal of the quality of life, pointing out that particularly during the senior years, the individual's ability to enjoy life and live independently will depend on the extent to which fitness goals have been pursued over the lifespan.

There remain other important challenges for both scientific investigators and practitioners who are involved in fitness research and programming. Although more reliable information is now being accumulated on the safety of exercise testing and participation, both in health and disease (Warburton et al., 2011a), this data will need further refining, as a Canada-wide registry records and evaluates all critical incidents that occur while participating in various types of exercise. There also remains a need for precise information on an appropriate minimum weekly dosage of exercise, with a much clearer definition of the optimal frequency, intensity, and duration of exercise to prescribe for healthy individuals, and for those with various clinical conditions. The recommendations offered to clients will need to change in order to reflect new forms of work (particularly the home office) and alterations in the environment of large cities. At the same time, exercise specialists will be increasingly well-qualified to recommend changes in the built environment that will encourage people to engage in more physical activity.

The *PAR-Q* clearance process (and its medical counterpart the *PARmed-X*) have recently undergone extensive review and a total re-envisioning, leading to the new PAR-Q+ and the ePARmed-X+ (Warburton et al., 2011a). Currently, a much larger fraction of those who wish to exercise should receive appropriate exercise clearance without the personal intervention of a physician. Modern computer technology and social media should allow a rapid, regular, detailed and standardized interaction with each client. It should prove possible to adapt these new technologies to the important task of maintaining a client's adherence to the exercise programme that has been prescribed. Inexpensive pedometer/ accelerometers and GPS devices will also allow objective assessment of the degree of compliance that can be obtained from various forms of motivation.

As exercise is prescribed not only for health individuals, but also for those of advanced age and with a variety of chronic medical conditions, the supervisory role of qualified exercise and fitness professionals will become ever more important, and there may be a need for a further extension of their training. There will also be a strong demand to delineate the minimum qualifications needed for various tasks, with a categoric exclusion of those lacking appropriate skills and training (Warburton et al., 2012).

Finally, governments will need to look critically at their investment in major international athletic competitions. Are these yielding the health dividends that their proponents claim, or could a much greater advantage be obtained from the investment of equivalent funds in other health and fitness initiatives?

Author's Qualifications

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

References

Aitken, J. (1996). *Nixon: A Life*. Washington, D.C.: Regnery Publishing.

Ambrose, S. E. (1987). *The Education of a Politician 1913–1962*. New York, NY: Simon & Schuster.

Andermann, A., Blancquaert, I., Beauchamp, S., and Déry, V. (2008). Revisiting Wilson and Jungner in the genomic age: a review of screening criteria over the past 40 years. *Bull World Health Organ., 86*, 317-319.

Andersen, K. L., Shephard, R. J., Denolin, H., Varnauskas, E., and Masironi, R. (1971). *Fundamentals of exercise testing*. Geneva, Switzerland: World Health Organisation.

Anderson, P. (1998). *The origins of postmodernity*. London, U.K. : Verso.

Anderson, T. W., and Le Riche, W. H. (1970). Ischemic heart disease and sudden death, 1901-1961. *Brit. J. Prev. Soc. Med., 24*, 1-9.

Aoyagi, Y., and Shephard, R., J. (2009). Steps per day- the road to senior health? *Sports Med. , 39*, 423-438.

Aoyagi, Y., and Shephard, R., J. (2011). A model to estimate the potential for a physical activity-induced reduction in health care costs for the elderly, based on pedometer/accelerometer data from the Nakanojo Study. *Sports Med. , 41*, 695-708.

Ashwell, Z., McKay, M. P., Brubacher, J. R., and Gareau, A. (2012). The epidemiology of mountain bike park injuries at the Whistler Bike Park, British Columbia (BC), Canada. *Wilderness Environ. Med., 23*, 140-145.

Āstrand, I. (1967). Degree of strain during building work and its relationship to individual aerobic work capacity. *Ergonomics, 10*, 293-303.

Australian Government. (2010). *Sydney 2009 World Masters Games: Final Report*. Canberra: Australian Government.

Bailey, D. A., Shephard, R. J., and Mirwald, R. (1976). Validation of a self-adminstered home test of cardio-respiratory fitness. *Can. J. Appl. Sports Sci., 1*, 67-78.

Ballantyne, K. N., Kayser, M., and Grootegoed, J. A. (2012). Sex and gender issues in competitive sports: investigation of a historical case leads to a new viewpoint. *Br. J. Sports Med. , 46*, 614-617.

Bamberger, M., and Yaeger, D. (1997). Over the edge. *Sports Illustrated, 14*, 62-70.

Barilleaux, R. J., and Rozell, M. J. (2004). *Power and Prudence:The Presidency of George H. W. Bush*. Austin, TX: Texas A&M University Press.

Barnard, R. J., Edgerton, V. R., Furukawa, T., and Peter, J. B. (1971). Histochemical, biochemical and contractile properties of red, white and intermediate fibers. *Am. J. Physiol., 220*, 410-414.

Barnes, R. M. (1963). *Motion and Time Study*. London, U.K.: Wiley.

Baron, D. A., Martin, D. M., and Magd, S. A. (2007). Doping in sports and its spread to at-risk populations: an international review. *World Psychiatr., 6 (2)*, 118-123.

Bateman, C. (2012). Marathon deaths 'potentially preventable'. *S. Afr, Med. J. , 97*, 492-498.

Bauman, A. (2000). Precepts and principles of mass marketing media evaluations in Australia. *Health Prom. J. Australia, 10*, 89-92.

Bauman, A., Madill, J., Craig, C., and Salmon, A. (2004). ParticipACTION. This mouse roared, but did it get the cheese? *Can. J. Publ. Hlth., 95 (Suppl. 2)*, 16-21.

Beaubien, P. D. (2004). Foreword. *Can. J. Publ. Hlth, 95 (Suppl. 2)*, 54.

Bennell, K., Wajswelner, H., Lew, P., Schall-Riaucour, A., Leslie, S., Plant, D., and Cirone, J. (1998). Isokinetic strength testing does not predict hamstring injury in Australian Rules footballers. *Br. J. Sports Med. , 32*, 309-314.

Benson, M. (2004). *Bill Clinton*. Minneapolis, MN: Lerner.

Bonjer, F. H. (1966). Relationships between physical working capacity and allowable caloric expenditure. In W. Rohmert (Ed.), *Colloquium on muscular exercise and training*. Darmstadt, Germany Gentner Verlag

Bonneau, J. (2001). Evaluating physical competencies. Fitness related tests. Task simulation or hybrid? In N. Gledhill, J. Bonneau and A. Salmon (Eds.), *Bona Fide Occupational Requirements. Proceedings of the consensus forum on establishing BONA FIDE requiremnts for physically*

demanding occupations. Toronto, ON: York University, Toronto.

Bornø, A., Aachmann-Andersen, N. J., Munch-Andersen, T., Hulston, C. J., and Lundby, C. (2010). Screening for recombinant human erythropoietin using [Hb], reticulocytes, the OFF (hr score), OFF (z score) and Hb (z score): Status of the blood passport. *Eur. J. Appl. Physiol. , 109*, 537-543.

