Chapter 9
The Post-Modern Era: Chronic Disease and the Onslaught of a Sedentary Lifestyle

9.1 Background to the "Post-Modern" Era

This chapter discusses developments in health and fitness over the last fifty years, a period that many historians would class as the Post-Modern Era. The actual term "*Post-Modernism*" was coined in part as a reaction against experimental scientists who pursued with seeming ever-growing success an objective description of reality during the Modern Era. Stereotypical *Post-Modernists* have expressed a healthy scepticism towards "*scientific*" explanations of phenomena that claim to be valid for all groups, societies, cultures, traditions, and races. They have argued that the truths encountered by a given individual are relative, and that the way a person perceives the world is inherently subjective. Further, they have maintained that language, power relations, and motivations play a crucial role in the shaping not only ideas and beliefs but also the ways in which we investigate and describe them.

Although I accept the general validity of this critique, I must admit to a semantic discomfort with 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 could 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 also controversial (Anderson 1998). The historian Arthur Toynbee wrote in 1939 CE:

> *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.

R.J. Shephard, *An Illustrated History of Health and Fitness, from Pre-History to our Post-Modern World*, Studies in History and Philosophy of Science 39,
DOI 10.1007/978-3-319-11671-6_9

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 North America, the present era was probably initiated by formation of the President's Council on Physical Fitness in the U.S. (1956 CE) and in Canada by a speech that the Duke of Edinburgh made to the *Canadian Medical Association* (in 1959 CE). For Canadians, the Duke's speech was quickly followed by passage of the Federal *Bill C-131,* and formation of the Federal *Directorate of Fitness & Amateur Sport* in 1961 CE. On the world stage, also, the early 1960s was an important turning point for Exercise Scientists, as the sophisticated apparatus previously available only to a few privileged Medically-staffed clinical laboratories became available to Kinesiologists and Physical Educators. The Post-Modern Era that we shall discuss in this chapter thus extends from the early 1960s through to the present day. Paradoxically for some Post-modernists, it is marked by ever more precise objective measurements, and the basing of health-care decisions upon evidence derived from the grouped responses of substantial numbers of people rather than individual perspectives.

As in previous chapters, we look first at the impact of new technology upon our scientific understanding of Health and Fitness. We then explore governmental attitudes, discuss new findings in health and fitness. and explore the impact of major international competitions and new types of sport upon the activity patterns and physical fitness of the general population.

9.2 The Impact of New Technology upon Our Understanding of Health and Fitness

Much (but not all) of the knowledge of health and fitness garnered during the Post-Modern Era reflects the investigator's 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 movements 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, force platforms that evaluate details of a single jump, and data from needle biopsies that 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 human reactions to environmental extremes has pointed to methods of enhancing performance and reducing the dangers of exercise under a variety of adverse conditions.

9.2.1 Developments in Respiratory Physiology and Studies of Metabolism

The last few decades have seen replacement of the traditional Douglas bag technique for the measurement of oxygen consumption by the use of metabolic carts equipped with electronic flow meters and electronic gas analysers. Moreover, miniaturization of this equipment has allowed use of this sophisticated apparatus in studies of competitors on the athletic field. Respiratory Physiologists have continued to explore individual factors limiting oxygen transport, However, controversy has persisted over both the interpretation and the practical value of maximal oxygen intake measurements to those studying health, fitness and athletic ability.

9.2.1.1 Douglas Bag Technique

When evaluating metabolic responses to exercise, 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 s intervals. This required a very precisely timed turning of valves; a one-breath difference in the duration of gas 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 a large syringe. Finally, the gas composition was determined by a tedious process of chemical analysis, and the volume of gas that had been expired was measured by emptying the Douglas bag through a dry gas meter. Up to 30 min was required in order to complete a single measurement of oxygen consumption, and this greatly limited the number of observations that could be made during any one investigation. Further, if the bag was stored for any considerable time, gas concentrations were changed by selective diffusion of carbon dioxide, oxygen and nitrogen through the fabric of the bags (Shephard 1955a).

9.2.1.2 Automated Flow and Gas Analysis Measurements

The measurement of respiratory gas flow was greatly facilitated around 1950 CE, when the Swiss-born Physiologist Alfred Fleisch [1892–1973 CE) (Kingisepp 2011), working at the University of Tartu in Estonia, devised an electronic flow meter that he called a *pneumotachograph* (Fleisch 1952; 1954; Shephard 1955b). His device measured pressure differentials across a 35 mm pipe that was filled with small parallel tubes. Others, such as myself, measured the pressure drop across a broad metal gauze that was inserted into the expired gas flow line. There were two main problems with either type of pneumotachograph: calibration curves became non-linear at the high flow rates encountered in maximal exercise, due to turbulence, and pressure differentials could be further distorted by an accumulation of water droplets in the tubes or on the gauze.

During the late 1950s, a biomedical engineer Basil Martin Wright (1910–2001 CE) who was working at the British Medical Research Council laboratories in Hampstead suggested the alternative of using a small turbine flow meter to measure human respiratory air flow (Wright 2001). The turbine approach has been adopted in most current metabolic carts. Turbine flow-meter data can also be compromised because of inertia of the rotors at low flow rates, and slippage of gas at high respiratory minute volumes.

The electronic measurement of expired gas composition began soon after World War I, with the introduction of the katharometer. This device exploited the fact that the rate of heat loss (and thus electrical resistance) in one arm of a Wheatstone bridge network could be modulated by a change in the carbon dioxide content of gas surrounding 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 of assessing oxygen concentrations. However, both of these devices had rather slow response times, making them unsuitable for breath-by-breath analyses of respiratory gas, and the infra-red monitor had the further disadvantage that a minimum gas sample of at least 100 mL per was needed for each 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 by a system where an electrode was surrounded by a thin film of a bicarbonate solution contained within a plastic sheath; diffusion of carbon dioxide through the sheath modified the pH of the bicarbonate and thus the electrical output of the glass electrode (Severinghaus and Bradley 1958). A polarographic electrode (originally conceived for the analysis of blood oxygen levels) was used to determine gaseous oxygen concentrations (Clark et al. 1953); electron flow reduced oxygen to hydroxyl ions at the cathode, creating an electrical output proportional to oxygen pressures (Fig. 9.1). Other oxygen sensors that are now used occasionally in metabolic studies include a high temperature Zirconia fuel cell (Roe et al. 1987), and a mass spectrometer (Hunter et al. 1949).

The rapid response metabolic carts proved particularly useful when determining maximal oxygen intake, as the performance of a subject could be tracked until he or she attained a clear plateau of oxygen consumption. The main drawback was their substantial size, with the consequence that they had to be used in conjunction with a stationary exercise device such as a treadmill or a cycle ergometer.

9.2.1.3 Miniaturization

Progressive miniaturization of the metabolic cart components enabled the apparatus that was previously mounted on a substantial trolley to be incorporated into the

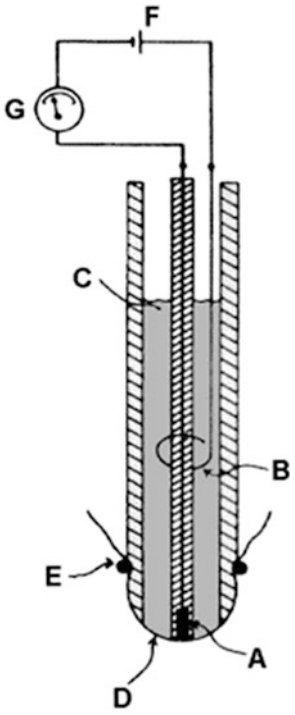


Fig. 9.1 Clark oxygen electrode. A=Pt; B=Ag/AgCl electrode; C=KCl electrolyte; D=Teflon membrane, permeable to oxygen; E=rubber ring; F=voltage supply; G=galvanometer (Source: http://en.wikipedia.org/wiki/Clark_electrode)

outflow tube of a standard face-mask. The information is now transmitted by radio-telemeter to a nearby recording system, or stored on a memory stick (Crouter et al. 2006; Hausswirth et al. 1997); this allows measurements to be made on the athletic field and in the factory. Field measurements have been particularly important for the Sports Scientist, since the maximal oxygen intake observed during a laboratory treadmill test does not reflect the full aerobic potential of a competitor who uses other muscle groups (for example, a rower or a cross-country skier).

Early miniaturized devices (the Morgan *Oxylog*, the Mijnhardt *Oxycon*, and the *Cosmed K2*) simply recorded ventilation and estimated oxygen concentrations by paramagnetic sensor; after making assumptions about the likely respiratory gas exchange ratio during exercise, one could then estimate the subject's oxygen consumption. The *Oxylog* was devised by Humphrey, who had spent much of his two years of compulsory Military Service struggling to keep a collection of integrated motor pneumotachographs (IMPS) functional (Humphrey and Wolff 1977). In the new device, the troublesome sliding potentiometer (which had been used to measure ventilation, and frequently jammed in use) was replaced by a Wright turbine flow-meter. Nevertheless, during moderate physical activity the *Oxylog* still yielded values some 5 % lower than those obtained by a traditional Douglas bag and mouthpiece (mainly because of leakage around the facemask) (Louhevaara et al. 1985). The *Oxycon* (Rietjens et al. 2001) was developed by the

Meijnhart Company. It also used a turbine flow-meter, with gas sampling every 10 ms; estimates of oxygen consumption were claimed to match Douglas bag readings to within 2–3 %. Several authors compared the output of the *Cosmed K2* against Douglas bag data; some found good agreement (Lucia et al. 1993), but others noted substantial divergences (Lothian et al. 1993).

Modifications of these devices over the last two decades have included the measurement of carbon dioxide concentrations (rather than assuming a respiratory gas exchange ratio) and in a few cases the use of a pneumotachograph rather than a turbine to determine airflow. A wide variety of commercially available equipment now includes almost every possible permutation of measuring devices: the *Aerosport KB1-C* [galvanic fuel cell, infra-red detector and pneumotachograph (King et al. 1999)], the *Cosmed K2* [(photoelectric turbine flow-meter, polarographic oxygen sensor, but no measurement of carbon dioxide (Lucia et al. 1993)], the *Cosmed K4b*[flow-meter, capillary polarograph and infra-red detector, with telemeter or memory stick (Eisenmann et al. 2003; McLaughlin et al. 2001)], the *MedGraphics VO2000 CPX* [Zirconium cell, infra-red detector and patented bidirectional pneumotachograph (Crouter et al. 2006)], the *Metamax III* [breath-by-breath analysis with electrochemical and infra-red sensors (Meyer et al. 2001)], the *Oxycon Mobile* [photoelectric turbine, electrochemical and infra-red sensors, (Perret and Mueller 2006)], the *ParvoMedGraphics TrueOne 2400* [Paramagnetic and infra-red analyzers, with correction for non-linearity of the pneumotachograph (Crouter et al. 2006)] and the *VmaxST* [a development of the *Metamax II* that allows breath-by-breath recording, with a turbine, oxygen electrode and infra-red analyzer (Blessinger et al. 2009)].

9.2.1.4 Attainment of an Oxygen Consumption Plateau

Debate has continued over much of the Post-Modern Era concerning the proportion of individuals who can reach the classically defined plateau of oxygen consumption during a progressive exercise test. In terms of healthy and well-motivated young adults, this question was largely answered by the observations of the International Biological Programme Working Party on the standardization of exercise tests; in 1966 CE, they demonstrated that plateau values were obtained consistently during repeated testing of 24 young men, irrespective of whether a continuous (ramp) or discontinuous test protocol was used (Shephard et al. 1968a). Maximal testing yielded plateaus less consistently in prepubescent children and the elderly. Nevertheless, the IBP Working Party were able to obtain a clear plateau in 35 of a representative sample of 47 young urban children (Shephard et al. 1969). Likewise, in seniors aged 65–84 years, a plateau was reached in 37 of 55 subjects at their first attempt at maximal exercise, and about a half of the remaining subjects reached a plateau when they were retested (Sidney and Shephard 1977). Moreover, both in the children and the seniors, failure to reach a plateau was associated with evidence of poor motivation such as a low peak heart rate, a low respiratory gas exchange ratio and low peak lactate readings (Sidney and Shephard 1977; Shephard 1994).

9.2.1.5 Electronic Lactate Analysers

During the 1960s, capillary blood lactate concentrations were usually determined by the Boehringer enzymatic method (Mohme-Lundholm et al. 1965). Electronic analysers based on the enzyme/electrode principle were developed by the Yellow Springs Instruments, Boehringer-Mannheim and Radiometer companies during the 1980s, and these devices were in turn quickly supplanted by small portable lactate analyzers that could be used in the field (Buckley et al. 2003). The portable analyzers also employed an enzymatic electrode system, and their normally acceptable accuracy could be disturbed if they were used at cold temperatures (Franklin 2000). However, these instruments greatly facilitated not only assessment of the quality of maximal aerobic effort, but also the determination of other closely related metabolic parameters such as the anaerobic threshold (Wasserman 1984; Wasserman and McIlroy 1964), the work rate at which blood lactate begins to accumulate (Sjödin and Jacobs 1981) and the maximal lactate steady state (Heck et al. 1985).

9.2.1.6 Factors Limiting Oxygen Transport

Respiratory physiologists have continued to examine factors that can limit oxygen transport through much of the Post-Modern Era (Table 9.1). I was intrigued to seek out the "bottle-neck" during my first few years in Toronto, and measured maximal values for individual links in the oxygen transport chain during near-maximal effort; the variables examined included the maximal voluntary ventilation (Shephard 1967b), the oxygen cost of breathing (Shephard 1966b), the maximal pulmonary diffusing capacity (Anderson and Shephard 1968), and the maximal cardiac output (Simmons and Shephard 1971). Both the late John Sutton (Sutton 1992) and Peter Wagner (Wagner 1996) have had a similar idea of looking at oxygen consumption as a closely linked chain reaction. By applying the analogue of an electrical conductance (Shephard 2010a), and looking at the distribution of gas pressure gradients, I concluded that for oxygen the most important factor limiting oxygen transport in the average healthy individual was blood stream conductance (the product of peak muscle blood flow and the oxygen carrying capacity of unit volume of blood) (Shephard 1969, 1970).

Table 9.1 Potential factors limiting maximal oxygen transport

Ventilatory: Maximal power of respiratory muscles; airway collapse; poor matching of ventilation and perfusion; maximal pulmonary diffusing capacity.
Central circulation: Peak stroke volume and heart rate; haemoglobin level and oxygen affinity; tolerance of rising blood pressure.
Peripheral circulation: Muscle blood flow and capillary density; tissue diffusing capacity and oxygen extraction.
Muscle: Myoglobin and energy reserves, substrate delivery, mitochondrial enzyme activity

Table 9.2 Relationship between active muscle volume and peak oxygen transport (L/min) (Shephard et al. 1988b).