Borodulin, K., Laatikainen, T., Juolevi, A., and Jousilahti, P. (2007). Thirty year trends of physical activity in relation to age, calendar time and birth cohort in Finnish adults. *Eur. J. Public Health, 18*, 339-344.

Bouchard, C., Lesage, R., Lortie, G., Simoneau, J.-A., Hamel, P., Boulay, M. R., Pérusse, L., Thériault, G., and Leblanc, C. (1986). Aerobic performance in brothers, dizygotic and monzygotic twins. *Med. Sci. Sports Exerc., 18*, 639-646.

Bouchard, C., Lortie, G., Simoneau, J.-A., Leblanc, C., Thériault, G., and Tremblay, A. (1984). Submaximal power output in adopted and biological siblings. *Ann. Hum. Biol., 11*, 303-309.

Bouchard, C., Sarzynski, M. A., Rice, T. R., Kraus, W. E., Church, T. S., Sung, Y. J., Rao, D. C., and Rankinen, T. (2011). Genomic predictors of the maximal O2 response to standardized exercise training programs. *J. Appl. Physiol., 110*, 1160-1170.

Bouchard, C., Shephard, R., J. , Stephens, T., Sutton, J. R., and McPherson, B. J. (1990). *Exercise, Fitness & Health*. Champaign, IL: Human Kinetics

Bouchard, C., Shephard, R., J., and Stephens, T. (1994). *Physical activity, fitness & health*. Champaign, IL: Human Kinetics.

Bouchard, C., Wolfarth, B., Rivera, M. A., Gagnon, J., and Simoneau, J.-A. (2000). Genetic determinants of endurance performance. In R. J. Shephard and P.-O. Åstrand (Eds.), *Endurance in Sport.* Oxford, U.K.: Blackwell Scientific.

Brownson, R. C., Boehmer, T. K., and Luke, D. A. (2005). Declining rates of physical activity in the United States: What are the contributors? *Annu. Rev. Public Health, 26*, 421-443.

Bryant, J. (2010). *The London Marathon*. London, UK: Random House.

Buckley, W. E., Yesalis, C. E., Friedl, K. E., Anderson, W. A., Streit, A. L., and Wright, J. E. (1988). Estimated prevalence of anabolic steroids use by male adolescents. *JAMA, 260*, 3441–3445.

Buick, F., Gledhill, N., Froese, A. B., Spriet, L., and Meyers, E. C. (1980). Effect of induced erythrocythemia on aerobic work capacity. *J. Appl. Physiol., 48*, 636-642.

Burtscher, M. (2012). Climbing the Himalayas more safely. *BMJ, 344 (7863) 9.*

Bush, G. W. (2010). *Decision Points*. Toronto, ON: Random House Canada.

Butz, T., van Buuren, F., Mellwig, K. P., Langer, C., Plehn, G., Meissner, A., Trappe, H. J., Horstkotte, D., and Faber, L. (2011). Two-dimensional strain analysis of the global and regional myocardial function for the differentiation of pathologic and physiologic left ventricular hypertrophy: a study in athletes and patients with hypertrophic cardiomyopathy. *Int. J. Cardiovasc. Imag., 27*, 91-100.

Campbell, D. (2012). London's Olympic public health legacy: Will it turn to dust? *BMJ, 344*, 19-22.

Campbell, K. (1997). *Time and chance: the political memoirs of Canada's first woman prime minister*. Toronto, ON: Seal Books.

Canada Fitness Survey. (1983). *Fitness and Lifestyle in Canada*. Ottawa, On: Fitness Canada.

Canada Fitness Survey. (1983). *Fitness and lifestyle in Canada*. Ottawa, ON Fitness & Amateur Sport.

Canadian Association for Physical Education and Recreation. (1966). *Fitness Performance Manual*. Toronto, ON: Canadian Association for Physical Education and Recreation.

Canadian Heart Foundation. (2006). *Tipping the Scales of Progress: Heart and Stroke Foundation of Canada releases new data and recommendations on tobacco, obesity and disease prevention* Ottawa, ON: Canadian Heart Foundation.

Canadian Public Health Association. (1979). *Employee fitness project 1978*. Ottawa, ON: Minister of State, Fitness & Amateur Sport.

Canadian Public Health Association. (1983). *National Conference on Fitness in the Third Age, Government Conference Centre, Ottawa, November 8-10, 1982*. Ottawa, ON Canadian Public Health Association

Cantelon, H. (1982). The "Proletarian Culture" movement and its influence on the

International Workers' Sports Organisations in the 1920s. In B. Kidd (Ed.), *Proceedings of the 5th Canadian Symposium on the History of Sport and Physical Education*. Toronto, ON.: University of Toronto School of Physical & Health Education

Centers for Disease Control and Prevention. (2009). Healthier worksite initiative. Atlanta, GA, Author.

Chisholm, D. M., Collis, M. L., Kulak, L. L., Davenport, W., and Gruber, N. (1975). Physical activity readiness. *Br. Col. Med. Jl, 17*, 375-378.

Chodos, R., Hamovitch, E., and Murphy, R. (1998). Paul Martin : a political biography. Toronto, ON: Lorimer.

Chretien, J. (1986). *Straight from the heart*. Toronto, ON: McClelland & Stewart/Bantam.

Church, T. S., Thomas, D. M., Tudor-Locke, C., Katzmarzyk, P. T., Earnest, C.P., Rodarte, R. Q., Martin, C. K., Blair, S. N., and Bouchard, C. (2011). Trends over 5 decades in U.S. occupation-related physical activity and their associations with obesity. *PLoS ONE 6(5): e19657. doi:10.1371/journal.pone.0019657*.

Clark, L. C., Wolf, R., Granger, D., and Taylor, Z. (1953). Continuous recording of blood oxygen tensions by polarography *J. Appl. Physiol. , 6*, 189-193.

Coalter, F. (2004). London, 2012- a sustainable sporting legacy? In A. Vigor and M. Mean (Eds.), *After the Goldrush- a sustainable Olympics in London*. London, UK: Institute for Public Policy Research, Demos.

Cohen, A. (2008). *Lester B. Pearson*. Toronto, ON: Penguin.

Colley, R. C., Garriguet, D., Janssen, I., Craig, C. L., Clark, J., and Tremblay, M. (2011). Physical activity of Canadian adults: Accelerometer results from the 2007 to 2009 Canadian Health Measures Survey. *Health Rep., 22, 82-003-X.*

Collier, R. (2008). Most Paralympians inspire, but others cheat. *Can. Med. Assoc. J. , 179*, 624.

Collis, M. L. (1976). *Employee Fitness*. Ottawa, ON: Fitness & Amateur Sport.

Cooley, J. K. (1973). *Green March, Black September: the story of the Palestinian Arabs*. London, U.K.: Frank Cass.

Cooper, C. E. (2012). *Run, swim, throw, cheat : the science behind drugs in sport*. Oxford, U.K.: Oxford University Press.

Cooper, K.H. (1968). A means of assessing maximal oxygen intake. Correlation between field and treadmill testing. *JAMA, 203*, 201-204.

Cooper, R., Cutler, J., \DesvigneNickens, P., Fortmann, S. P., Friedman, L., Havlik, R., Hogelin, G., Marler, J., McGovern, P., Morosco, G., Mosca, L., Pearson, T., Stamler, J., Stryer, D., and Thom, T. (2000). Trends and disparities in coronary heart disease, stroke, and other cardiovascular diseases in the United States. *Circulation, 102*, 3137-3147.

Corrado, D., Basso, C., Pavei, A., Michieli, P., Schiavon, M., and Thiene, G. (2006). Trends in sudden cardiovascular death in young competitive athletes after implementation of a preparticipation screening program. *JAMA, 296*, 1593-1601.

Corrado, D., Pellicia, A., and Heidbuchel, H. et al. (2010). Recommendations for interpretation of 12-lead electrocardiogram in the athlete. *Eur. Heart J., 31*, 243-259.

Coulter, W. H. (1953). Means for Counting Particles Suspended in a Fluid. Washington, DC: U.S. Patent Office,

Craig, C. L., Russell, S. J., Cameron, C., and Bauman, A. (2004). Twenty-year trends in physical activity among Canadian adults. *Can. J. Public Health, 95*, 59-63.

Crouter, S. E., Antczak, A., Hudak, J. R., Della Valle, D. M., and Haas, J. D. (2008). Accuracy and reliability of the ParvoMedics TrueOne 2400 and Medigraphics VO2000 metabolic systems *Eur. J. Appl. Physiol., 98*, 139-151.

Cumming, G. R., and Glenn, J. (1977). Evaluation of the Canadian Home Fitness Test in middle-aged men. *Can. Med. Assoc. J., 116*, 472-473.

Cumming, G. R., and Keynes, R. (1967). A fitness performance test for school children and its correlation with physical working capacity and maximal oxygen uptake. *Can. Med. Assoc. J. , 96*, 1262-1269

Cunningham, D. A., Rechnitzer, P. A., Jones, N. L., Andrew, G. M., Kavanagh, T., Parker, J. O., Shephard, R. J., and Sutton, J. R. (1990). The issue of poor compliance in exercise

trials: A place for post-hoc analyses? . *Sports Training, Med. Rehab., 2*, 131-139.

Dallek, R. (2011). *John F. Kennedy*. New York, NY: Oxford University Press.

Davis, J. A., Whipp, B. J., and Wasserman, K. (1980). The relation of ventilation to metabolic rate during moderate exercise in man. *Eur. J. Appl. Physiol. , 44*, 97-108.

Daynes, H., and Shakespear, G. (1920). The theory of the katharometer. *Proc. Roy. Soc. Lond , 97*, 273-286.

DeJong, J. R. (1967). The contribution of ergonomics to work study. *Ergonomics 10*, 579-588.

Dekker, D. L., Piziali, R. L., and Dong, E. R. (1974). A system for ultrasonically imaging the human heart in three dimensions. *Comput. Biomed. Res., 7*, 544-553.

Derderian, T. (1996). *Boston Marathon: The First Century of the World's Premier Running Event*. Champaign, IL: Human Kinetics .

Dittrich, W., and Gohde, W. (1969). Impulsfluoremetrie bei Einzelzellen in Suspensionen [Impulse fluorometry of single cells in suspension]. *Z. Naturforsch. - Teil B - Anorganische Chemie, Organische Chemie, Biochemie, Biophysik, Biologie, 24* 360-361.

Doran, D. A., and Reay, M. (2000). Injuries and associated training and performance characteristics in recreational rock climbers. In N. Messenger, W. Patterson and D. Brook (Eds.), *The Science of Climbing and Mountaineering*. Champaign, IL: Human Kinetics.

Drake, V., Jones, G., Brown, J. R., and Shephard, R. J. (1968). Fitness performance tests and their relationship to maximum oxygen uptake. *Can. Med. Assoc. J. , 99*, 844-848.

Dubois, A. B., Fowler, R. C., Soffer, A., and Fenn, W. O. (1952). Alveolar CO2 measured by expiration into the rapid infrared gas analyser. *J. Appl. Physiol. , 4*, 526-534.

Edler, I., and Lunstorm, K. (1954). History of echocardiography. *Ultrasound Med. Biol., 30*, 1565-1644.

Edwards, P. (2004). No country mouse. Thirty years of effective marketing and health communications. *Can. J. Publ. Hlth., 95 (Suppl. 2)*, 8-15.

Eid, E. (2001). Challenges posed by the Supreme Court of Canada in the Meiorin decision to employers in physically demanding occupations. In N. Gledhill, J. Bonneau and A. Salmon (Eds.), *Bona Fide Occupational Requirements. Proceedings of the consensus forum on establishing BONA FIDE requirements for physically demanding occupations* (pp. 53-61). Toronto, ON: York University.

Engel, W. K. (1962). The essentility of histo- and cytochemical studies of skeletal muscle in the investigation of neuromuscular disease. *Neurol., 12*, 778-784.

Feigenbaum, H. (1996). Evolution of echocardiography. *Circulation 93*, 1321-1327.

Fleisch, A. (1952). Métabographie: appareils pour l'enregistrement de la consommation d'oxygène, la production de dioxyde de carbone, le quotient respiratoire et de la dette d'oxygène (Metabography; apparatus for the direct measurement of oxygen consumption, carbon dioxide production, respiratory quotient and oxygen debt. *J. Physiol. (Paris) 44*, 615-616.

Fleisch, A. (1954). *Nouvelles méthodes d'études des échanges gazeux et de la fonction pulmonaire (New methods of studying gas exchange and pulmonary function)*. Basel, Switzerland: Benno Schwabe & Co. .

Food and Agriculture Organisation. (2009). The double burden of malnutrition Case studies from six developing countries. Geneva, Switzerland, Author.

Fort, E., and Stevens, D. (2010). *Sporting scandals: Doping scandals, including Ben Johnson, Marion Jones, USC Steroid, BALCO, the Mitchell Report, and the 2007 Tour de France*. Charelston, SC: Bibliobazaar.

Fowler, R. C. (1949). A rapid infra-red gas analyzer *Rev. Sci. Instr., 20*, 175-178.

Fulwyler, M. J. (1965). Electronic separation of biologicl cells by volume. *Science, 150* 910-911.

Gabriel, H., and Kindermann, W. (1995). Flow cytometry. Principles and applications in exercise immunology *Sports Med., 20* 302-320.

Garvican, L. A., Eastwood, A., Martin, D. T., Ross, M. L., Grippe, A., and Gore, C. J. (2010). Stability of hemoglobin mass during a 6-day UCI Pro tour cycling race. *Clin. J. Sports Med., 20*, 200-204.

Gherman, B. (2003). *Jimmy Carter*. Minneapolis, MN: Twenty-first Century Books.

Gledhill, N., Bonneau, J., and Salmon, A. (2001). *Bona Fide Occupational Requirements. Proceedings of the consensus forum on establishing BONA FIDE requirements for physically demanding occupations*. Toronto, ON: York University.

Gledhill, N., and Jamnik, V. (2003). *Canadian Physical Activity, Fitness and Lifestyle Approach* (3rd ed.). Ottawa: Canadian Society for Exercise Physiology.

Godin, G., and Shephard, R., J. (1990). Use of attitude-behaviour models in exercise promotion. *Sports Med., 10*, 241-250.