Test-type	Men	Women
2-leg ergometer	3.43	2.23
1-leg ergometer	2.20	1.63
Arm ergometer	1.26	0.85
Forearm ergometer	1.09	0.82

Oxygen transport=0.61 MV+0.8 L/min (r=0.97) (where MV is active muscle volume)

However, a variety of other factors can limit oxygen transport, both in athletes with a very large maximal oxygen intake, and in individuals with chronic disease (Table 9.1), If the exercise does not involve most of the major muscles in the body, the local accumulation of lactate and the rise of blood pressure may limit muscular effort before the capacity of the central circulation has been fully taxed (Table 9.2). Fatigue of the respiratory muscles is a minor factor in most healthy individuals (Macklem 1979), but in some people, maximal performance may be limited by the sensation of dyspnoea, which depends in part on the strength of the inspiratory muscles (Killian and Campbell 1974). In athletes who develop very high respiratory flow rates, during maximal exercise, collapse of the airway and a limitation of expiratory gas flow can also become a significant factor (Grimby et al. 1971), particularly if there is a tendency to exercise-induced bronchospasm; this can also be an issue for individuals with chronic respiratory disease. The maximal circulatory transport of oxygen depends on pulmonary venous blood being almost fully saturated with oxygen during its passage through the lungs; however, in some athletes, a poor matching of ventilation and perfusion may cause a significant desaturation of pulmonary venous blood during maximal effort (Gledhill et al. 1977); again, this is a problem that can also arise in chronic respiratory disease. In the central circulation, the maximization of stroke volume can be limited by poor venous tone and thus a limitation of venous return, as in vaso-regulatory asthenia (Holmgren 1967); this problem is most likely when a person is exercising in the vertical position, and is avoided when swimming. Maximal circulatory transport also depends on the peak heart rate; the maximal heart rate decreases with age, and it may also be limited by the administration of beta-blocking drugs. Athletes may attempt to boost their haemoglobin concentration and thus oxygen carriage per unit of cardiac output by high altitude residence (Stray-Gunderson et al. 2001); some also use tactics not sanctioned by athletic anti-doping organizations (such as autologous blood transfusion or the administration of erythropoietin to stimulate red cell formation). Conversely, anemia can compromise the volume of oxygen transported per unit of cardiac output. When exercising in an urban environment, the oxygen carrying capacity of the blood may be reduced by exposure to carbon monoxide (Wright and Shephard 1978). Again, the efficiency of circulatory transport depends upon the almost complete removal of oxygen from the capillaries within the active muscles. The capillary density per muscle fibre can be enhanced by training, thus tending to facilitate tissue diffusion and peripheral oxygen extraction; however, because of associated hypertrophy of the muscle fibres,

the average diffusion distance from the capillary to the muscle membrane is not necessarily diminished by aerobic training (Hermansen and Wachtlova 1971). Finally, the ability of muscle to consume the oxygen that is delivered to it depends on local energy reserves, delivery of substrates and an adequate level of aerobic enzyme activity within the muscle mitochondria.

One important factor influencing the blood transport of any gas is its effective solubility in blood. For oxygen, the sigmoid shape of the dissociation curve has long been recognized; the average solubility factor for oxygen, integrated between arterial and venous blood, is around five (Shephard 1969, 1970). In contrast, for carbon dioxide, the dissociation curve is such that the effective solubility is only about a fifth of that for oxygen; in consequence, the conductances for carbon dioxide are more evenly distributed between the pulmonary and the circulatory systems (Shephard 1969, 1970).

9.2.1.7 Interpretation of Metabolic Data

Although the measurement of oxygen consumption has been greatly facilitated by introduction of the new metabolic equipment, the resulting gains in scientific knowledge are 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 much easier 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, Chap. 8). However, it is worth underlining that both the standardization of fitness test methodology that was conducted by the International Working Party (Shephard et al. 1968a, b, 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 depended upon the volume of muscle activated by the exercise test equipment. Thus, the Working Party demonstrated that in ordinary people, a treadmill test yielded a maximal oxygen transport that was 7 % larger than that for cycle ergometry, and 4 % larger than that for maximal stepping (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. We were able to show a gradation of peak oxygen intakes that correlated with anthropometric estimates of the muscle volume that had been activated (Shephard et al. 1988b), although there was also a substantial intercept due to

the oxygen cost of maintaining body posture during the less standard forms of exercise (Table 9.2).

Sports Scientists have demonstrated a more than two-fold difference of maximal aerobic power (expressed in mL/[kg.min]) between several classes of endurance athlete such as cross-country skiers and the ordinary healthy young adult (Shephard and Åstrand 2000). Moreover, most Exercise Scientists accept the view of Consensus Committees that one of the most 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). 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). Noakes has drawn upon an idea advanced by C.V. Ulmer (Ulmer 1996), arguing that endurance performance is limited by an ill-defined "*Central Governor*," rather than by the oxygen-carrying capacity of the central circulation. In Noakes' view, this governor operates as a feed-forward control system that protects an athlete from exercising to a level that could cause tissue damage through either hypoxia or hyperthermia (Noakes and Marino 2009; Noakes et al. 2001). Most Exercise Scientists would agree that athletes do limit their energy expenditure in prolonged endurance events, but they regard this as a pacing tactic that has been learned in collaboration with their coaches rather than as the operation of some shadowy Central Governor; the learned objectives of the competitor are to avoid depleting glycogen reserves too early in a prolonged event, and to limit a punishing build-up of tissue lactate until the final sprint.

Practical applications of maximal oxygen intake determinations at the present time include among other items (Shephard 2010a):

- Making National and regional comparisons of endurance fitness
- Examining secular trends in endurance fitness
- Evaluating the effectiveness of community and work-site fitness programmes
- Establishing relationships between aerobic activity and chronic disease
- Examining suitability of an individual for physically demanding employment
- Obtaining an objective measure of training status and thus habitual physical activity
- Prescribing an appropriate intensity of training exercise
- Determination of the response to training
- Monitoring of over-training and the course of rehabilitation
- Determination of prognosis in cardiac disease

9.2.2 Developments in Cardiology

The Post-Modern Era has seen considerable technical advances in electrocardiography, the use of ultrasound, and techniques for detecting obstruction of the

coronary vasculature and injury of myocardial tissue. Cardiac reactions to both acute and chronic exercise in health and disease have also been understood more clearly.

9.2.2.1 Recording of the Exercise ECG Clearance and Mandatory ECG Clearance

Until the early 1960s, a combination of a "wandering baseline," electrical signals from muscles underlying 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, careful grounding of ancillary equipment, shielding of cables and the development of electronic averaging and filtering devices now permits quite precise measurements of average heart rates and the extent of ST segmental depression during vigorous 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, and that it is an appropriate time to halt a progressive exercise test.

It was initially hoped that the quantifying of exercise-induced ST depression might identify those apparently healthy individuals who were at particular risk of a heart attack, much as Master had proposed in his study of the recovery ECG following a simple step test (Chap. 8). However, a clearer understanding of Bayes theorem and the principles of biological screening quickly dashed such hopes. Bayes theorem was described many years ago by Thomas Bayes (1702–1761 CE), a Presbyterian minister living in Tunbridge Wells, Kent. During the 1970s, clinical investigators began to apply this mathematical concept to a critical evaluation of various current and proposed biological screening procedures (Andermann et al. 2008; Wilson and Jungner 1968). They soon appreciated 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 would inevitably develop false positive test responses. Such apparently abnormal findings would then require further evaluation, and had the potential to cause long-lasting cardiac neuroses in the individuals who were misdiagnosed (Shephard 1981).

Unfortunately, not everyone has yet recognized the difficulties of ECG screening 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 detecting and avoiding the sudden exercise-related deaths that have occasionally occurred in young competitors (Corrado et al. 2006). In 1982 CE, the Italian Parliament enacted legislation making such resting ECG 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. Further, many competitors faced the expense and anxiety of undergoing secondary clearance by

such techniques such as echocardiography in order to clarify that their ECG test results were false rather than true positive test results.

Italian Cardiologists claimed that as a result of the mandatory ECG screening, there was a small reduction in the number of sudden exercise-related deaths among Italian athletes. However, critics have pointed out that the incidence of such episodes was still no lower in Italy than in North America (where preliminary ECG screening of athletes was 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 CE (Corrado et al. 2010), and unfortunately, this late recognition of the need for altered, athletic-specific criteria of ECG normality 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, c).

9.2.2.2 Pulse Rate Monitors

Early experiments in transmitting the telemetric signal of an exerciser's heart rate as derived from an ECG recording were initiated by Goodwin and Levitt (1962). A commercially available device based upon chest-strap ECG electrodes and recorder transmitting the resultant signal to a wrist-watch type monitor was developed for the Finnish ski team in 1977 CE (Burke 1998). This simple instrument was later marketed by the Polar Company in Kempele, Finland (Fig. 9.2), and it has proven invaluable in the precise regulation of the intensity of exercise training programmes.

Fig. 9.2 Pulse rate recorder showing chest strap and wrist-mounted monitor (Source: http://en.wikipedia.org/wiki/Heart_rate_monitor)

9.2.2.3 Echocardiography

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 by this technique. The first practical form of echocardiography was developed in 1953 CE (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*; they used this equipment to assess cardiac dimensions in patients with mitral valve disease (Edler and Lunstorm 1954).

Echocardiograohy is now widely used to assess the thickness and movements of the ventricular walls (Fig. 9.3). 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 that could be 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 where supposed abnormalities had been detected during mandatory ECG screening, and also to search for evidence of hypertrophic cardiomyopathy, which some authors claimed was the commonest cause of sudden exercise-induced death in young athletes (Maron et al. 2009). 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. Many cardiologists have expressed concern if the ratio of interventricular septum to

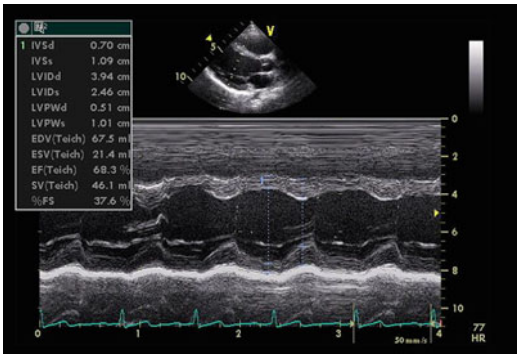


Fig. 9.3 Echocardiographic parasternal long axis view of the left ventricle (Source: http://en.wikipedia.org/wiki/Echocardiography)

posterior ventricular wall thickness exceeds 1.3, although septum to wall thickness ratios can rise as high as 2.0 in some endurance athletes, apparently without adverse consequences (Huston et al. 1985). Upper limits for the dimensions of interest have thus 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 physiological hypertrophy seen in all endurance athletes from the pathological changes associated with hypertrophic cardiomyopathy (Pelliccia et al. 2012a, b). A recent ultra-sound study of 114 Olympic athletes, spanning their participation in two to five Olympic Games, emphasized that despite large left ventricles, 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 as a result of echocardiography was the undesirable approach of forbidding exercise, and watching whether the size of the myocardium then decreased to what were deemed "normal" values (Fig. 9.4).

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).

Fig. 9.4 Automated defibrillator, open and ready for the attachment of paddles (Source: http://en.wikipedia.org/wiki/Defibrillation#cite_note)

The use of ultra-sound continues to expand in the clinical sports medicine laboratory, with other 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).

9.2.2.4 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 extra-cellular 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 echo-cardiographic 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 must be 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.

9.2.2.5 Technology in the Prevention and Treatment of Acute Myocardial Disease

The mortality from acute coronary disease has been greatly reduced through the development and widespread distribution of cardiac defibrillators in public areas, particularly gymnasia and sports facilities. New techniques to visualize the coronary blood supply have also helped in detecting coronary stenosis in those individuals who develop symptoms suggestive of myocardial ischaemia, and this has served as a prelude to rapid angioplasty or by-pass surgery in those with significant vascular obstruction.

Cardiac Resuscitation Two physiologists from the University of Geneva (Jean-Louis Prévost, 1838–1927 CE, and Frédéric Batelli, 1867–1941 CE) demonstrated that the application of a small electrical shock to the dog heart would cause defibrillation, but that a larger shock would restore a normal cardiac rhythm (Prévost and Batelli 1899). Claude Beck (1894–1971), a surgeon at Case Western Reserve Hospital in Cleveland first applied a defibrillator to a human heart in 1947 CE. His patient was a 14-year-old boy undergoing surgery for a congenital cardiac defect, and the direct application of an alternating current by paddles

placed on the ventricles restored a normal sinus heart rhythm. In the mid-1950s, two Russian Cardiologists (V. la Eskin and A.M. Klimov) began to experiment with applying larger alternating voltages (1,000 V or more) to the exterior of the chest cage. In 1959 CE, Bernard Lown (1921–) of Harvard University suggested the alternative of applying a single direct current shock; this had a potential of perhaps 1,000 V, and an energy content of 100–200 J, discharged over 5 ms (Eisenberg 2006). The Lown design held sway until the late 1980s, when it was shown that a biphasic truncated electrical waveform was even more effective (with rates for the reversal of fibrillation rising from 60 to 90 %). Lower voltages were also required for the biphasic device, thus reducing its weight, and allowing the development of portable versions for use outside of hospitals. A further improvement was the design of an automated defibrillator that could be used by untrained lay personnel; the new equipment was able to analyze the heart rhythm, determine chest impedance and apply a shock of appropriate magnitude.

Angiography Angiography was first used to examine the cerebral vasculature in 1927 CE. Introduction of radio-contrast material into the heart was facilitated by the development of cardiac catheterization (Chap. 8). However, the first injection of radio-contrast material into the coronary artery occurred accidentally at the Cleveland Clinic in 1960 CE, when the left ventricular catheter of Mason Sones (1918–1985 CE) slipped into one of the coronary vessels. The patient went into cardiac arrest, but this was quickly reversed, and the potential value of the intra-coronary injection was quickly recognized. Over the next 6 years, Sones and his colleagues reported angiographic findings in a series of over 1,000 patients (Proudfit et al. 1966).

Magnetic Resonance Imaging Walter Gerlach (1889–1979 CE), working in Munich, and Otto Stern (1988–1969 CE), in Hamburg, described the quantum nature of the magnetic moment of silver atoms as early as 1924 CE (Geva 2006). At Columbia University in New York, Isidor Rabi (1898–1988 CE) followed up this discovery during the 1930s, describing the phenomenon of nuclear magnetic resonance (NMR) (Rabi et al. 1939), and receiving the Nobel Prize for his research in 1944 CE. In 1959 CE, Jay Singer, working at the University of California (Berkeley) used NMR to measure blood flow in the tails of mice. However, magnetic resonance imaging of the heart was not applied clinically until around 1980, with early protagonists including Goldman et al. (1980) in New York and Hawkes et al. (1981) at the University of Nottingham in England.

The idea behind this technique is that powerful magnets align hydrogen protons along the same vector, and radio wave pulses knock the protons out of alignment. As the protons return to their original position, they send out signals. These are fed to a computer, and images of the underlying tissue are created. Cardiac and respiratory movements initially complicated imaging of the heart, but this difficulty was largely solved in the 1980s by the use of an ECG-based gating of the image. For cardiac investigations, a contrast agent such as gadolinium is usually administered intravenously. One can thus visualize areas of heart muscle where the contrast material does not penetrate due to coronary narrowing or occlusion. Following infarction, the area of scarred muscle appears white, in contrast with dark, normally-perfused cardiac muscle.

Cardiac Scintigraphy During cardiac scintigraphy (from the Latin, *scintilla*=spark), an intravenous dose of radio-active material is distributed through the coronary vessels and into heart muscle in proportion to local perfusion. Thallium-201 scintigraphy was first introduced in the late 1980s, although since the early 1990s many investigators have preferred to use technetium, because the images are of better quality and the marker has a shorter radioactive half-life. Despite increasing use of computed tomography and magnetic resonance imaging, in the year 2008 CE, 8.5 million myocardial perfusion scintigrams were performed in the U.S. alone (Vitola et al. 2009; Notghi and Low 2011).

Viable cardiac tissue has active Na^+/K^+ pumps; thus, if thallium is used, this binds to the K + and is then transported into the cells, giving a more permanent image. The radioactive material generates a local pulse of electromagnetic radiation that can be detected by a photomultiplier.

In 2003 CE, Britain recommended cardiac scintigraphy as the "gate-keeper" evaluation for angioplasty candidates (Notghi and Low 2011), although more recent guidelines have advocated an initial stratification of patients based on a scoring of coronary calcification (National Institute for Health and Clinical Excellence 2010).

Computed Tomography Computed tomography (CT) was first invented in 1972 CE by Godfrey Hounsfield of EMI (1919–2004 CE) and Allan Cormack (1924–1998 CE) of Tufts University. In 1979 CE, they were jointly awarded the Nobel Peace Prize for this discovery (Hurlock et al. 2009). CT is not used routinely in clinical practice. The patient receives an intravenous injection of iodine, and the heart is then scanned by a high-speed CT scanner. The test has a high negative predictive value (93 %) but some 18 % of false positive results. It is thus more useful in ruling out coronary disease than in diagnosing it. It may also be useful in demonstrating the severity of coronary narrowing (Fig. 9.5).

Impact of New Technology Although this range of new technology looks impressive, diagnosis and prognosis have shown quite small improvements relative to the taking of a careful clinical history. Thus, Ladenheim et al. (1987) found that

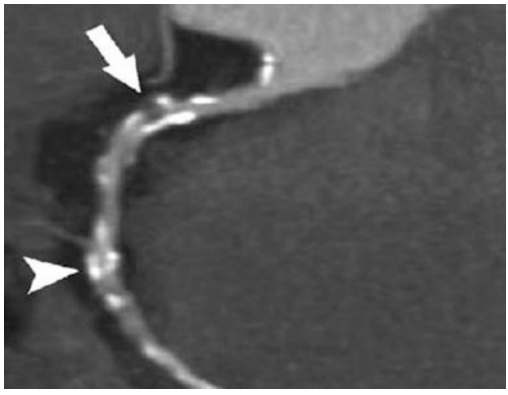


Fig. 9.5 Coronary vascular narrowing demonstrated by computed tomography (Source: http://en.wikipedia.org/wiki/Computed_tomography_of_the_heart)

in 1,451 patients with a normal resting ECG, the clinical history accounted for 72 % of the information regarding the likelihood of a coronary attack within one year, and scintigraphy contributed only an additional 5 % of information. In the remaining 208 patients, those with an abnormal resting ECG, the clinical history still contributed 58 % of the prognostic information, but in these individuals scintigraphy contributed a further 14 %.

There is little question concerning the value of early coronary angioplasty or surgical grafting when narrowed vessels are detected; the balloon-dilation of the stenosed artery or the by-pass operation also relieve chest pain more rapidly than medical therapy. However, evidence that early surgical treatment prolongs the patient's life is less convincing.

9.2.3 Developments in Understanding of Muscle Function

New techniques that have facilitated the description of muscle function during the post-modern era include the development of isokinetic dynamometers, force plates, needle biopsy and non-invasive assessments of muscle metabolism.

9.2.3.1 Isokinetic Dynamometers

Some historians trace the origins of isokinetic equipment back to the mechanical exercise machines of Gustav Zander that appeared during the nineteenth century (Chap. 8). Early versions of the isokinetic dynamometer allowed only concentric contraction. Pioneers included T.H. Hettinger (1961), and H.G. Thistle, a physician interested in muscular rehabilitation (Thistle et al. 1967). In 1967 CE, Perrin introduced the Cybex I isokinetic dynamometer (Perrin 1993), and this became commercially available three years later. The equipment was enhanced by adding a variety of servo-motors and microprocessors. Several forms of isokinetic dynamometer capable of assessing both concentric and eccentric effort became commercially available during the 1980s (Abernethy et al. 1995). 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.

The use of isokinetic equipment has now become an important component of assessments undertaken in well-equipped strength testing laboratories. Machines such as the *KinCom*, *Cybex* and *Biodex* allow subjects to exercise at computer-controlled speeds over a pre-determined range of motion, with measurements made most easily at the knee and arm joints. 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). The nature of the movement also bears little relationship to that experienced in most forms of athletic endeavour (Abernethy et al. 1995).

9.2.3.2 Force Platforms

The first force platform was used by Etienne Jules Marey (Chap. 7) at the end of the nineteenth century (Novacheck 1998), but the modern form of this equipment only became available to Exercise Scientists during the 1970s. The introduction of force platforms has greatly facilitated examination of the explosive force developed by the muscle groups of the legs, largely replacing the earlier jump tests of physical educators. Piezo-electric crystals measure ground reaction forces, and facilitate studies of balance and gait. Since 2007 CE, inexpensive equipment has provided much of the same information as the traditional force platform for a cost of less than $100 (Clark et al. 2010).

9.2.3.3 Cycle Ergometer Tests

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 Chap. 8. The force-velocity test developed by Henri Vandewalle and Hugues Monod during the 1980s allows the extrapolation of cycle ergometer data to both the peak power at zero velocity and the peak velocity at zero loading, when using either the legs or the arms to drive the ergometer (Vandevalle et al. 1987).

9.2.3.4 Needle Biopsy and Muscle Fibre Characteristics

Needle biopsies of muscle have given new insights into both fibre types and muscle metabolism, with implications for the selection of athletes, training and sports nutrition. Throughout the 1950s, muscle fibres were classified as having either fast or slow twitch properties, with the distinction based simply on estimations of their myoglobin content (Lawrie 1953). However, in the 1960s, classification began to be based on enzyme profile, typing fibres as slow or fast twitch based upon their content of either myosin vs. actomyosin ATPase (Engel 1998), or oxidative vs. glycolytic enzymes (Barnard et al. 1971) (Fig. 9.6). For a while, there was considerable debate as to whether humans had an intermediate fibre type (IIx), but advances in muscle protein chemistry during the 1990s allowed resolution of this question. A variety of fibre types were defined very precisely in terms of their main protein constituents (Moss et al. 1995; MacIntosh et al. 2006).

Bengt Saltin of the Copenhagen Muscle Research Centre began studies of muscle glycogen content in 1967 CE. He demonstrated that intramuscular stores normally provided a total body reserve of some 400 g of glycogen, but that these

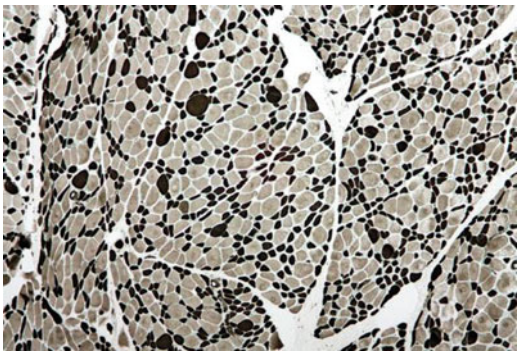


Fig. 9.6 ATPase staining of muscle; the type II (fast twitch) fibres stain more darkly than type I (slow twitch) fibres (Source: http://en.wikipedia.org/wiki/Skeletal_striated_muscle)

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 stores and thus preparing endurance athletes for events lasting longer than about 90 min.

Needle biopsy of the muscles was never very pleasant for the subjects involved. Towards the end of the 1980s, it was found that non-invasive assessments of liver and muscle glycogen could be made by nuclear magnetic resonance spectroscopy (Zang et al. 1990; Roden 2001), and although the equipment required is much more sophisticated than that required for needle biopsy, the NMR method holds promise for future Sports Science studies of muscle metabolism.

9.2.3.5 Muscle Mass Determinations

With aging of the population, there has been concern about a progressive loss of muscle mass and weakness that eventually limits the individual's ability to carry out the activities of daily living (Shephard 1997a). Determination of overall and localized muscle volumes has been helped by the development of several techniques such as the measurement of creatinine excretion or isotopic creatine dilution, body potassium determinations based on the gamma emissions of the naturally occurring isotope ^{40}K, neutron activation of muscle nitrogen, dual energy x-ray absorptiometry, and nuclear magnetic resonance technology (Shephard 2011d).

Such measurements have been useful in the diagnosis of sarcopenia (Park et al. 2010). Sarcopenia has been diagnosed when data for an individual fell 1 SD or more below the norms for a young and healthy reference population. Such techniques have also allowed the monitoring of rehabilitation (Fiatarone et al. 1990). But for Sports Scientists without access to expensive equipment, it has also been shown that the muscle volume of the limbs can be estimated from simple anthropometric measurements of limb circumferences, bone diameters and skinfold assessments of the thickness of overlying fat (Jones and Pearson 1969; Shephard et al. 1988b) (Table 9.3).

Table 9.3 Anthropometric estimation of lean tissue mass in lower limbs (Shephard et al. 1988b).

Total limb volume = $(\Sigma C^2)L/62.8$, where ΣC^2 is the sum of 5 selected limb circumferences and L is the limb length.
Bone volume = $(0.235D)^2$ 3.14 L, where D is the intercondylar diameter at the knee, corrected for overlying fat.
Fat volume = $(\Sigma C/5)(\Sigma S/2n)L$, where ΣS is the sum of skinfolds overlying the limb, and n is the number of skinfold determinations.
Muscle volume = Total volume − (fat + bone volumes).

9.2.4 Developments in the Determination of Other Body Tissues

New technology has allowed more precise determinations of body fat content and bone density, important pieces of information in the evaluation of both athletes liable to the female athletic triad (disordered eating, amenorrhoea and osteoporosis) and older sedentary populations.

9.2.4.1 Body Fat Content

New methods of estimating body fat available in hospital laboratories include the use of ultra-sound, magnetic resonance imaging, computerized tomography and dual photon absorptiometry (Shephard 2011d). In fitness laboratories, the bio-electrical impedance method has proven popular since the 1970s (Lukaski 2013). It is a safe, inexpensive and portable tool, and it allows the fitness professional to make quite rapid determinations. Originally conceived for blood flow measurements, it was first applied to the determination of total body water (and thus lean tissue mass) by Hoffer et al. (1969) and Nyboer (1970). The principle is simple: since fat has only 14–22 % of the water content of lean tissue, a fat person conducts an electrical signal much less readily than a thin person. The main problem arises from inter-individual differences in body shape, as most commercially available devices simply adjust the wrist to ankle impedance for the square of the person's height (Shephard 2011d).

The importance of the regional distribution of body fat to cardiovascular health was first noticed by Jean Vague, a physician from Marseille, in 1947 CE, with an English-language publication of his observations some 9 years later (Vague 1956). He found a greater risk of various metabolic complications in individuals with a central (male) distribution of body fat. His research was initially regarded with some scepticism, and it was not until the 1980s that epidemiological research in Sweden and the U.S. confirmed his hypothesis, showing that a simple measure of this characteristic (the waist to hip ratio) was a better predictor of cardiovascular risk than the body mass index (Kissebah et al. 1982; Larsson et al. 1984).

9.2.4.2 Bone Density

Many options for the assessment of bone health have become available during the last fifty years, including single and dual photon absorptiometry, single and dual x-ray absorptiometry, neutron activation, computerized tomography and ultrasound (Shephard 2011d). Methods that have proven particularly helpful in population surveys have included dual energy x-ray absorptiometry (Park et al. 2007) and ultrasound technology (Shephard et al. 2014).

Dual energy x-ray absorptiometry was introduced by Jay A. Stein of M.I.T. in 1987 CE. It is presently the most frequently used approach. The relative absorption of two x-ray beams of differing energy levels allows the investigator to distinguish soft tissue from bone. Radiation exposure is minimal, in contrast with dual photon absorptiometry, where there are problems with slowly decaying isotopes.

The ultrasound approach was developed to monitor fracture healing in the 1990s, and in 2004 CE Michael Liebschner of Rice University pioneered its application to the monitoring of bone loss in astronauts. The osteosonic index (OSI, closely correlated with dual energy X-ray energy absorptiometry data) is calculated as the product of the transmission index (T) and the speed of transmission of the sound wave through the bone (S). The individual's rating is given by $OSI=TS^2$.

Both dual x-ray absorptiometry and ultrasonic data are interpreted in terms of T scores relative to normal values for healthy young adults. Osteopenia is commonly diagnosed with T scores of −1.0 to −2.5, and osteoporosis with scores of −2.5 or lower.

9.2.5 Developments in Understanding of the Immune Response to Exercise

Until the 1980s, few Exercise Science laboratories had the equipment to investigate immune responses to exercise, 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 (Chap. 8). 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 2000a). Development of Exercise Immunology over the past 3 decades has been spurred by new technology, with an increased study of mucosal immunoglobulins, establishment of a parallel between strenuous exercise and sepsis, appreciation of the importance of leukocyte demargination, discovery of a metabolic role for cytokines, application of reverse transcription techniques to cytokine detection, and an understanding of a complicated cascade of humoral secretions (Shephard 2014).

9.2.5.1 Technical Developments in Immunology

Progress in Exercise Immunology was greatly stimulated by several technical developments (Chap. 8); these included introduction of the *Coulter Automated Cell Counter,* the *FACScan Cell Sorter* that 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 first commercial 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.

9.2.5.2 Increased Study of Mucosal Immunoglobulins

Decreases 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. However, 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 barriers to most hostile micro-organisms (Tharp and Barnes 1990). The first observations on immunoglobulin responses to heavy exercise were made by Tomasi et al. (1982); they reported decreased concentrations of IgA in saliva following strenuous cross-country skiing. Others soon confirmed these findings, noting also some chronic suppression of salivary immunoglobulins with periods of heavy training (Gleeson 2000). Laurel Mackinnon and associates (1991) were able to relate the exercise-related decreases in immunoglobulin levels to episodes of upper respiratory infection.