Goetzel, R. Z., and Ozminkowski, R. J. (2008). The health and cost benefits of work site health-promotion programs. *Annu. Rev. Publ. Health, 29*, 303=323.

Gormley, B. (2000). *President George W. Bush: Our Forty-Third President.* New York, NY: Simon & Schuster.

Greene, J. R. (1885). *The Presidency of Gerald R. Ford*. Lawrence, KS, University of Kansas Press.

Harris, J. F. (2006). *The Survivor: Bill Clinton in the White House*. New York, NY: Random House.

Hart, P. (2004). *Windsurfing*. Ramsbury, Wilts, U.K.: Crowood.

Hausswirth, C., Bigard, A.X., and Chevalier, J. M. (1997). The Cosmed K4 telemetry system as an accurate device for oxygen uptake measurements during exercise. *Int. J. Sports Med. , 18*, 449-453.

Horvath, S.M., and Horvath, E.C. (1973). *The Harvard Fatigue Laboratory: Its history and contributions*. Englewood Cliffs, NJ: Prentice-Hall.

House of Commons Select Committee on Culture, Medicine and Science (2007). *2012 Olympic Games and Paralympic Games: funding and legacy*. London, UK: H,M, Stationery Office.

Howell, M. L., and MacNab, R. B. J. (1968). *The physical work capacity of Canadian children 7-17 years*. Ottawa, ON.: Canadian Association of Health, Physical Education and Recreation.

Hsu, A. R., Barnholt, K. E., Grundmann, N. K., Lin, J. H., McCallum, S. W., and Friedlander, A. L. (2006). Sildenafil improves cardiac output and exercise performance during acute hypoxia, but not normoxia. *J. Appl. Physiol , 100*, 2031–2040.

Humphreys, D. L. (1978). *Joe Clark: A portrait*. Ottawa, ON: Deneau & Greenberg.

Hunter, J. A., Stacy, R. W., and Hitchcock, F. A. (1949). A mass spectrometer for continuous gas analysis. *Rev. Sci. Instr., 20*, 333-336.

International Olympic Committee. (2009). *Sport as a vehicle for social change: 4th World Conference on Women and Sport*. Lausanne, Switzerland: International Olympic Committee.

Jackson, S. S. (1975). *Diffusion of an innovation. An exploratory study of the consequences of Sport Participation Canada's campaign at Saskatoon.* Edmonton, AL: University of Alberta.

James, W. P. (2008). The fundamental drivers of the obesity epidemic. *Obes. Res., 9 (Suppl. 1)*, 6-13.

Janssen, I. (2007). Physical activity guidelines for children and youth *Appl. Physiol. Nutr. Metab., 32 (Suppl. 2E)*, S109-S121.

Johnson, B. (2010). *Seoul to soul*. Markham, ON: Ben Johnson Enterprises.

Jones, N. L., and Kane, M. (1979). Inter-laboratory standardization of methodology. *Med. Sci. Sports, 11*, 368-372.

Jonson, B., Werner, O., Jansson, L., Johansson, K., Olsson, L. G., and Westling, H. (1976). A system for computer-assisted ECG recording at rest and exercise. *Scand. J. Clin. Lab. Invest., 145 (Suppl.)*, 7-21.

Karpovich, P. V. (1944). Physical training for flyers. *Air Surg. Bull. , 1*, 24-25.

Kavanagh, T., Lindley, L. J., Shephard, R. J., and Campbell, R. (1988). Health and socio-demographic characteristics of the Masters competitors. *Ann. Sports Med , 4*, 55-64.

Kavanagh, T., and Shephard, R., J. (1977). On the choice of fluid for the hydration of middle-aged marathon runners. *Br. J. Sports Med , 11*, 26-35

Kavanagh, T., Shephard, R., J., and Pandit, V. (1974). Marathon running after myocardial infarction. *J.A.M.A., 229*, 1602-1605.

Keilani, M., Krall, C., Lipowec, L., Posch, M., Komanadj, T., and Crevenna, R. (2010). Skateboarding injuries in Vienna: location, frequency, and severity. *PM R. 2010 Jul;2(7):619-624.*

Kesaniemi, F. A., Danforth, E., Jensen, M. D., Kopelman, P. G., Lefèbvre, P., and Reeder,

B. A. (2001). Dose-response issues concerning physical activity and health: An evidence based symposium. *Med. Sci. Sports Exerc,, 33 (Suppl. 6)*, S351-S358.

Klissouras, V. (1972). Genetic limits of functional ability. *Int. Z. Angew. Physiol., 30*, 85-94.

Kraus, H., and Hirschland, R. (1954). Minimum muscular fitness tests in school children. *Res. Quart., 25*, 178-188.

Krishnamoorthy, V. K., Sengupta, P. P., Gentile, F., and Khandheria, B. K. (2007). History of echocardiography and its future applications in medicine. *Crit. Care Med., 35 (*Suppl.)*, S309-S313.

Lagarde, F. (2004). The challenge of blingualism. ParticipACTION campaigns succeeded in two languages. *Can, J. Publ. Hlth., 95 (Suppl. 2)*, 32-34.

LaGerche, A., Connelly, K. A., Mooney, D. J., MacIsaac, A. I., and Prior, D. L. (2008). Biochemical and functional abnormalities of left and right ventricular function after ultra-endurance exercise. *Heart, 94*, 860-866.

Lalonde, M. (1974). *A new perspective on the health of Canadians. A working document.* Ottawa, ON: Government of Canada.

LaPorte, W. (1966). The influence of a gymnastic pause upon recovery following post-office work. *Ergonomics, 9*, 501-506.

LaPorte, W. (1970). *La gymnastique de pause dans l'entreprise (The gymnastic pause in industry)*. Brussels, Belgium Editions de l'Administration de l'Education Physique des Sports.

Lawler, D. (2012). *Frequently asked questions on bribery and corruption*. Chichester, U.K.: John Wiley.

Lawrence, M. (2003). *Iron man : the defiant reign of Jean Chrétien*. Toronto, ON: Viking.

Lawrie, R. A. (1953). The activity of the cytochrome system in in muscle and its relation to myoglobin *Biochem. J., 55*, 298-305.

Lemco, J. (1994). *National health care: lessons for the United States and Canada*. Ann Arbor, MI: University of Michigan Press.

Levine, B. D., and Stray-Gundersen, J. (1997). "Living high-training low": effect of moderate-altitude acclimatization with low-altitude training on performance. *J. Appl. Physiol. , 83* 102-112.

Linnan, L., Bowling, M., Childress, J., Lindsay, G., Blakey, C., Pronk, S., Wieker, W., and Royall, P. (2008). Results of the 2004 National Worksite Health Promotion Survey. *Am. J. Public Health, 98*, 1503–1509.

Litt, P. (2011). *Elusive destiny : the political vocation of John Napier Turner*. Vancouver, BC: UBC Press.

Mackey, L. (2005). *The Pilgrimage of Stephen Harper*. Toronto, ON: ECW Press.

Mansfield, S. (2004). *The Faith of George W. Bush*. New York, NY: Penguin.

Maraniss, D. (2008). *Barack Obama: The Story*. New York, NY: Simon & Schuster.