9.2.5.3 Parallel Between Strenuous Exercise and Sepsis

Camus and associates (1994) first drew attention to a possible parallel between sepsis and the immune reactions to very heavy exercise. Further, they suggested that exercise might prove a useful model for those interested in countering problems of sepsis. Three years later, an international symposium in Toronto was devoted to this question (Hoffman-Goetz et al. 1998). Although there was agreement with the concept of Camus and colleagues, encouraging continued animal experimentation, it was not thought ethical to require human volunteers to undertake an intensity of exercise sufficient to cause a long-term suppression of immune function.

9.2.5.4 Importance of the Demargination Phenomenon

Substantial changes in the circulating leukocyte count have long been observed during and immediately following a bout of vigorous exercise. The migration of leukocytes to the periphery of blood vessels, with subsequent adherence to the vessel walls and migration into the extravascular space, was first described in 1824 CE by the French Physiologist René Joachim Henri Dutrochet (1776–1847 CE). In 1938 CE, the Swedish Physician G. Vejlens further demonstrated an association between margination and erythrocyte aggregation. Much of the margination was flow dependent, but Crary et al. (1983) made the important discovery that leukocyte adherence to the vascular wall was also modulated by an action of catecholamines upon cell adhesion molecules, with a resulting attachment or release of immune cells from storage sites (Weicker and Werle 1991). This conclusion spurred an extensive study of the modulation of the activity of adhesion molecules by hormones such as the catecholamines (Shephard et al. 2000), and the relationship of such modulation to the immune responses observed during exercise.

9.2.5.5 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 important roles in controlling responses to infection and injury, secretion of the cytokine IL-6 may make a significant contribution to metabolic regulation (Pedersen et al. 2004). The IL-6 gene is rapidly activated during exercise, and the IL-6 released from muscle can induce lipolysis, suppress TNF production and stimulate cortisol production, particularly when muscle stores of glycogen are low. Cytokines also seem to be important regulators of muscle protein turnover (Zoico and Roubenoff 2002).

9.2.5.6 Application of Reverse Transcription Techniques

Determinations of plasma cytokine concentrations have proven challenging, since the circulating 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), and competitive binding to a receptor molecule,. But recently, cytokine determinations have been facilitated by the transcription of cytokine mRNAs (Moldoveanu et al. 1995), using the technique of reverse transcription polymerase chain reaction assay that was pioneered by Chelly et al. (1990) and Weis et al. (1992).

9.2.5.7 Cytokine Chain Reactions

The new sensitivity of methods for cytokine detection has led to the realization that circulating cytokines may be derived from sites other than circulating leucocytes. Thus, the *in vitro* production of cytokines by mitogen- or phytohaemagglutinin-stimulated cells may give only a partial picture of what happens *in vivo*. Investigations by Northoff et al. (1995) and by Pedersen and Toft (2000) have shown that a bout of strenuous exercise typically unleashes a complex cascade response, with the sequential appearance of a number of interacting cytokines (Fig. 9.7).

9.2.6 Genetics of Health and Fitness

In the planning of health and fitness interventions, it is important to ascertain how far all individuals will react in a uniform manner. If responses show substantial and genetically-related differences, this may be helpful both in selecting competitors for particular athletic events, and in understanding why some clients fail to respond to treatment despite seemingly good compliance with a prescribed lifestyle regimen. The understanding of genetic issues during the Post-Modern Era has been

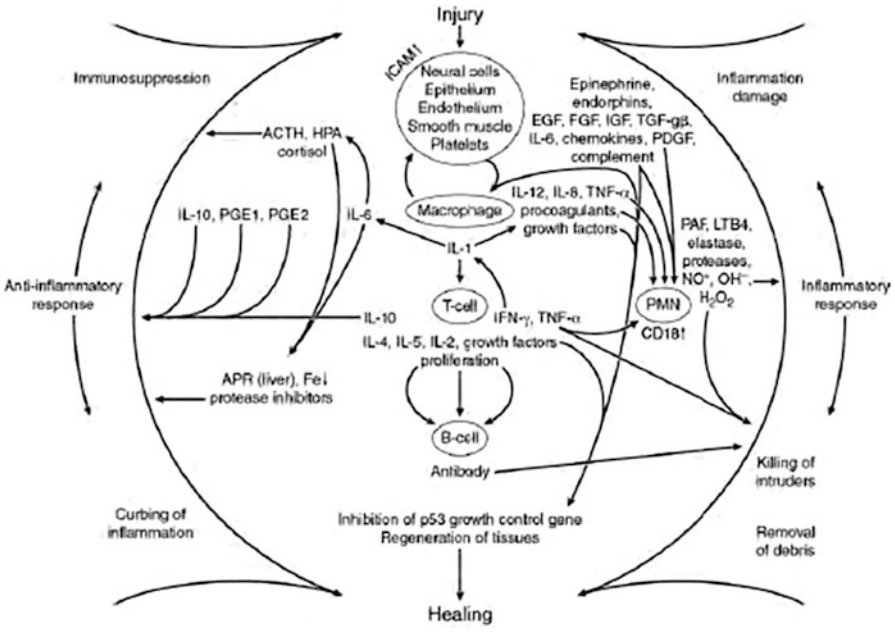


Fig. 9.7 Illustration of the complex interaction of hormones and cytokines involved in the healing process (Reprinted from Northoff et al. (1995) by permission of the authors)

Table 9.4 Intra-class correlations for maximal oxygen intake in monozygous (MZ) and dizygous (DZ) twin pairs (see Bouchard et al. 2000 for details of references).

MZ	DZ	Author
0.91	0.44	Klissouras (1971)
0.95	0.36	Klissouras et al. (1973)
0.71	0.51	Bouchard et al. (1986)
0.77	0.04	Fagard et al. (1991)
0.85	0.56	Maes et al. (1993)

advanced by twin and family studies of fitness characteristics, an analysis of inter-individual differences in training response, genome mapping, and a growing interest in epigenetic influences.

9.2.6.1 Twin and Family Studies

Attempts at 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 line of research (Klissouras 1972). However, different investigators obtained strikingly dissimilar data from such analyses, particularly with respect to the intra-class correlations for variables such as the maximal oxygen intake in monozygous and dizygous twin pairs (Table 9.4).

Subsequently, extensive investigations were undertaken at Laval University, where Claude Bouchard directed the *Quebec Family Study* (Bouchard et al. 1984, 1986, 2000); this measured many fitness-related variables in entire extended families. The primary intent of much of this research was to partition the variance in an individual's initial fitness and his or her response to training between genetic and environmental influences. Unfortunately, the repetition of apparently very similar analyses yielded widely differing verdicts on the partition of this variance, in part because of unmeasured interactions between genetic and environmental influences.

Nevertheless, there now seems 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 who were engaged in the occupational fitness screening of firefighters found that 6 of 1,900 young men with no history of specific physical training had a maximal oxygen intake that was some 50 % greater than that of their peers, apparently in part because they were endowed with a larger blood volume than others of their age (Martino et al. 2002). Likewise, maximal oxygen intakes averaging 88 mL/[kg.min] that have been reported for cross-country skiers (Bergh and Forsberg 2000) reflect as much a genetic advantage of body build (an ectomorphic frame, a low body fat content, and only moderate muscular development) as a response to years of rigorous endurance training.

9.2.6.2 Inter-individual Differences in Training Response

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 young men followed an identical 20-week aerobic conditioning regimen. The mean gain in maximal oxygen intake was about 400 mL/min, but the range of reported response varied from 0 to 1 L/min (Bouchard et al. 2000). The immediate conclusion drawn from these experiments was that some members of the group lacked any ability to improve their physical condition by training. However, this view had to be modified when it was pointed out that about a half of apparent inter-individual differences in training response was simply an expression of laboratory errors in the measurement of maximal oxygen intake; the data obtained after training followed the well-known statistical principle of "*regression to the mean*" (Shephard 2003b; Shephard et al. 2004), obscuring the training response in those with high values at the initial test, and exaggerating it in those with low initial values. However, there were still substantial inter-individual differences in response after correcting for regression to the mean. Plainly, the inheritance of a high initial aerobic power and an above-average response to aerobic training give some individuals a substantial advantage in athletic events that require a large maximal oxygen intake.

9.2.6.3 Genome Mapping

The mapping of the human genome has given further impetus to the research of Sports Geneticists; a consortium of investigators led by Claude Bouchard in Quebec City is conducting research looking at linkages of specific gene configurations with the risks of cardiovascular and metabolic disease, and with fitness attributes such as maximal oxygen intake, muscle strength and the response to various training programmes (Bouchard et al. 1986, 2000).

Initial studies at the Mexico City Olympic Games in 1968 CE yielded essentially negative findings in terms of inter-individual genetic differences; participants in the Games were not distinguished by allelic variations in red cell antigens or enzyme variants of red blood cells (deGaray et al. 1974). Further observations at the Montreal Olympic Games in 1976 CE again disclosed no differences of red cell antigens or enzymes between athletes and controls (Chagnon et al. 1984). However, the search has continued on a systematic basis (Pérusse et al. 2013), and a growing number of statistically significant linkages have now been discovered. Individual gene variants have been linked to such factors as physical activity behaviour, cardiorespiratory fitness and endurance performance, muscle strength and power, body mass and adiposity, and characteristics of glucose and lipid metabolism. 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). This has kindled 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.

But in most cases, individual genes seem to account for only a very small fraction of the total variance in data relating to health, fitness and training responses The discovery of substantial new information that can help the practitioner of Sports Medicine as yet remains a tantalizing distant dream. Further advances await a better understanding of possible interactions between individual genes, and clarification of epigenetic factors that can activate and deactivate particular segments of the human genome.

9.2.7 Adaptations to Exercise in Challenging Environments

The Post-Modern Era has seen important advances in our understanding of acclimation to high altitudes, to hot and cold environments, and to disturbances of circadian rhythm, with implications for those (including competitive athletes) planning to exercise or compete in the face of such challenges.

9.2.7.1 Exercise at High Altitudes and on Return to Sea Level

The hosting of the Olympic Games in Mexico City (1968 CE) was a major factor sparking interest in the speed with which athletes could adapt to low ambient pressures of oxygen. At least two weeks was required to maximize the adaptive increase in haemoglobin concentration; Heath and Williams (1989) found that despite a reduction in aerodynamic resistance, endurance athletes were initially running 8.5 % slower in Mexico City than at sea level, and even after their 29th day at altitude their speed was still reduced by 5.7 %. Some competitors found negative effects from a disturbance of their normal training routines and life in an unaccustomed environment; moreover, tissue bicarbonate reserves were reduced, and at least initially there was a reduction of blood volume at altitude (Shephard 2000b). Thus, some Sports Scientists argued that athletes who were travelling to high altitudes could achieve a better performance by arriving immediately before competition, and racing before their buffering capacity and blood volume were depleted (Kirkendall 2011).

The Mexico City Games raised the issue of more permanent adaptations to low oxygen pressures, since the first five places in the 10,000 m run were taken either by high altitude natives or those who had lived for long periods at high altitude. Specific advantages of these individuals appeared to include not only a high haemoglobin concentration, but also a reduced sensitivity of the carotid chemoreceptors (thus avoiding excessive respiratory effort) and an increased activity of

aerobic enzymes in the skeletal muscles (thus allowing muscular activity to be maintained at lower partial pressures of oxygen) (Milledge 1986, 1994). Continued study of Kenyan and Ethiopian competitors has suggested that other factors may also contribute to their advantage- distance walking and running from an early age, a favourable somatotype, and a strong motivation to succeed as a means of social and economic advancement (Wilber and Pilsiladis 2012).

It was quickly 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. Moreover, this physiological advantage persisted for several weeks, as the haemoglobin concentration only gradually reverted to its sea level norm. Mimicking the polycythaemia of the high altitude resident, some athletes attempted to gain an unfair competitive advantage by using other methods to boost their blood volume and/or their red cell count. Tactics included transfusion of their own (autologous) blood and administration of the erythropoietin that stimulates red cell production in the bone marrow (erythropoietin was first identified and extracted from urine in 1977 CE). Investigators at York University in Toronto played an important role in demonstrating the potential impact of this abuse upon maximal oxygen intake (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 blood specimens, and requiring endurance athletes to keep a passport recording their haemoglobin levels on a regular basis throughout the year (Bornø et al. 2010; Garvican et al. 2010).

Some endurance competitors have decided to boost their haemoglobin "legally" by living and/or training at actual or simulated high altitudes (Fig. 9.8). The disadvantage of prolonged residence at altitude is that training intensity is often curtailed. The most effective technique thus seems to live at altitude (or the simulated high altitude conditions of a tent or room where the partial pressure of oxygen is reduced), but to continue training at sea level (so that the normal vigour of conditioning programmes can be maintained) (Levine and Stray-Gundersen1997).

Fig. 9.8 Large low-pressure room constructed in East Germany to allow adaptation of athletes to low partial pressures of oxygen (Source: http://en.wikipedia.org/wiki/Altitude_training)

9.2.7.2 Exercise Under Warm and Hot Conditions

Knowledge of thermoregulatory mechanisms was advanced by Jan Snellen, at Memorial University, St. John's NFD during the early 1970s; he demonstrated that the rate of sweating was proportional to the mean body temperature (Snellen 1972). With prolonged strenuous exercise, the body's capacity for heat loss is exceeded, and there is then a progressive rise of core temperature. Bruck and Olschewski (1987), working in Giessen, suggested that there was a critical body temperature of around 40 °C; above this, the central motor centre was inhibited, giving a sensation of fatigue and limiting a further rise in body temperature

Issues of optimal techniques and speed of heat acclimation gained prominence during the 1960s. Not only were athletes travelling to compete in hot environments, but the British government also wanted to deploy their troops from English barracks to tropical colonies and dependencies when emergencies developed. South African companies also wished to dig ever deeper gold and diamond mines, thus increasing the thermal stress on their labourers. Relevant research was undertaken by Sid Robinson in Bloomington, IN (Chap. 8), Otto Edholm (1909–1985 CE) and his colleagues at the British Medical Research Council, and by Cyril Wyndham (1916–1987 CE) at the Chamber of Mines Laboratories in Johannesburg. Robinson and his associates maintained that heat acclimatization could be achieved by an appropriate regimen of endurance training, even if this was undertaken in a cool environment (Piwonka et al. 1965). Certainly, a high level of fitness increases tolerance of hot environments, but in the early 1970s Wyndham and his colleagues demonstrated categorically that maximum acclimation required a combination of physical activity and heat exposure (Wyndham et al. 1973). Moreover, and unfortunately for the British military commanders, the full adaptive potential realized by residence in a tropical environment could not be achieved simply by exercising in a hot chamber (Edholm and Bacharach 1965).

One environmental issue that has attracted considerable controversy over the last 50 years has been the quantity of fluids that endurance athletes should ingest when competing under warm conditions (Table 9.5). Ekblom et al. (1970) suggested that even a 1 % decrease of body mass increased the rise of rectal temperature when a person was exercising in the heat at 60 % of maximal oxygen intake. However, much depends upon whether the exercise depletes muscle and liver reserves of glycogen. During the 1970s, we established that in marathon runners, the liberation of water associated with the glycogen molecule could allow a 2 % decrease of body mass with little net dehydration (Shephard and Kavanagh 1975; Shephard et al. 1975). Fluid intake could usefully include a modest

Table 9.5 Changes seen in post-coronary patients after running a 42 km marathon event in 4–5 hours. (Based on the data of Shephard 1978).