Marcus, B. H., Owen, N., Forsyth, L. H., Cavill, N. A., and Fridinger, F. (1998). Physical activity interventions using mass media, print media, and information technology. *Am. J. Prev. Med. , 15*, 362-378.

Maron, B. J., Thompson, P. D., Ackerman, M. J., G., B., Berger, S., Cohen, D., Dimeff, R., Douglas, P. S., Glover, D. W., Hutter, A. M., Krauss, M. D., Maron, M. S., Mitten, M. J., Roberts, W.O., Puffer, J. C., and American Heart Association Council on Nutrition, P. A., and Metabolism. (2007). Recommendations and considerations related to preparticipation screening for cardiovascular abnormalities in competitive athletes: 2007 update: a scientific statementfrom the American Heart Association Council on Nutrition, Physical Activity, and Metabolism: endorsed by the American College of Cardiology Foundation. *Circulation, 115*, 1643-1655.

Martin, P. P., and Weaver, D. A. (2005). Social Security: A Program and Policy History. *Soc. Sec. Bull , 66 (1) On-line document, accessed Sept. 1st 2012*.

McFarlane, D. J. (2001). Automated metabolic gas analysis systems. *Sports Med., 31*, 841-861.

Meyers, J. H. (1987). *Decreasing barriers- a blueprint for workplace health in the nineties*. Dallas, TX American Heart Association

Moldovan, A. (1934). Photoelectric technique for the counting of microscopical cells. *Science, 80*, 188-189

Moldoveanu, A. I., Shephard, R. J., and Shek, P. N. (1995). Exercise elevates plasma levels but not gene expression of IL-1b, IL-6, and TNF-a in blood mononuclear cells *J. Appl. Physiol., 89* 1499-1504

Morrison, T. (1998 (October)). Clinton as the first Black President. *The New Yorker*.

Moss, R. L., Diffee, G. M., and Greaser, M. L. (1995). *Contractile properties of skeletal muscle fibers in relation to myofibrillar protein isoforms*. ew York, NY: Springer.

Mundel, M. E. (1950). *Motion and Time Study.* New York, NY: Prentice-Hall.

Myers, T. (2011). Blistered and bleeding, tired and determined: Visual representations of children and youth in the Miles for Millions Walkathon. *J. Can. Hist. Assoc. , 22*, 245-275.

National Department of Health and Welfare. (1986). *Achieving Health for all: A framework for health promotion*. Ottawa, ON: National Dept. of Health & Welfare.

National Institute for Occupational Safety and Health. (2012). Total worker health. Atlanta, GA, Author.

Neilan, T. G., Januzzi, J. L., Lee-Lewandrowski, E., Ton-Nu, T. T., Yoerger, D. M., Jassal, D. S., Lewandrowski, K. B., Siegel, A. J., Marshall, J. E., Douglas, P. S., Lawlor, D., Picard, M. H., and Wood, M. J. (2006). Magnetic resonance imaging of myocardial injury and ventricular dysfunction related to training levels among nonelite participants in the Boston marathon. *Circulation 120*, 143-152.

Newman, P. (2006). *The secret Mulroney tapes: Unguarded confessions of a Prime Minister,*. Toronto, ON: Vintage Canada.

Noakes, T. D. (2008). How did A.V. Hill understand the VO2 max and the "plateau phenomenon"? Still no clarity. *Br. J. Sports Med. , 42*, 574-580.

Noakes, T. D. (2011). Changes in body mass alone explain almost all of the variance in serum sodium concentrations during prolonged exercise. Has commercial influence impeded scientific endeavour? *Br. J. Sports Med. , 45*, 475-477.

Noakes, T. D., and Marino, F. E. (2009). Maximal oxygen intake is limited by a central nervous system governor. *J. Appl. Physiol., 106*, 338-339.

Noakes, T. D., Peltonen, J. E., and Rusko, H. K. (2001). Evidence that a central governor regulates exercise performance during acute hypxia and hyperoxia *J. Exp. Biol. , 204 (Pt. 18)*, 3225-3234.

Noakes, T. D., and Speedy, D. B. (2007). Lobbyists for the sports drink industry: an example of the rise of "contrarianism" in modern scientific debate. *Br. J. Sports Med., 41*, 107-109.

Nolan, M. (1978). *Joe Clark : the emerging leader*. Don Mills, ON: Fitzhenry & Whiteside.

Norman, A., Bellocco, R., Vaida, F., and Wolk, A. (2003). Age and temporal trends of total physical activity in Swedish men. *Med. Sci. Sports Exerc., 35*, 617-622.

Nowak, M. R., Kirkpatrick, A. W., Bouffard, J. A., Amponsah, D., and Dulchavsky, S. A. (2009). Snowboarding injuries: a review of the literature and an analysis of the potential use of portable ultrasound for mountainside diagnostic. *Curr. Rev. Musculoskelet Med., 2*, 25-29.

O'Dowd, A. (2012). Olympic drug testing centre will house new $10m research facility. *BMJ, 345:e5233*.

Oborne, D. J. (1982). *Ergonomics at work.* Chichester, U.K.: Wiley.

Okada, K., and Iseki, T. (1990). Effect of a ten-year corporate fitness program on employee's health. In M. Kaneko (Ed.), *Fitness for the aged, disabled and industrial worker*. Champaign, IL: Human Kinetics.

Orban, W. R. (1961). *The Royal Canadian Air Force 5BX program for men*. Ottawa, ON: The Queen's Printer.

Ory, M., Kinney-Hoffman, M., Hawkins, M., Sanner, B., and Mockenhaupt, R. (2003). Challenging aging stereotypes: Strategies for creating a more active society. *Am. J. Prev. Med. , 25*, 164-171.

Pappous, A. (2011). Do the Olympic Games lead to a sustainable increase in grass roots sport participation? A secondary analysis of Athens 2004. In J. Savery and K. Gilbert (Eds.), *Sustainability and sport*. Chicago, IL: Common Ground Publishing.

Parker, J. J. (2007). *Lyndon Johnson*. Bloomington, IN: XLibris Corporation.

Paterson, D. H., Jones, G. R., and Rice, C. L. (2007). Ageing and physical activity: evidence to develop exercise recommendations for older adults. *Appl. Physiol. Nutr. Metab, 32 (Suppl. 2E)*, S69-S108.

Pedersen, B. K., Steensberg, A., Fischer, C., Keller, C., Keller, P., Plomgaard, P., Wolsk-Petersen, E., and Febbraio, M. (2004). The metabolic role of IL-6 produced during exercise: is IL-6 an exercise factor? *Proc. Nutr. Soc., 63* 263-267

Pelliccia, A., Maron, M. S., and Maron, B. J. (2012). Assessment of left ventricular hypertrophy in a trained athlete: differential diagnosis of physiologic athlete's heart from pathologic hypertrophy. *Prog. Cardiovasc. Dis., 54*, 387-396.

Pelliccia, A., Kinoshita, N., Pisichio, C., Quattrini, F., Dipaolo, F. M., Ciardo, R., Di Giacinto, B., Guerra, E., De Blasiis, E., Casasco, M., Culasso, F., and Maron, B. J. (2012a). Long-term consequences of intense uninterrupted training in Olympic athletes. *J. Am. Coll. Cardiol. , 55*, 1619-1625.