Decrease of body mass	2.8±0.5 kg
Sweat loss	3.6±0.5 L
Dehydration (estimated)	0.7±0.5 L
Plasma Na^+	4.0±3.0 mE/L
Plasma K^+	0.0±0.2 mE/L

pre-event drink of 500 mL, and a further 150 mL of fluid should be ingested in each subsequent 15 min of running, to match the likely rate of fluid absorption from the gastro-intestinal tract during vigorous exercise (Shephard and Kavanagh 1975). In terms of maintaining hydration during competition, water was shown to be as effective a replacement fluid as proprietary sports drinks (Costill et al. 1975; Kavanagh and Shephard 1977), and indeed the plasma sodium concentrations of water drinkers were typically increased rather than decreased at the end of a distance run (Table 9.5). Weighing offered a simple means of estimating final over- or under-dehydration, if due allowance was made for the water liberated from stored glycogen (a total of up to 2 l). However, Carl Gisolfi (1942–2000 CE) continued to argue that runners should drink a dilute glucose mixture (<6 %) to reduce the rate of glycogen depletion. He established that a glucose/electrolyte mixture emptied from the stomach almost as rapidly as water (Ryan et al. 1989), and that at intensities of effort demanding less than 70 % of maximal oxygen intake, fluid absorption from the small intestine proceeded almost as fast as at rest (Gisolfi et al. 1991).

Some athletes and coaches (possibly encouraged by the manufacturers of proprietary sports beverages) ignored these simple guidelines, reasoning that if a little fluid was good for a runner, more would be even better. Thus, some endurance competitors ended their event with a biochemical hyponatremia (a plasma sodium concentration in the range 130–135 mE/L), and in a few instances they 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 both companies manufacturing sports drinks and the scientific agencies that received grants from these companies were actively conspiring to suppress information on the dangers of hyponatraemia. In his view, this condition had become epidemic (Noakes and Speedy 2007; Noakes 2011; Shephard 2011b).

The field diagnosis of disturbances in body electrolyte balance has been greatly facilitated by the development of portable sodium ion meters during the late 1990s. Nevertheless, users have not always distinguished between biochemical hyponatraemia (Na^+ concentrations of 130–135 mE/L) and clinical hyponatraemia (Na^+ concentrations of less than 130 mE/L), nor have they recognized that the field devices have errors of at least 2 mE/L, and sometimes register hyponatraemic values before an athlete begins running! (Shephard 2011b).

9.2.7.3 Exercise Under Cold Conditions

Exercise in a very cold environment can enhance fat loss. However, it may have a negative impact upon habitual physical activity, provoking bronchospasm and also angina in cardiac patients. Potential acclimatization to cold seems quite limited.

The issue of cold-induced angina came into prominence around 1970, as North American cardiac patients began to undertake some of their prescribed physical

activity not only in the gymnasium, but also in parks and streets. The inhalation of cold air was found to precipitate angina; possibly, a reflex spasm of the coronary vessels was initiated by the stimulation of vagal receptors in the trachea (Hattenhauer and Neill 1975; Shephard 1981). However, Terence Kavanagh of the Toronto Cardiac Rehabilitation Centre demonstrated that the problem could be solved quite simply by breathing air warmed from a tube passed under the exerciser's sweat shirt (Kavanagh 1970). Cold exposure also increases the workload of the heart through vasoconstriction of the skin blood vessels, and thus a rise in blood pressure.

The English physician John Floyer (1648–1734 CE) (Chap. 6), himself severely affected by asthma, noted some 300 years ago that exercise could provoke bronchospasm (Floyer 1698):

> *All violent Exercise makes the Asthmatic to breathe short ... and if the Exercise be continued it occasions a Fit*

Modern research on this topic began some fifty years ago; Simon Godfrey at the Hadassah Hospital in Jerusalem and Ken Fitch in Australia were pioneers in this field (Fitch and Morton 1971; Godfrey et al. 1973). Issues that have been resolved over the Post-Modern Era include the diagnostic criterion (a decrease in expiratory flow rate of >10 % following a bout of exercise), the fact that spasm is less likely to develop following swimming, that the likely physiopathology is the release of chemical mediators from airway mast cells in response to their cooling and drying by vigorous ventilation, and that effects can be reversed by drugs such as salbutamol and sodium cromoglycate. However, debate continues on medications that can be administered to high-performance athletes without conferring systemic benefits by boosting function in other parts of the body (Fitch et al. 2008; McKenzie and Fitch 2011).

The existence of non-shivering thermogenesis, possibly based upon the activation of brown fat, was demonstrated by T.R. Davis (1961). This type of fat is mobilized during cold exposure, and it produces heat rather than the energy that is required for exercise. Perhaps for this reason, aerobic training (energy expenditure 13 MJ/day over 2.5 h of treadmill walking and stepping exercise, 2.9 MJ/day negative energy balance) appeared to produce greater fat loss when it was performed in the cold (1 week at -40 °C, still air, wearing arctic clothing) than when 1 week of identical activity was undertaken at a temperate temperature (O'Hara et al. 1979) (Table 9.6).

The potential for cold acclimatization was examined in the late 1950s. Evidence of adaptation was seen in the Korean Ama pearl divers (Hong et al. 1987) and

Table 9.6 Controlled comparison of fat loss with exercise in the cold (−40 °C, still air, arctic clothing) vs. performance of the same exercise under temperate conditions in 15 middle-aged men (O'Hara et al. 1979).

	Fat loss (kg)	
Method	Cold	Temperate
Summed skinfolds	−2.3	−0.7
Hydrostatic weighing	−0.8	−0.6

bushmen exposed to the cold nights of the Australian desert (Hammel et al. 1959). Eric Glaser and I also established that it was possible to acclimatize to hot and cold conditions simultaneously (Glaser and Shephard 1963), with the subjects feeling more comfortable and shivering less under cold conditions. The body temperatures of those who have been acclimatized often drop to lower temperatures than in those who are not accustomed to cold conditions, suggesting that much of the apparent benefit may be no more than habituation to various unpleasant sensations. However, Jacques LeBlanc, working with Québecois fishermen in the Gaspé Peninsula, demonstrated that there was also some local vascular adaptation, in that those who were used to immersing their hands in cold water showed a lesser rise of blood pressure than those unaccustomed to this stimulus (LeBlanc 1975).

9.2.7.4 Disturbances of Circadian Rhythm

Factors increasing the likelihood of facing disturbances of circadian rhythm during the Post-Modern Era have included the need for shift-work to keep industrial plants and associated services operating 24 h per day, and ever-increasing international air travel for business, leisure and world-wide athletic competitions. The repeated disturbance of circadian rhythms can have adverse health consequences, and Physiologists have sought to speed the process of circadian adjustments through exposure to artificial light and the administration of melatonin.

Abnormal working hours are not a new phenomenon. In the seventeenth century, Ramazzini (Chap. 6) noted that bakers, inn-keepers and soldiers were often required to work at unusual times of the day, and during the early part of the industrial revolution, workers also had to contend with very long hours of employment. But by 2001 CE, it was estimated that a fifth of European workers were engaged in shift work, and about one in 20 employees worked extended hours, sometimes associated with a compressed working week (Harrington 2001). Adverse health effects that have been associated with shift work include a reduction in the quality and quantity of sleep, fatigue and resulting injuries, anxiety, depression and neuroticism, a 40 % increase in the risk of cardiovascular disease (possibly due to increased smoking, poor diet and lack of exercise, Bøggild and Knuttson 1999), gastrointestinal disorders (again probably related to the poor diet available to shift workers), disruption of the menstrual cycle and an increased risk of spontaneous abortion. Studies of alternative shift arrangements have suggested that the least harmful is a rapid clockwise 8-h rotation (morning, afternoon, night); attention must also be paid to the recreational, dietary and transportation needs of the night shift, and the provision of bright lighting may possibly help night-time adaptation (Harrington 2001).

Attempts to speed the adaptation of circadian rhythms by exposure to bright lights (an intensity of 5,000–12,000 lux) began in the early 1990s (Czeisler et al. 1990; Eastman 1992; Eastman et al. 1995). Benefit was optimized if the light exposure continued for 6–8 h per night for 4 days before the shift of rhythm, and dark glasses were worn during the daytime to minimize exposure to natural

sunlight. Although the secretion of melatonin is involved in setting the circadian rhythm, attempts to speed adjustments by therapeutic use of melatonin have had only limited success, in part because of side effects of the drug, and in part because of unfavourable pharmacokinetics when it is administered orally (Turek and Gillette 2004).

9.3 Attitudes of Governments and Political Leaders

We will examine briefly the attitudes of some recent governments to issues of health and fitness, focussing particularly upon the initiatives and personal lifestyles of leaders in the United States and Canada.

9.3.1 United States

United States leaders during the Post-Modern Era have included Kennedy, Johnson, Nixon, Ford, Carter, Reagan, Bush Sr., Clinton, Bush Jr., and Obama.

9.3.1.1 John Kennedy

John Fitzgerald "Jack" Kennedy (JFK, 1917–1963 CE) (Fig. 9.9) brought a deliberately youthful and athletic image to the Oval Office when he became U.S. President in 1961. However, as a schoolboy he had suffered from various bouts of illness, and had lived under the shadow of his brother Joe, who was the

Fig. 9.9 John F. Kennedy, U.S. President 1961–1963 CE (Source: http://en.wikipedia.org/wiki/John_F._Kennedy)

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 a 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 CE, Kennedy was diagnosed as suffering from Addison's disease. This condition, together with severe back pain, led to use of a multiplicity of drugs, sudden mood swings, and periods of impaired judgment which may have contributed to a plethora of extra-marital affairs.

An early positive contribution of the Kennedy administration to international health was the establishment of the *U.S. Peace Corps* (Whittlesey 1963), directed by his brother-in-law, Sargent Shriver (1915–2011 CE). Under this programme, some 10,000 volunteers provided help in education, farming, health care, and construction to underdeveloped nations. On the domestic front, one item promised in Kennedy's "*New Frontier*" acceptance speech of 1960 CE was free medical care for the elderly (although Congress failed to enact it). The option of retirement at age 62 was introduced, social security benefits were increased, food distribution to the needy was augmented, services for those with mental disorders was improved, and millions of children were vaccinated against various diseases (Bernstein 1991). U.S. attitudes towards fitness also became more positive under Kennedy. He was himself a major proponent of fitness, lending his name to articles in magazines such as *Sports Illustrated* (Chap. 8).

9.3.1.2 Johnson

Lyndon Baines Johnson (1908–1973 CE) (Fig. 9.10) 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 CE, following the assassination of John Kennedy. Johnson continued in office through 1969 CE.

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 an overall healthy lifestyle. He reputedly smoked 60 cigarettes per day and worked 18–20 h per day with no obvious leisure pursuits, until he sustained a near-fatal heart attack in 1955 CE. He then stopped smoking, but he became overweight, particularly after leaving his Presidential office. At this point, he also resumed smoking heavily. He suffered further massive heart attacks in 1972 and 1973 CE, the last proving fatal.

Fig. 9.10 Lyndon B. Johnson, U.S. President 1963–1969 CE (Source: http://en.wikipedia.org/wiki/Lyndon_B._Johnson#.22War_on_Poverty.22_and_healthcare_reform)

During his time as President, Johnson launched what was termed a "*war on poverty*." He also set in motion the *Medicare* and *Medicaid* programmes which had been proposed by the Kennedy administration (Martin and Weaver 2005). The latter encountered fierce opposition (Patel and Ruchefsky 2006):

> *Opponents, especially the AMA and insurance companies, opposed the Johnson administration's proposal on the grounds that it was compulsory, it represented socialized medicine, it would reduce the quality of care, and it was un-American*

Nevertheless, the proposal was enacted in July, 1965 CE. 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. Other initiatives that Johnson introduced included the "*head start"* for pre-school children, food stamps and work-study (to allow impoverished youth to complete their education) (Dallek 2005). Official statistics suggested that the number of U.S. citizens living below the poverty line dropped from 22 to 12 % during his administration.

9.3.1.3 Nixon

Richard Milhous Nixon (1913–1994 CE) (Fig. 9.11) 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.

Fig. 9.11 Richard Nixon, U.S. President from 1969 to 1974 CE (Source: http://en.wikipedia.org/wiki/Richard_Nixon)

His term in office ran from 1969 to 1974 CE. 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) and the *Occupational Safety & Health Organization* (OSHA), and enactment of the *Clean Air Act* (1970). In our present context, he was also the first President of the "*President's Council on Physical Fitness*" (Chap. 8). The EPA was created on January 1st 1970 CE, in response to mounting public concern over the impact of human activities upon the environment, and a Council on Environmental Quality was established within the office of the President; this Council required environmental impact statements for all new major Federal initiatives. In 1971 CE, 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 Medicaid for low-income families with dependent children, 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 CE.

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*.

9.3.1.4 Ford

Gerald Rudolph "Jerry" Ford (1913–2006 CE) was the only unelected U.S. President. He came to office in 1974 CE with the enforced resignation of Nixon, and continued as President through 1977 CE. His 3-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 University. 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 light aircraft carrier *USS 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 rank of *Eagle Scout*. Despite his athletic career, Ford tripped on one occasion when leaving the Presidential plane in Austria, and in consequence he was often lampooned as a klutz by cartoonists.

9.3.1.5 Carter

James Earl "Jimmy" Carter (1924-) was U.S. President from 1977 to 1981 CE. Before entering politics, he had been a Naval Officer and then a Georgia peanut farmer. As a Naval Officer, he worked on the nuclear propulsion system for the Sea Wolf submarine, and he had been seconded to Chalk River, ON, in 1952 CE (Fig. 9.12), following a partial melt-down and explosion at a Canadian nuclear reactor that had spilled 4500 tons of radioactive fluid into the building's basement; this water was later dumped in ditches, contaminating the Ottawa River. After rehearsing the operation on a tennis court, Carter and a team of 23 men entered the damaged reactor to carry out repairs. Although they were only inside the building briefly, radiation exposures were much higher than would be permitted today, and Carter's urine showed evidence of radioactivity for 6 months.

Following the death of his father, Carter returned to Georgia to help with the family farm. 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 (Bourne 1997). By applying scientific methods to his farming, Carter quickly became relatively wealthy.

During his Presidency, the Soviet invasion of Afghanistan precipitated an American boycott of the Moscow Olympic Games (below). After leaving office,

Fig. 9.12 The nuclear reactor at Chalk River, ON, in 1945 CE. While serving as a naval officer (1952 CE), President Jimmy Carter oversaw the cleanup of a nuclear explosion at this facility (Source: http://en.wikipedia.org/wiki/Chalk_River_Laboratories)

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.

9.3.1.6 Reagan

Ronald Wilson Reagan (1911–2004 CE) served as U.S. President from 1981 to 1989 CE. 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 CE his message ran (Jonas and Nissenson 1994):

> *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, Reagan was the simplistic front-man for those pushing the Reaganomics agenda. 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 CE, he also budgeted $1.7 billion for a *War on Drugs*, specifying a mandatory minimum penalty for drug offences; his wife Nancy travelled to 65 cities with her "Just say no" campaign, striving to prevent children and adolescents from experimenting with drugs.

Reagan was formally diagnosed with Alzheimer's disease in 1994 CE, 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. Former CBS White House correspondent Lesley Stahl recounts a meeting in 1986 CE (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.

9.3.1.7 Bush Sr.

While at school, George Herbert Walker Bush Sr. (1924 CE-) captained both baseball and soccer teams. As a sports-minded boy, he thought that one of the advantages of going to heaven was that one might get a better overview of football plays (Gormley 2000). He continued to use sports analogies frequently 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 University after demobilization, he again captained the baseball team, and in the summer of 1966 CE 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 CE) was haunted by pragmatic attempts to reduce the National deficit, which had tripled under President Reagan. This objective led to increased taxes and 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 CE). This legislation prohibited discrimination based upon disabilities (with the exception of current substance abuse and visual impairment correctable by eye-glasses). Senator Tom Harkin introduced parts of this bill in sign language, so that his deaf brother could understand it.

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). He was a great believer in the efficacy of volunteers, and spoke of the "1000 points of light" to typify the ability of volunteers to combat the Nation's social problems. These efforts were honoured by the establishment of the Daily Point of Life Award in 1989 CE.

9.3.1.8 Clinton

The father of William Jefferson "Bill" Clinton (1946 CE-) 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 CE) saw a long period of economic expansion and prosperity, but his Presidency was marred by several allegations of sexual improprieties, most notably between Clinton and his intern Monica Lewinsky.

He introduced the *Family and Medical Leave Act* in 1993 CE. 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 provision of 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.

Fig. 9.13 George W. Bush, U.S. President from 2001 to 2009 CE (Source: http://en.wikipedia.org/wiki/George_W._Bush)

9.3.1.9 Bush Jr.

George Walker Bush (1946 CE-) (Fig. 9.13) is the eldest son of George Bush Sr. When at boarding school, George W. played baseball and was the head cheerleader. 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 CE, although seven years later the televangelist James Robison still dismissed him as fun-loving and sports-crazed.

George W. had been ticketed at least once for public drunkenness, but he had continued his drinking in the belief that a 3-mile run the "*morning after*" would overcome any hangover. One morning in 1986 CE, 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). Bush continued regular running, and completed the Houston Marathon in 1993 in 3 h 45 min. 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 CE), 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 CE. 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*, and he had attempted to address the issue of poorly performing inner city schools with the "*No child left behind*" Act (Zelizer 2010). 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 the

details of this plan made it 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. opposed expansion of the *State Children's Health Insurance Program*, which would have provided medical care to an additional four million children from poor families, seeing this as a step towards Socialized medicine. 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 CE (Zelizer 2010).

9.3.1.10 Obama

Barack Hussein Obama (1961 CE-) 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. Obama plays basketball (Fig. 9.14) and earned a place on his school team, but he also admits to using alcohol, marijuana, and cocaine during his youth, 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 CE.

Prior to entering politics, he was a civil rights attorney. He became U.S. President in 2009 CE. He inherited the deep financial crisis that beset the

Fig. 9.14 President Obama playing basketball on the White House court in 2009 CE (Source: http://en.wikipedia.org/wiki/Barack_Obama#Family_and_personal_life)

second term of the George W. Bush Administration. However, unemployment has now dropped from its officially reported peak of 10.2 % in October 2009 CE to around 6.1 %.

Early in his mandate, Obama moved ahead with health care reforms (Gibson and Singh 2010). 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 is 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 CE, the public option was deleted. Premiums are 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.

9.3.2 Canada

Among Canadian Governors General and Prime Ministers, we will comment on the contributions to health and fitness of Michener, Pearson, Trudeau, Clark, Turner, Mulroney, Campbell, Chretien, Martin and Harper, both through legislation and personal example.

9.3.2.1 Michener

Daniel Roland Michener (1900–1991 CE) was one of the fittest of Canada's *Governors General*, travelling to Oxford on a Rhodes scholarship, and playing hockey for that University. He served as Governor General from 1967–1974 CE, and was a keen participant in several of the government-sponsored Ottawa Fitness Conferences of that era. Although he was then in his seventies, he would out-run many of the conference delegates in a 5 km lunch-time jog along the banks of the Rideau Canal. At the age of 80, he climbed to the peak of Mount Michener to celebrate the Province of Alberta naming the 2,545 m peak after him (Fig. 9.15). Michener was also a keen sport fisherman, and introduced the Michener Tuna trophy.

From 1973 to 1980 CE, he served as Chancellor of Queen's University in Kingston, ON, where he remained involved in promoting physical activity among both children and seniors.

Fig. 9.15 Roland Michener climbed Mount Michener (2,545 m) at the age of 80, to celebrate the naming of the Alberta peak after him (Source: http://en.wikipedia.org/wiki/Mount_Michener)

9.3.2.2 Pearson

Lester Bowles Pearson (1897–1972 CE) led a minority government throughout his term of office as Prime Minister (1963–1968 CE), Pearson's government successfully introduced such important social 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 CE (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 CE. The Pearson Cup is awarded based on the outcome of a contest between two baseball teams (the Toronto Blue Jays and the Montreal Expos).

9.3.2.3 Trudeau

Beneath his image as an astute politician and society playboy, Joseph Philippe Pierre Yves Elliott Trudeau (1919–2000 CE) (Fig. 9.16) 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).

As a young man, 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 centrist Liberal Party of Canada. He succeeded Lester Pearson in 1968 CE, and continued as Prime Minister (with one brief interlude in opposition) through to 1984 CE.

Trudeau vigorously defended the newly introduced *Universal Health Care System*, and expanded welfare programming for the aged, the young and the

Fig. 9.16 Pierre Trudeau, Prime Minister of Canada 1968–1984 CE (Source: http://en.wikipedia.org/wiki/Pierre_Trudeau)

under-privileged. Other notable actions were invoking the *War Measures Act* to defuse the Separatiste FLQ *October Crisis* of 1970 CE, *Patriation of the Canadian Constitution* from the U.K., and policies of bilingualism and multiculturalism. He saw disparities of health among racial and ethnic groups as an important factor to address in his quest for social justice (Levy 2005). In 1974 CE, Marc Lalonde (1929-), a Québecois Federalist politician who was then Trudeau's *Minister of Health and National Welfare*, also 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 not only support of the health care system, but also 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*

Trudeau saw Sport as a part of the Canadian National culture, and he argued that support of sport would play an important role in his National Unity agenda (Landry et al. 1991). His policies were dismissed by the Laxers, members of the ultra-leftist Waffle Group of the New Democratic Party, as (Laxer and Laxer 1977):

> *a frothy mixture of appeals to environmentalism and physical fitness, and attacks on mindless material consumption*

9.3.2.4 Clark

Charles Joseph Clark (1939 CE-) was Canada's youngest Prime Minister. He came to office in June 1979 CE, 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 he showed no particular interest in sport or athletics. His preferred pastimes have included reading, debating, and essay writing.

9.3.2.5 Turner

John Napier Wyndham Turner (1929 CE-) was another Canadian with an ephemeral term of office, serving as Prime Minister for a mere 79 days of 1984 CE (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. Only a knee injury had prevented him from participating in the London Olympics of 1948 CE. While attending Oxford University, he found himself on the same track and field team as Roger Bannister (Chap. 8). 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 (Chap. 8) when the latter was caught in an undertow on a Barbados beach. However, as a politician Turner's main appointments had been in Justice and Finance, and he had no strong influence on Canadian health and fitness policies either before of after becoming Prime Minister.

9.3.2.6 Mulroney

Early attempts by Martin Brian Mulroney (1939 CE-) to lead the Conservatives in 1975–1976 CE 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 addictions (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. Once he had secured the support of the Conservative party, Mulroney quickly defeated John Turner, becoming Prime Minister in 1984 CE and continuing in office until 1993 CE. Mulroney is best known for negotiating the *Free Trade Agreement* with the United States. He also introduced 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 CE, and was successfully treated for pulmonary cancer in 2005 CE. His Minister of Health, Jake Epp, was successful in getting increased funding for medical research, apparently in part through the strong 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 min for a limousine to drive him a distance of 200 m to a ceremony celebrating the importance of exercise and physical fitness (Newman 2006).

9.3.2.7 Campbell

Avril Phædra Douglas "Kim" Campbell (1947 CE-) succeeded Mulroney as Prime Minister in 1993 CE. 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 she was Mulroney's 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. She emphasized that doctors need not fear prosecution for performing abortions (Interim Staff 1990):

> *It is facile and misleading to say that Bill C-43 is making criminals out of women and doctors. As long as a doctor honestly forms an opinion that continuation of the pregnancy could endanger a woman's physical, mental or psychological health, he need not worry about the possibility of prosecution; there is no mechanism for looking behind that opinion*

In her autobiography, Kim Campbell 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 patented type of exercise boot.

9.3.2.8 Chrétien

Joseph Jacques Jean Chrétien (1934 CE-) was Canada's 20th Prime Minister, serving the country in this role for more than 10 years (1993–2003 CE) (Chretien 1986). This was an era of National belt-tightening, as his Minister of Finance (Paul Martin) struggled to control a 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, Provincial transfers of funding for Health Services were substantially reduced during the early part of his administration, and the

possible restoration of a part of this funding was used as a bargaining chip in subsequent discussions between the Federal and Provincial governments.

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. The move was described by some reporters as a "*Shawinigan handshake,*" a reference to Chrétien's rough and tumble boyhood as the 18th of 19 children in the mill town of Shawinigan. Chrétien enjoyed swimming and he 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 (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 looking into the incident, the Prime Minister's *Ethics Counsellor* ruled that Chrétien had not been guilty of any wrong-doing.

In 2004 CE, Justice Gomery was charged with investigation of the *"Sponsorship Scandal."* Gomery was less generous in his assessment of Chrétien's administration. Moneys earmarked to promote Federalism in Quebec had ended up in the coffers of the Federal Liberal Party. 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*" (Kinsella 2007). Chrétien responded by pulling from his pocket several golf balls that had been autographed by U.S. Presidents, and he asked the Judge which of these Presidents he thought was "*small town cheap*."

In 2007, Chrétien complained of anginal pain while he was playing in a charity golf match in Montreal; two 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; he suffers from the foetal alcohol syndrome, and has had various unfortunate brushes with the law.

9.3.2.9 Martin

Paul Edgar Philippe Martin (1938-) (Fig. 9.17) 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 CE, Martin was perceived by many as too old for the job, "*yesterday's man*." Martin served as Prime Minister from 2003 to 2006 CE.

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 (Chodo et al. 1998).

Fig. 9.17 Paul Martin, Prime Minister of Canada from 2003 to 2006 CE (Source: http://en.wikipedia.org/wiki/Paul_Martin)

Martin's austere policies while Minister of Finance had reduced Canada's debt to GDP ratio dramatically, from 70 to 50 %, with a balancing of the current Federal budget. However, this had been achieved at the cost of endangering social, health and infrastructure programmes. As Prime Minister, Martin reversed some of these constraints, reaching 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.

9.3.2.10 Harper

Canada's current Prime Minister, Stephen Joseph Harper (1959 CE-) (Fig. 9.18), came to power in 2006 CE. He led a minority government until 2012 CE, when he gained a substantial majority.

Prior to gaining power, Harper had told the *Council for National Unity*, an American think-tank that (Conway 2014):

> *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 CE, following the death of Pierre Trudeau, Harper accused Trudeau of "*unabashed socialism*," stating that Canada (Plamondon 2009):

> *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

Fig. 9.18 Stephen Harper, Canada's current Prime Minister, 2014 CE (Source: http://en.wikipedia.org/wiki/Stephen_Harper#Personal_life)

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. He is the first Canadian Prime Minister to have hired a clothing and hair stylist!

One small positive initiative of the Harper government was the establishment of a children's *Fitness Tax Credit* in 2007 CE. This legislation allowed parents to claim an income tax deduction of up to $500 for enrolling a child under the age of 16 in any eligible physical activity programme; this year, he is proposing to increase the allowance to $1000. For children with disabilities, an additional tax credit of $500 can be claimed until the child is 18 years old.

9.4 Health in the Post-Modern Era

The Post-Modern Era has been marked by a continuing disparity in health and resulting life-expectancy between rich and poor countries. Developed societies have seen growing governmental emphasis upon preventive medicine, with the development of professional activities focussed upon such goals. Both occupational health and rehabilitation have attracted increasing interest. Other developments in public health have included recognition of the toxicity of cigarette smoke,

increasing control of automotive emissions, appearance and control of the HIV epidemic, a growing reluctance to accept vaccination and the spread of disease by ever-growing international air travel.

9.4.1 Life Expectancy

Despite some narrowing of the gap, those in developed societies continue to live for 20 years longer than people from the poorest countries in the world.

9.4.1.1 Developed Societies

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 who was born in 2009 CE can expect to live a total of 81.2 years [10 years longer than in 1961 CE (Statistics Canada 2012)], and despite the snide remarks that Americans sometimes make about the "Socialized" 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., for roughly half as great a total expenditure upon medical services. Although the gap is narrowing, there remains a substantial discrepancy between the life expectancy in Canadian urban centres and that in the isolated Inuit communities of Nunavut; the average life expectancy of the Inuit for the period 2000–2003 CE was 69 years (Statistics Canada 2014).

More than a half of the increase in Canadian urban life expectancy over the past 20 years has been due to an increase in life expectancy at the age of 65 years. An important factor in recent decades has been 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 gains in life expectancy, although these benefits have been offset by an increase in metabolic risk factors.

9.4.1.2 Developing Societies

Although there has also been a substantial improvement of life expectancy in the poorest countries over the Post-Modern Era, figures for such populations are still 20 or more years poorer than those for developed societies (Table 9.7). Reasons include a continuing high maternal and perinatal mortality, persistence of controllable infections such as malaria, limited access to hospital and nursing care, and the widespread HIV/AIDS epidemic.

In 2013 CE, the shortest life expectancy was in Angola (38.2 years at birth). However, a low Gross National Product is not synonymous with a poor life

Table 9.7 Changes in life expectancy (years at birth) for developed societies and the poorest countries during the Post-Modern Era. (Based on statistics of the U.N. Population Division)

	1950–1955	2005–2010
Developed societies	66.0	77.1
Developing societies	41.7	67.7
Poorest countries	36.4	55.9

expectancy. In Cuba, very limited but well-distributed health care expenditures gave a life expectancy (76.1 years) in 2010 CE, slightly greater than that of the United States (75.9 years) (Das and Samarasekera 2012).