Pett, L. B., and Ogilvie, G. F. (1956). The report on average Canadian heights, weights and skinfolds. *Hum. Biol. , 28*, 177-188.

Pigalev, S. A. (1963). Worksite gymnastics at the Votkinskii machine factory *Teor. Prakt. Fiz. Koult. , 36 (9)*, 57-58.

Pope, H. G., Katz, D. L., and Champoux, R. (1988). Anabolic-androgenic steroid use among 1,010 college men. *Phys. Sports Med., 16 (7)*, 75-81.

Pravosudov, V. P. (1978). Effects of physical exercises on health and economic efficiency. In W. A. R. Orban (Ed.), *Physical activity and human well-being* (pp. 261-271). Miami, FL: Symposia Specialists.

Prince, S. A., Adamo, K. B., Hamel, M. E., Hardt, J., Gorber, S. C., and Tremblay, M. (2008). A comparison of direct versus self-report measures for assessing physical activity in adults: A systematic review. *Int. J. Behav. Nutr. Activity, Nov 6; 5:56.*

Prior, G. (1999). Physical activity. In B. Erens and P. Primatesta (Eds.), *Health Survey for England & Wales. Cardiovascular Disease*. London, U.K.: Her Majesty's Stationery Office.

Radak, Z., Hart, N., Sarga, L., Koltai, E., Atalay, M., Ohno, H., and Boldogh, I. (2010). Exercise plays a preventive role against Alzheimer's disease. *J. Alzheimers Dis., 20*, 777-783.

Rechnitzer, P. A., Sangal, S., Cunningham, D., Andrew, G., Buck, C., Jones, N. L., Kavanagh, T., Parker, J. O., Shephard, R. J., and Yuhasz, M. S. (1975). A controlled prospective study of the effect of endurance training on the recurrence rate of myocardial infarction. *Am. J. Epidemiol. , 102*, 358-365.

Rechnitzer, P. A., Cunningham, D., Andrew, G., Buck, C., Jones, N. L., Kavanagh, T., Oldridge, N. B., Parker, J. O., Shephard, R., J., Sutton, J. R., and Donner, A. P. (1983). The relationship of exercise to the recurrence rate of myocardial infarction in men- Ontario Exercise-Heart Collaborative Study. *Am. J. Cardiol., 51*, 65-69.

Reeve, S. (2011). *One day in September: the full story of the 1972 Munich Olympics massacre and the Israeli revenge operation "Wrath of God" : with a new epilogue*. New York, NY: Arcade.

Rode, A., and Shephard, R. J. (1993). Acculturation and loss of fitness in the Inuit: the preventive role of active leisure. *Arctic Medical Research 52*, 107-112.

Roe, P. G., Tyler, C. K., Tennant, R., and Barnes, P. K. (1987). Oxygen analyzers. An evaluation of five fuel cell models. *Anaesthesia, 42*, 178-181.

Román-Viñas, B., Serra-Majem, L., Ribas-Barba, L., Roure-Cuspinera, E., Cabezas, C., Vallbona, C., and Plasencia, A. (2007). Trends in physical activity status in Catalonia, Spain (1992-2003). *Public Health Nutr., Nov; 10(11A):1389-95.*

Rosen, D. M. (2008). *Dope : a history of performance enhancement in sports from the nineteenth century to today*. Westport, Conn: Praeger Publications.

Roth, H. J., Leithäuser, R. M., Doppelmayr, H., Doppelmayr, M., Finkernagel, H., von Duvillard, S. P., Korff, S., Katus, H. A., Giannitsis, E., and Beneke, R. (2007). ardiospecificity of the 3rd generation cardiac troponin T assay during and after a 216 km ultra-endurance marathon run in Death Valley. *Clin. Res. Cardiol., 96*, 359-364.

Saltin, B., and Hermansen, L. (1967). Glycogen stores and prolonged severe exercise. In G. Blix (Ed.), *Nutrition and Physical Activity*. Uppsala, Sweden: Almqvist & Wiksell.

Sawatzky, J. (1992). *Mulroney: The politics of ambition*. Toronto, ON: McClelland & Stewart.

Scrivener, L. (2010). *Terry Fox: His Story*. Toronto, ON: Random House.

Severinghaus, J. W., and Bradley, A. F. (1958). Electrodes for blood pO2 and pCO2

determination. *J. Appl. Physiol., 13*, 515-520.

Sharratt, M. T., and Hearst, W. E. (2007). Canada's physical activity guides: background, process, and development. *Appl. Physiol. Nutr. Metab. 32 (Suppl. 2E)*, S9-S15.

Shave, R., and Oxbrough, D. (2012). Exercise-induced cardiac injury: Evidence from novel imaging techniques and highly sensitive cardiac troponin assays. *Prog, Cardiovasc. Dis. , 54*, 407-415.

Shea-Simonds, C. (1971). *Sport parachuting*. New York, NY: Black.

Shephard, R., J. (1955). Pneumotachographic measurement of breathing capacity *Thorax, 10*, 258-268

Shephard, R. J. (1966). World standards of cardiorespiratory performance. *AMA Arch. Envir. Hlalth 13*, 664-672.

Shephard, R. J. (1967a). Guest Editor. Proceedings of the International Symposium on Physical Activity & Cardiovascular Health. *Can. Med. Assoc. J. , 96*, 695-915.

Shephard, R., J. (1970). The validity of the oxygen conductance equation. *Int. Z. angew. Physiol., 28*, 61-75.

Shephard, R. J. (1978). *Human physiological work capacity*. Cambridge, U.K.: Cambridge University Press.

Shephard, R., J. (1981). *Ischemic heart disease and exercise*. London, U.K. : Croom Helm

Shephard, R. J. (1982). The daily workload of the postal carrier. *J. Hum. Ergol., 11*, 157-164.

Shephard, R. J. (1983). Equal opportunity for a geriatric labor force. Some observations on marine surveying. *J. Occup. Med. , 25*, 211-214.

Shephard, R. J. (1986). *Fitness of a Nation: Lessons from the Canada Fitness Survey*. Basel, Switzerland: Karger.

Shephard, R., J. (1986a). *Economic benefits of enhanced fitness*. Champaign, IL: Human Kinetics.

Shephard, R. J. (1986b). Exercise in coronary heart disease. *Sports Med.*\, *3*, 26-49.

Shephard, R. J. (1990). Assessments of occupational fitness in the context of Human Rights legislation. *Can. J. Sport Sci., 15*, 89-95.

Shephard, R. J. (1991). Historical perspective. A sort history of occupational fitness and health promotion. *Prev. Med. , 20*, 435-445.

Shephard, R. J. (1991a). Occupational demand and human rights: Public safety and cardiorespiratory fitness. *Sports Med., 12*, 94-109.

Shephard, R., J. (1996). The athlete's heart: Is big beautiful? *Br. J. Sports Med. , 30* 5-10.

Shephard, R. J. (1997). *Aging, physical activity and health*. Champaign, IL: Human Kinetics.