9.4.2 Governmental Emphasis upon Preventive Medicine.

In the U.S., health promotion has been fostered through the Centers for Disease Control and Prevention in Atlanta. The World Health Organization also has developed a growing interest in promoting a healthy lifestyle. 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*.

9.4.2.1 Activities of the Centers for Disease Control (CDC)

The Communicable Disease Center in Atlanta opened its doors in 1946 CE. Initially, it was focussed narrowly on the problem of preventing malaria in the Southern United States through a programme of DDT spraying. Its mandate has since expanded to include health surveillance. The first National Health and Nutrition Examination Survey (NHANES) was conducted in 1971 CE; this collected information on a probability sample of 32,000 U.S. citizens aged 1–74 years (CDC 2014a). Beginning in 1999 CE, the NHANES surveys were organized on an annual basis, with the data being used to shape U.S. Public Health policy.

The five strategic areas for the CDC are currently: supporting state and local health departments; improving global health; implementing measures to decrease the leading causes of death; strengthening health surveillance and epidemiology; and reforming health policies.

9.4.2.2 Activities of the World Health Organization (WHO)

An International Conference on Primary Health Care was held in Alma Ata, Kazakhstan in 1978 CE; it set the goal of "Health for All." In 1986 CE, the WHO also participated in the Ottawa Charter (below). One of the more important

WHO initiatives has been its efforts to reduce cigarette smoking on a global basis, and in 2003 CE the World Health Assembly adopted a Convention on Tobacco Control, designed to reduce tobacco-related deaths around the world. It envisaged among other items price and taxation measures to reduce consumption, control of passive smoking, packaging and labelling requirements for cigarettes, education, and control of advertising and sponsorship (WHO 2004/2005).

In 2004 CE, a Global Strategy was established on diet, physical activity and health. Among other initiatives, this programme set out global recommendations for physical activity and health (WHO 2014). The WHO organized its first global ministerial conference on healthy lifestyles and the control of non-communicable diseases in Moscow in 2011 CE. During the period 2014–2019 CE, the 12th Work Programme of the WHO is focussed heavily on prevention, under the title "*Not merely the absence of disease*."

9.4.2.3 The Lalonde Report

A Canadian Federal governmental report entitled "*A new perspective on the Health of Canadians*" was published when Marc Lalonde (1929-) was the *Minister of National Health and Welfare* (Lalonde 1974). This document recognized the heavy financial demands upon government that were already being 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.

The report 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. . .*

9.4.2.4 Romanow Commission

During the last decade, there has been ever-increasing concern in Canada, as in many developed societies, about the ability of Federal and Provincial governments to sustain the current system of universal health care. Large year-to-year increases in health expenditures have reflected an aging population, growing public expectations of the services that will be provided and the availability of ever more costly forms of treatment. Thus in 2005 CE, the *Romanow Commission on The Future of Health Care in Canada* was appointed. Among its findings, it estimated that in 1999 CE, 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 (Katzmarzyk 2011).

In Canada, health care expenditures peaked at 11.9 % of the Gross Domestic Product in 2010 CE, and since then have fallen marginally to 11.6–11.7 % of GDP (Canadian Institute for Health Information 2012). In the U.S., health care costs were already consuming some 17.2 % of GDP by 2011 CE.

9.4.2.5 Ottawa Charter

In 1986 CE, 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"* (National Department of Health and Welfare 1986). This document underlined the concept of active living, suggesting that people should incorporate much of the physical activity needed to maintain health into their daily routine. The *Charter* also emphasized the importance of "*strengthening community action*" as a key to success.

9.4.3 Professional Development of Health and Fitness Personnel

Major factors enhancing the professional development of health and fitness workers during the Post-Modern Era have included the emergence of Professional associations and journals concerned specifically with health and fitness, the hosting of a series of major consensus conferences, and Professional certification. The parallel development in Professional associations and journals dedicated to Exercise Science is discussed later in this chapter.

9.4.3.1 Professional Associations and Journals

In the United States, a growing array of journals that focus upon health and fitness now includes (with the date of initiation) *Preventive Medicine* (1959 CE), the *American Journal of Preventive Medicine* (1970 CE), the *American Journal of Health Promotion* (1987 CE), *ACSM's Health & Fitness Journal* (1997 CE) and the *Journal of Physical Activity & Health* (2004 CE). The interest of the lay public in this topic was such that in 1950 CE 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.

In Canada, the *Canadian Public Health Association* (1910 CE) and the *Canadian Association of Health, Physical Education and Recreation*, now known as *PHE Canada* (1933 CE) both came into existence long before the Post-Modern Era,

as did their primary house journals, the *Canadian Journal of Public Health* (1910 CE) and the *CAHPERD Journal* (1934 CE). Both of these organizations have boosted their output of publications in more recent years, with launching of the *CPHA Health Digest* (beginning in 1977 CE) and the on-line resource *PHEnex* (commenced in 2009 CE). In 2008 CE, Canada also saw publication of the first issues of the *Health & Fitness Journal of Canada*.

9.4.3.2 Consensus Conferences

Health Policy is now essentially evidence-based, and in recent years, several major international consensus conferences have sought to provide agreed information on the relationships between physical activity, health and the prevention and treatment of chronic disease. These conferences have built upon the *International Symposium on Physical Activity and Cardiovascular Health*, held in Toronto in October of 1966 CE (Shephard 1967a). New methodologies adopted for the more recent conferences have included the use of *Citation Indices* to select on a global basis the most knowledgeable panel of invitees and the employment of professional facilitators to develop a consensus from among a large and representative group of world experts, often with initially quite disparate views.

All of the consensus conferences were hosted in Southern Ontario. In 1988 CE, Claude Bouchard of Laval University headed a team that organized a conference entitled *Exercise, Fitness and Health*. Over four and a half days of meetings, around 1,000 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 CE. 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) (Fig. 9.19). Since information was still lacking on the optimal dose of exercise for many of the conditions that were identified, Dr. Bouchard and his colleagues embarked on a third consensus conference in October of 2000 CE. 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 this 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 presentations that would be in a format accessible to front-line workers. They organized a 2001 CE Whistler conference entitled "*Communicating physical activity and health messages: science into practice*" (Shephard 2002, 2003c).

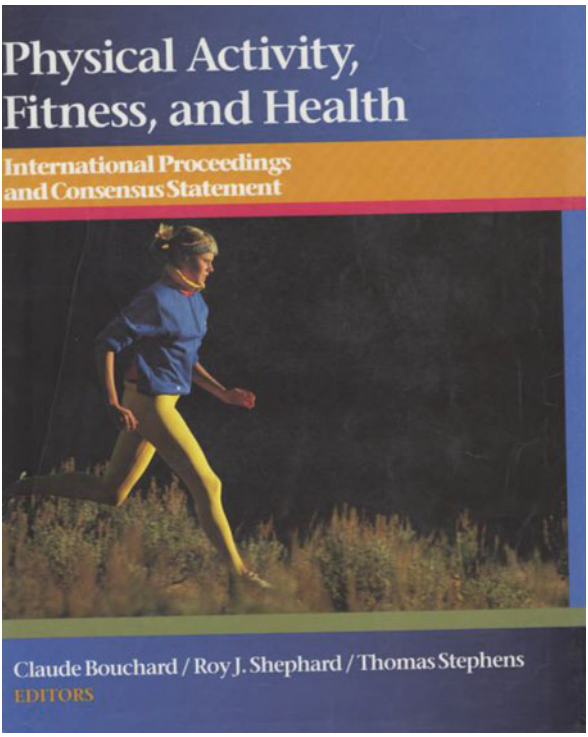


Fig. 9.19 Proceedings of the 1992 consensus conference on physical activity, fitness and health, held in Toronto, ON

The definition of dose-response relationships 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, carefully 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. 2011b). This has allowed them to develop electronic tools for exercise prescription in a variety of clinical conditions (the new PAR-Q + and the e-PARmed-X+, as discussed below).

9.4.3.3 Professional Certification

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 of Exercise Physiology* (*CSEP)*, beginning during the 1990s (Warburton et al. 2011a, 2012).

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 CE. It now includes three primary levels of Certification [the *Certified Personal Trainer*® (CPT), the *Certified Health Fitness Specialist*^{SM} (HFS) who provides programmes for both healthy individuals and those affected by various diseases, and the *Certified Group Exercise Instructor*^{SM} (GEI)] (ACSM 2014). ACSM also offers two forms of Clinical Certification [the *ACSM Certified Clinical Exercise Specialist*^{SM} (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, orthopaedic, 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 relevant Canadian legislative initiative was the establishment in 2007 CE of the *College of Kinesiologists of Ontario*, designed to regulate the profession of Kinesiology in accordance with the Regulated Health Professions Act of 1991 CE and the Kinesiology Act, of 2007 CE. This legislation covered such issues as minimum standards of education, use of title and designations, fees and billing, professional boundaries and collaboration, scope of practice and controlled acts, record keeping, mandatory reporting, and prevention of sexual abuse (College of Kinesiologists of Ontario 2014). The Canadian Society of Exercise Physiology had earlier initiated Professional Certification through its *Health and Fitness Programme* in 1981 CE. The CSEP programme was created and administered by Dr. Norman Gledhill from York University, Toronto. CSEP currently recognizes two levels of Certification: the *CSEP Certified Exercise Physiologist*® (*CSEP-CEP)* and the *CSEP-Certified Personal Trainer*, and it provides appropriate continuing education for its members through its Annual General Meeting. The person recognized as a *CSEP-CEP* possesses advanced formal academic preparation and practical experience in both health-related, and performance-related physical activity/exercise science fitness applications for non-clinical and clinical populations (CSEP 2014).

The *British Association of Sport and Exercise Science* has gained licensed body status with the British Science Council, so that accredited members of BASES can now become Chartered Scientists. It, also, has introduced a form of Accreditation to set, maintain and enhance the professional and ethical standards of Exercise Scientists; the two categories of qualification in Britain are termed *BASES Certified Exercise Practitioner* (renewable every 3 years) and *BASES High Performance Accreditation*. For the latter designation, the candidate must demonstrate both knowledge of high performance physiology, biomechanics and skill acquisition and a personal commitment to high performance sport (British Association of Sport and Exercise Sciences 2014).

9.4.3.4 Changing University Programmes

With the new opportunities offered by these forms of Professional Accreditation, the career paths of many Physical Educators have shown a dramatic shift. Instead of becoming physical education teachers for healthy schoolchildren or athletic coaches, many graduates have found themselves offering fitness and lifestyle guidance to middle-aged and older adults, sometimes affected by chronic disease. This has required a corresponding change in the orientation of University Exercise Science programmes.

In Canada, reorientation began during the 1960s and 1970s, starting with some of the newer Universities, such as Simon Fraser in BC and the University of Waterloo in Ontario. Often, there was a name change. Commonly, the Academic units became known as Faculties of Kinesiology or Kinanthropology. There was also a change in the underlying curricular philosophy. Course-content shifted from material appropriate for 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 had found it necessary to travel to the United States (frequently to the laboratory of Tom Cureton, at the University of Champaign-Urbana, IL, and more recently to the programme of a Canadian expatriate, 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 the 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 doctoral 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 occurred less readily than in Canada, because of pressure from University Governors to maintain the excellence of sports teams and thus assure Alumnal support.

9.4.4 Epidemiology, Chronic Disease and Physical Inactivity

In many developed countries, the epidemic of cardiovascular disease seen during the Modern Era (Chap. 8) has now waned, to be replaced by an obesity epidemic.

Fig. 9.20 The Omron HJ-112, one of the pedometers used in modern epidemiological surveys (Source: http://en.wikipedia.org/wiki/Pedometer)

However, cardiovascular disease remains a major concern among more wealthy people in developing countries. The Post-Modern Era has seen a growing application of sophisticated epidemiological techniques to make quantitative examination of the relationships between physical activity and various forms of disease, including cardiac problems, obesity and the metabolic syndrome.

9.4.4.1 Quantification of Habitual Physical Activity

Until recently, quantification of habitual physical activity relied mainly on self-reports, 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 2003a; Shephard and Aoyagi 2012).

The use a pedometer (Fig. 9.20) to measure physical activity is not particularly recent; Leonardo da Vinci found military applications for an early form of pedometer (Chap. 5), Abraham-Louis Perrelet (1729–1826 CE) exploited this type of device in Enlightenment France, and President Jefferson brought the idea to the United States in order to monitor his personal exercise habits (Chap. 7). However, the scientific use of pedometers by epidemiologists depended upon the development of accurate and inexpensive electronic devices. Y. Hatano marketed the first reliable electronic pedometer in Tokyo in 1965 CE, and he used it in a campaign to encourage wearers to take 10,000 steps/day (Tudor-Locke2003). The best of currently available pedometers, such as the Kenz Lifecorder, can now record 500 paces

on a track with an accuracy of -0.2±1.5 steps (Schneider et al. 2003). Their performance is necessarily somewhat less precise when measuring the wider range of activities encountered in normal daily living, but they can monitor activity patterns continuously for periods of 30–60 days, and they are enabling earlier questionnaire-based 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 and Aoyagi 2010, 2012), 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).

9.4.4.2 The Cardiac Epidemic

Epidemics of chronic disease related to low levels of physical inactivity have been a continuing concern during the Post-Modern Era. Terry Anderson, the first doctoral graduate from the University of Toronto's Exercise Sciences programme, established that the epidemic of cardiovascular deaths previously noted by Morris and his associates in Great Britain was replicated in Canada during the 1950s and 1960s (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 its decline, albeit more slowly, through the 1990s, as smoking became less prevalent and hypertension was better controlled (Cooper et al. 2000). 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). However, there was little evidence that the population had increased its habitual physical activity over this period.

Unfortunately, these impressive gains in the Western World have been offset by a growing prevalence of cardiac disease in developing nations, as the latter populations have moved to cities and have adopted the adverse lifestyle previously found in much of Western Society. The shift in the global health burden is such that in 1990 CE there were 5.3 million deaths from cardiovascular disease in developed societies, but 8 to 9 million in developing societies (Reddy and Yussuf 1998).

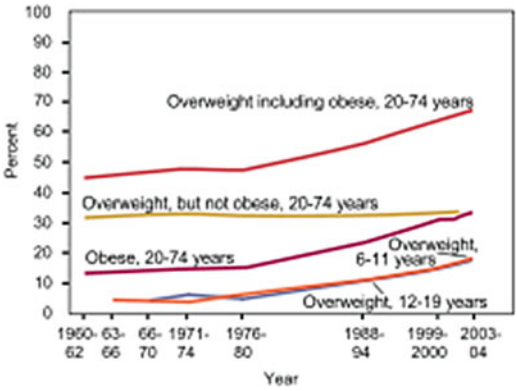


Fig. 9.21 Prevalence of overweight and obesity in the United States, 1960–2004 CE (Source: http://en.wikipedia.org/wiki/Epidemiology_of_obesity#cite_note-Caballero-4)

9.4.4.3 The Obesity Epidemic and the Metabolic Syndrome

An obesity epidemic began to be of major concern towards the end of the twentieth century. In the U.S., which is perhaps the most affected by this problem, less than 15 % of the adult population were obese in 1990 CE, but by 2012 CE, 36 States had a prevalence of obesity greater than 25 %, and in 13 States, the figure was greater than 30 % (CDC 2014b) (Fig. 9.21).