Shephard, R. J. (2000). Special feature for the Olympics: effects of exercise on the immune system: overview of the epidemiology of exercise immunology. *Immunology & Cell Biology, 78* 485-495 Shephard, R., J. (2002). Whistler 2001: A Health Canada/CDC Conference on "Communicating physical activity and health messages- science into practice". *Am. J. Prev. Med., 23*, 221-225.

Shephard, R., J. (2003a). Regression to the mean. A threat to exercise science? *Sports Med., 33*, 575-584.

Shephard, R. J. (2003b). What is the physical activity message, and how do we get it across? In R. Shephard, J., M. J. L. Alexander, R. C. Cantu, W. M. Kohrt, D. C. Nieman and I. Shrier (Eds.), *Year Book of Sports Medicine 2003*. Philadelphia, PA: Mosby/Elsevier.

Shephard, R. J. (2007). Guest Editor. Advancing physical activity measurement and guidelines in Canada: A scientific review and evidence-based foundation for the future of Canadian physical activity guidelines. *Appl. Physiol. Nutr. Metab., 32 (Suppl. 2E)*, S1-S224.

Shephard, R., J. (2009a). Is it time to retire the Central Governor? *Sports Med., 39*, 709-721.

Shephard, R. J. (2009b). The future of Masters Games: Implications for policy and research. In J. Baker, S. Horton and P. Weir (Eds.), *The Mastewrs athlete: Understanding the role of sport and exzercise in optimizing aging*. London, UK: Routledge.

Shephard, R. J. (2011). The developing understanding of human health and fitness. 1. Prehistory. *Health Fitness J. Canada,* 4(4), 3-19.

Shephard, R., J. (2011a). Is electrocardiogram screening of North American athletes now warranted? . *Clin. J. Sports Med. , 21*, 189-191.

Shephard, R. J. (2011b). Suppression of information on the prevalence and prevention of exercise-associated hyponatraemia. *Br. J. Sports Med., 45*, 1238-1242.

Shephard, R., J. (2011c). Mandatory ECG screening of athletes. Is this question now resolved? *Sports Med. , 41*, 981-1002.

Shephard, R. J. (2012a). The developing understanding of human health and fitness. 2. Early city life. *Health Fitness J. Canada*, 5(1), 27-46.

Shephard, R. J. (2012b). The developing understanding of human health and fitness: 3. The classical era. *Health Fitness J. Can.,* 5(2), 3-29.

Shephard, R. J. (2012c). The developing understanding of health and finess. 4. Middle Ages. *Health Fitness J. Can.* 5(3), 18-46.

Shephard, R. J. (2012d). The developing understanding of health and fitness: 5. The Renaissance. *Health Fitness J. Canada*,5(4), 15-29.

Shephard, R. J. (2013a). The developing understanding of health and fitness: 6. The Enlightenment. *Health Fitness J. Canada*. 6(1), 82-118.

Shephard, R. J. (2013b). The developing understanding of health and fitness: 7. Victorian times. *Health Fitness J.Canada,* 6(2), 3-83.

Shephard, R. J. (2013c). The developing understanding of health and fitness, 8: The Modern Era. *Health Fitness J. Can.,* 6(3), 3-113.

Shephard, R., J. (2013d). History of Exercise Immunology. In C. Tipton (Ed.), *History of exercise physiology*. Champaign, IL.: Human Kinetics.

Shephard, R., J., and Kavanagh, T. (1975). Biochemical changes with marathon running-, observations on post-coronary patients. In J. R. Poortmans and H. Howald (Eds.), *Metabolic adaptations to prolonged exercise*. Basel, Switzerland: Karger.

Shephard, R. J., and Rode, A. (1996). *The health consequences of 'modernization'*. Cambridge, U.K.: Cambridge University Press.

Shephard, R. J., and Âstrand, P.-O. (2000). *Endurance in Sport* Oxford, UK: Blackwell Scientific.

Shephard, R. J., and Trudeau, F. (2005). Lessons learned from the Trois-Rivières physical education study: A retrospective. *Pediatr. Ex. Sci., 17*, 112-123.

Shephard, R., J., and Aoyagi, Y. (2010). Objective monitoring of physical activity in older adults: clinical and practical applications *Phys. Therap. Rev., 15*, 170-182.

Shephard, R. J., and Aoyagi, Y. (2012). Measurement of human energy expenditure, with particular reference to field studies. An historical perspective *Eur. J. Appl. Physiol. , 112*, 2785-2815.

Shephard, R. J., Allen, C., Benade, A. J. S., Davies, C. T. M., di Prampero, P. E., Hedman, R., Merriman, J. E., Myhre, K., and Simmons, R. (1968a). The maximum oxygen intake- an international reference standard of cardiorespiratory fitness. *Bull. W.H.O. , 38*, 757-764.

Shephard, R. J., Allen, C., Benade, A. J. S., Davies, C. T. M., di Prampero, P. E., Hedman, R., Merriman, J. E., Myhre, K., and Simmons, R. (1968b). Standardization of submaximal exercise tests. *Bull. W.H.O. , 38*, 765-776.

Shephard, R. J., Allen, C., Bar-Or, O., Davies, C. T. M., Degré, S., Hedman, R., Ishii, K., Kaneko, M., LaCour, J. R., di Prampero, P. E., and Seliger, V. (1969). The working capacity of Toronto school children *Can. Med. Ass. J. , 100*, 560-566; 705-714.

Shephard, R. J., Gannon, G., Hay, J. B., and Shek, P. N. (2000). Adhesion molecule expression in acute and chronic exercise. *Crit. Rev. Immunol., 20* 245-266

Shephard, R. J., Kavanagh, T., Mertens, D. J., Qureshi, S., and Clark, M. (1995). Personal health benefits of Master's competition. *Br. J. Sports Med., 29*, 35-40.

Shephard, R. J., Park, H., Park, S., and Aoyagi, Y. (2013). Objectively measured physical activity and calcaneal bone health in older Japanese adults: longitudinal data from the Nakonojo study. *Osteoporosis Internat., In press*.

Shephard, R. J., Prien, E., and Hughes, G. (1988a). Age resatrictions on bus driver selection. *J. Human Ergol., 17*, 119-138.

Shephard, R. J., Rankinen, T., and Bouchard, C. (2004). Test-retest errors and the apparent heterogeneity of training response. *Eur. J. Appl. Physiol., 91*, 199-203.

Shephard, R. J., Vandewalle, H., Bouhlel, E., and Monod, H. (1988b). Muscle mass as a factor limiting physical work. *J. Appl. Physiol., 64*, 1472-1479.

Shields, M. (2005). *The obesity epidemic in Canada*. Ottawa, ON : Parliament of Canada.

Simpson, J. L., Ljungqvist, A., de la Chapelle, A., Ferguson-Smith, M. A., Genel, M., Carlson, A. S., Ehrhardt, A. A., and Ferris, E. (1993). Gender verification in competitive sports. *Sports Med., 16*, 305–315.

Simpson, J. L., Ljungqvist, A., and Ferguson-Smith, M. A. (2000). Gender verification in the Olympics. *JAMA, 284*, 1568-1569.

Sonksen, P. H. (2001). Insulin, growth hormone and sport. *J. Endocrinol., 170*, 13–25.

Southam, N. (2005). *Pierre: Colleagues and friends Talk about the Trudeau they knew*. Toronto, ON: McLelland & Stewart.

Spriet, L., Gledhill, N., Froese, A. B., and Wilkes, D. L. (1986). Effect of graded erythrocythemia on cardiovascular and metabolic responses to exercise. *J. Appl. Physiol., 61*, 1942-1948.

Spriet, L. L., Gledhill, N., Froese, A. B., Wilkes, D. L., and Meyers, E. C. (1980). The effect of induced erythrocythemia on central circulation and oxygen transport during maximal exercise. *Med. Sci. Sports Exerc., 12*, 122-123.

Stahl, L. (1999). *Reporting live*. New York, NY: Simon & Schuster.

Starky, S. (2005). *The obesity epidemic in Canada*. Ottawa, ON: Parliament of Canada.

Statistics Canada. (2005). *Sports participation in Canada*. Ottawa, ON: Statistics Canada.

Statistics Canada. (2007-2009). *Canadian Health Measures Survey*. Ottawa, On: Statistics Canada.

Statistics Canada. (2012). Life expectancy at birth by sex and Province. *Electronic data source* http://www.statcan.gc.ca/tables-tableaux/sum-som/l01/cst01/health26-eng.htm *Acceessed 18th August 2012.*

Suozzo, A. G. (2006). *The Chicago Marathon*. Urbana, IL: University of Illinois Press.

Tharp, G. D., and Barnes, M. W. (1990). Reduction of saliva immunoglobulin levels by swim training. *Eur. J. Appl. Physiol., 60* 61-64

Thistle, H. G., Hislop, H. J., Moffroid, M., and Lowman, E. W. (1967). Isokinetic contraction: A new concept of resistive exercise. *Arch. Phys. Med. Rehabil., 48*, 279-282.

Thomas, S., Reading, J., and Shephard, R. J. (1992). Revision of the Physical Activity Readiness Questionnaire (PAR-Q). *Can. J. Sport Sci. 17*, 338-345

Timmins, B. W., Naylor, P.-J., and Pfeiffer, K. A. (2007). Physical activity for preschool children: how much and how? *Appl. Physiol. Nutr. Metab,. 32 (Suppl. 2E)*, S122-S134

Tinley, S. (1998). *Triathlon: a personal history*. Boulder, CO: Velo Press.

Tulchinsky, T. H., and Varavikova, E. (2009). *The new public health*. New York, NY: Academic Press.

Uher, M. (1963). *Medical experience with physical training breaks*. Prague, Czechoslovakia: Telesna Vychova Prac. Sympsium 95.

Ulmer, C. V. (1996). Concept of an extracellular regulation of muscular metabolic rate during heavy exercise in humans by psychophysiological feedback. *Experientia, 52*, 416-420

US Department of Health and Human Services. (1996). *Report of the Surgeon General*. Atlanta, GA: US Dept. of Health & Human Services, Centers for Disease Control and health Promotion, National Center for Chronic Disease Prevention and Health Promotion.

Vail, S. (1983). What the federal government is doing to promote women's sport. *Can. Wom. Stud., 4*, 75-76.

Vandevalle, H., Pérès, G., and Monod, H. (1987). Standard anaerobic exercise tests. *Sports Med., 4*, 268-289.

Waddington, I. (1996). The development of sports medicine. *Soc. Sport J. , 13*, 176-196.

Walsh, V., and Golins, G. L. (1976). *The exploration of the Outward Bound process*. Denver, CO: Colorado Outward Bound School.

Warburton, D. E. R., Bredin, S. D., Charlesworth, S., Foulds, H. A., McKenzie, D. A., and Shephard, R. J. (2011). Evidence-based risk recommendations for best practices in the training of qualified exercise professionals working with clinical populations. *Appl. Physiol. Nutr. Metab., 36 (Suppl. 1)*, S232-S265.

Warburton, D. E. R., Charlesworth, S., Foulds, H. A., McKenzie, D. A., Shephard, R. J., and Bredin, S. S. D. (2012). Qualified exercise professionals: Best practice for work with clinical populations. *Can. Fam. Phys. ,* 59(7), 759-761.

Warburton, D. E. R., Katzmarzyk, P. T., Rhodes, R. E., and Shephard, R. J. (2007). Evidence informed physical activity guidelines for Canadian adults. *Appl. Physiol. Nutr. Metab., 32 (Suppl. 2E)*, S16-S68.

Warburton, D. R. E., Jamnik, V., Bredin, S. D., Burr, J., Charlesworth, S., Chilibeck, P., Eves, N., Foulds, H., Goodman, J., Jones, L., McKenzie, D., Rhodes, R., Riddell, M., Shephard, R., J., Stone, J., Thomas, S., Zehr, P. E., and Gledhill, N. (2011b). Executive Summary: The 2011 Physical Activity Readiness Questionnaire for Everyone (PAR-Q+) and the Electronic Physical Activity Readiness Medical Examination (ePAR-med-X+). *Health Fitness J. Can., 4*, 24-25.

Webborn, A. D. (1999). "Boosting" performance in disability sport. *Br. J. Sports Med., 33*, 74-75.

Weicker, H., and Werle, E. (1991). Interaction between hormones and the immune system *Int. J. Sports Med., 12 (Suppl. 1)* S30-S37

Weinbruch, S., and Nordby, K. C. (2010). Fatal accidents among elite mountaineers: a historical perspective from the European Alps. *High Alt. Med. Biol. , 11*, 147-151.

Weiner, J. S. (1964). *Proposals for international research. Human Adaptability Project 5.* London, U.K.: Royal Anthropological Institute.

Weiner, J. S., and Lourie, J. A. (1969). *Human Biology: A guide to field methods*. Oxford, U.K.: Blackwell Scientific.

Wilson, J. M. G., and Jungner, G. (1968). Principles and practice of screening for disease. *WHO Chronicle (Geneva: World Health Organisation), 22 (11)*, 473.

Wilson, M., O'Hanlon, R., Prasad, S., Oxborough, D., Godfrey, R., Alpendurada, F., Smith, G., Wong, J., Basavarajaiah, S., Sharma, S., Nevill, A., Gaze, D., George, K., and Whyte, G. (2011). Biological markers of cardiac damage are not related to measures of cardiac systolic and diastolic function using cardiovascular magnetic resonance and echocardiography after an acute bout of prolonged endurance exercise. *Br. J. Sports Med. , 45*, 790-794.

World Health Organisation. (1985). *Energy and protein requirements: Report of a joint FAO/WHO/UNU expert consultation. Technical Report Series 724*. Geneva, Switzerland: World Health Organisation.

Wright, D. M., Royle, T. J., and Marshall, T. (2001). Indoor rock climbing: who gets injured? *Br. J. Sports Med. , 35*, 181-185.

Wright, G. M. (2001). Basil Martin Wright Obituary *Br. Med. J. , 322*, 1308.

Yim, E. S., and Corrado, D. (2012). Ultrasound in sports medicine. Relevance of emerging techniques to clinical care of athletes. *Sports Med., 42*, 665-680

Zelizer, J. E. (2010). *The presidency of George W. Bush: a first historical assessment*. Princeton, NJ: Princeton Univrsity Press.