Public Health officials were concerned about a possible obesity epidemic in Canada even during 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 recently, Canada has become affected (Shields 2005; Starky 2005). From 1978 to 2004, obesity rates among Canadians aged 18 and over increased from an initial 14 % to a final figure of 23 %, and among Canadians aged 2 to 17 years the corresponding values increased from 3 to 8 %.

The top countries in terms of the prevalence of obesity remain Mexico, the United States, the United Kingdom, Canada and Australia, but rates are rising in all except the poorest states of Sub-Saharan Africa, to the point that the WHO has recognized the problem as a global epidemic (Caballero 2007). World-wide, there were 2.1 billion obese people in 2013 CE, compared with 857 million in 1980 CE (Ng et al. 2014).

9.4.5 Improvements in Occupational Health

Efforts to upgrade the health and safety of workers began in the Victorian era (Shephard 1991a, Chap. 7). In Germany, Chancellor Otto von Bismark introduced compulsory state-run accident compensation during the 1880s. In Canada, the *Meredith Report* of 1913 CE addressed the issue of worker compensation,

and initiatives to improve occupational health were also taken in several U.S. States between 1902 and 1914 CE. Recently, issues including hours of work and the compressed working week have been addressed by increasingly effective occupational health physicians and staff.

9.4.5.1 Hours of Work

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 overall health and an increased rate of industrial injuries actually reduced output. A "*Health of Munition Workers' Committee*" was thus established (Oborne 1982). After the conclusion of hostilities, the committee was reconstituted as the British *Industrial Fatigue Board*, and in 1929 CE 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; Chap. 8). An 8-h day had been declared for U.S. Federal workers as early as 1868 CE, but this did not become general policy until the Fair Labor Standards Act of 1938 CE.

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). This left little opportunity for employee initiative. However, one favourable consequence of such a close examination of work practices was that it sometimes suggested changes in the design of machinery and task performance that could reduce the energy cost of heavy industrial jobs.

In Western Europe, the typical attitude of many Industrial Physiologists was to determine the intensity of effort required by a physically demanding task, to set an upper limit to the permitted duration of such activity, and then either to seek workers with a physique that would enable them to undertake the job (Åstrand 1967; Bonjer 1966), or to hire an Ergonomist to reduce physical demands to a more acceptable level.

9.4.5.2 Compressed Working Week, Flexible Schedules and Tele-Working

A number of companies have experimented with compressed working weeks over the past 70 years. The Mobile and Gulf Oil Companies moved to a 4-day, 40 h week in 1940 CE (Poor 1970). The arrangement proved popular with some employees, since it provided a longer weekend. One meta-analysis concluded that absenteeism, productivity and job satisfaction were all favourably influenced by this change

(Moores 1990), and it was adopted by a growing number of North American companies during the 1970s. Despite the positive response of employees, most studies found greater employee fatigue, in part because of the longer working day, but also because many people took advantage of the three days of "free" time to engage in demanding "do it yourself" projects, or even sought a second job.

From 1975 CE to the present day, the participation of women in the U.S. labour force has increased from 47 to 78 %, and this has created stress for many charged with child or elder care. A growing proportion of those with dependents have found relief in either flexible working hours or tele-work. The latter is regarded favourably by many corporations because of large savings in their real estate costs, and employees appreciate such arrangements because of the time that they save in ever-longer commutes. Reports suggest greater well-being, less stress and enhanced health among those working at home (Kossek and Michel 2014).

9.4.5.3 Appointment of Occupational Physicians and Governmental Legislation

Effective legislation ensuring safe working conditions did not develop until the Post-Modern Era, despite many prior attempts. In Ontario, for example, a Factory Act was enacted in 1884 CE. This defined such things as a child, young girl and factory, but the legislation was generally slanted in favour of the employer and the maximization of production; it did little to reduce injuries on the job. An incident that killed five workers during the construction of a tunnel in Toronto spurred passage of the Industrial Safety Act in 1964 CE; this legislation defined safety as "*freedom from injury to the body and freedom from damage to health*." In Canada, concern continued about the hazards associated with work in uranium and asbestos mines and exposure to lead and mercury, and a Royal Commission was appointed, led by James Ham. One outcome of this Commission was the *Occupational Health and Safety Act* of 1980 CE; this gave workers the rights to participate in discussions of occupational health, to know the risks, and to refuse work that they believed to be unsafe. The legislation was further strengthened in 1991 CE, with a requirement for a Joint Health and Safety Committee that included management and worker representatives certified by the Workplace Safety and Insurance Board (Public Services Health & Safety Association 2014).

Progress in the Unites States was in some respects even slower than in Canada and in Europe (Gochfeld 2005). President Kennedy had planned a Conference on Occupational Safety in 1964 CE, but this plan was thwarted by his assassination. In 1990 CE, there were 1200 worker compensation awards to children in New York State alone, with 42 % of these cases reflecting permanent disability (Pollack and Landrigan 1990). And in 1991 CE, although Occupational Safety and Health legislation had been enacted by President Nixon more than 20 years earlier, 25 workers died in a fire at a food processing plant because 8 of 9 exit doors were either locked or blocked (Bingham 1992).

Fig. 9.22 In 1848 CE, Rudolph Virchow lost his post as a government physician for advocating the rights of Silesian coal miners too strongly (Source: http://en.wikipedia.org/wiki/Rudolf_Virchow)

Occasional physicians such as Ramazzini (Chap. 6) have had an interest in occupational health since the Enlightenment. In 1775 CE, Percival Pott described the first occupational cancer, that found in chimney sweeps. In 1848 CE, a young physician named Rudolph Virchow (1821–1902 CE) (Fig. 9.22) was sent to investigate an epidemic of typhus in Silesian coal-miners, and he wrote a scathing report on conditions in that industry which cost him his job at the Charité Hospital in Berlin (Abrams 2001). Virchow wrote (Ashton 2006):

> *Medicine is a social science, and politics is nothing else but medicine on a large scale. Medicine, as a social science, as the science of human beings, has the obligation to point out problems and to attempt their theoretical solution: the politician, the practical anthropologist, must find the means for their actual solution… The physicians are the natural attorneys of the poor, and social problems fall to a large extent within their jurisdiction*

In part as a result of Virchow's concerns, Bismark introduced a system of workmen's compensation in Germany as early as 1884 CE. Similar legislation was not enacted in New York until 1910 CE, and Mississippi was the final State to make such provision in 1948 CE.

In the U.S., a worker directed health service had been organized between 1921 and 1928 CE by three women activists (Grace Burnham, Harriet Silverman and Charlotte Todes). This initiative had its own staff (physician, dentist, nurse and other employees) and its own laboratories and x-ray service, but in the end it was thwarted by opposition from the conservative leader of the American Federation of Labor, William Green (Abrams 2001). During the 1940s, a few of the more powerful U.S. Unions such as the Union of Mineworkers and the Union of Autoworkers were able to negotiate comprehensive health insurance plans with their employers.

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. Their responsibilities included watching that company practices complied with labour legislation, ensuring workplace safety, providing employee assistance to those with addictions and psychological problems, and more recently having general oversight

of work-site fitness and wellness programmes, as discussed below. The American College of Occupational and Environmental Medicine had its beginnings in 1916 CE, and the journal *Industrial Health* (since renamed *Occupational Health & Safety*) was founded in 1932 CE, against the bleak back-drop of the financial crash.

One adverse aspect of Occupational Health in the U.S., which I encountered while working at the Kettering Laboratory in the University of Cincinnati, was that any corporation interacting with investigators exerted a close control over research findings (particularly if they were adverse). Abrams (1992) cited a typical letter from management to a prominent Industrial Researcher:

> *It is our understanding that the results obtained will be considered the property of those who are advancing the required funds, who will determine whether, to what extent, and in what manner they shall be made public*

9.4.6 Rehabilitation Programmes

The novel view that a programme of progressive aerobic exercise would help a person who had sustained a myocardial infarction was first advanced by Herman Hellerstein in Cleveland, OH, and by Viktor Gottheiner in Israel, during the late 1950s, Chap. 8). The hosting of the *International Conference on Physical Activity and Cardiovascular Disease in Toronto* in 1966 CE (Shephard 1967a) thrust Canada into the forefront of efforts in primary, secondary and tertiary cardiac rehabilitation. Initiatives began with apparently healthy individuals and those with established myocardial infarction, but extended progressively to patients with a variety of cardiac conditions and other chronic illnesses.

9.4.6.1 Primary and Secondary Cardiac Rehabilitation

Primary cardiac rehabilitation is a programme of preventive exercise, intended to conserve good health in a sedentary but otherwise healthy individual. Secondary cardiac rehabilitation addresses the needs of the person who (through inadequate habitual physical activity) has developed such cardiac risk factors as obesity, a high blood pressure and a high serum cholesterol. The series of major consensus conferences on physical fitness and health that were held in Ontario (above) placed Canada in a unique position to develop well-informed, evidence-based physical activity guidelines for rehabilitation of both the sedentary but otherwise healthy individual and those who remain symptom-free, but have developed known cardiac risk factors.

Over the past two decades, *Health Canada* (Sharratt and Hearst 2007) has worked with various Canadian scientists, both individually and in consensus groups (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 (Table 9.8). Various groups such as the

Table 9.8 Weekly physical activity for healthy adults aged 18–65 years as currently recommended by the Public Health Agency of Canada.

Be active at least 2.5 h/week
Focus on moderate to vigorous aerobic exercise in sessions of 10 min or longer
Add activities that target your muscles and bones at least 2 days/week

U.S. Surgeon General (U.S. Department of Health and Human Services 1996), a consortium of the American Heart Association and the American College of Sports Medicine (Garber et al. 2011), the World Health Organisation (1985) and the European Union (2008) have also developed recommendations, largely independently of each other. Although the general tenor of advice has been consistent, the details of these recommendations have inevitably differed somewhat one from another, and this has had the unfortunate effect of causing the general public to be sceptical about all of the advice that has been offered (Shephard 2002). Interestingly, the WHO (World Health Organisation 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., with Canadian groups arguing that in order to counter one of North America's most urgent current health problems, the obesity epidemic, the required volume of exercise might need to exceed 150 min of moderate aerobic activity per week.

Currently, the problem in most developed societies is that only a small proportion of the population meet any of the recent recommendations, and the big issue for those currently engaged in primary and secondary rehabilitation is to find an effective method of motivating those who remain sedentary.

9.4.6.2 Tertiary Cardiac Rehabilitation

Tertiary cardiac rehabilitation programmes are designed to address the needs of those who have developed symptomatic cardiac disease such as angina or myocardial infarction. Tertiary cardiac programmes first began to appear during the 1950s (Chap. 8). Soon after the *Toronto International Symposium on Physical Activity and Cardiovascular Disease* of 1966 CE, the *Toronto Rehabilitation Centre* (TRC), in association with the University of Toronto, began its tertiary cardiac rehabilitation programme under the direction of Terence Kavanagh. This quickly progressed to become one of the world's leading cardiac programmes. Kavanagh initially offered medically supervised programmes of progressive and relatively 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 a stable cardiac failure or who had received a cardiac transplant.

The Toronto programme incorporated several unique features relative to its contemporaries. 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 Kavanagh to offer carefully individualized exercise prescriptions of an appropriate intensity. Other cardiac rehabilitation facilities offered a brief (2–3 month) course of standardized thrice-weekly group 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 often spent in travelling to and from the rehabilitation centre, and the limited guidance that the patient received on arrival at the facility. All TRC sessions were thus medically supervised, with individualized exercise prescriptions and 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 "*exercise log*" (Kavanagh 1976). Although many of the standard rehabilitation programmes had a 6-month compliance rate of under 50 %, Kavanagh achieved a complianc rate of 82 % with his approach.

One measure of the therapeutic success of the Toronto approach was seen in 1973 CE, when eight post-coronary patients elected to participate 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 h 17 min (Kavanagh et al. 1974). This feat not only gave new courage to other 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).

9.4.6.3 Multi-centre Trials of Cardiac Rehabilitation

The 1960s and 1970s saw many randomized controlled trials attempting to test the efficacy of cardiac rehabilitation in terms of reducing recurrences of myocardial infarction and cardiac mortality. Meta-analyses across various trials suggested that mortality was reduced by around 20 % (Shephard 1986c). A recent systematic review and meta-analysis (Oldridge 2012) included 71 trials, based on a total of 13,824 patients. It found clear evidence of benefit in terms of all-cause and cardiac mortality, rates of non-fatal reinfarction and hospitalization, and changes in modifiable cardiac risk factors.

However, the multi-centre trial that was conducted in Ontario during the 1970s 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 that were 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 indeed seen in the more active of the two cohorts (Cunningham et al. 1990).

9.4.6.4 Rehabilitation in Other Chronic Conditions

The experience gained with cardiac patients was quickly transferred to the rehabilitation of patients with other medical conditions, beginning with chronic obstructive respiratory disease (COPD). As in the case of cardiac patients, there was much prejudice to be overcome. Until the middle of the twentieth century, the accepted wisdom had been that since the main symptom of COPD was dyspnoea, the best advice was to avoid unnecessary exertion. Alvan L. Barach, a Physician at the Columbia University in New York, was one of the first to offer a contrary opinion. He exercised two patients with pulmonary emphysema and dyspnoea, and noted (Barach et al. 1952):

> *The progressive improvement in the ability to walk without dyspnea, suggested that a physiological response similar to the training program in athletes may have been produced*

Another early pioneer of respiratory rehabilitation was Thomas L. Petty, at the University of Colorado. He established an effective out-patient programme for this class of patients during the late 1960s (Petty et al. 1969). Nevertheless, motivation to exercise proved more difficult with chest patients than in those with cardiac disease (Mertens et al. 1978), and the basis of clinical improvement following rehabilitation remains controversial. Some at first attributed benefit simply to an increase of motivation, a desensitization to dyspnoea and an improved mechanical efficiency of walking (Belman 1986). However, it was later appreciated that many investigators were using too low an intensity of effort, and with an adequate stimulus physiological adaptations could develop in those with COPD, including a lesser production of lactate in strengthened muscles (Casaburi et al. 1991) and increased muscle enzyme activity (American Thoracic Society and European Respiratory Society 1999).

The international consensus conferences (above) identified many other diseases and conditions 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.

9.4.7 Other Developments in Public Health

Other developments in Public Health during the Post-Modern Era have included definitive recognition of the toxicity of cigarette smoke, increased control of

Fig. 9.23 Advertisement from 1907 CE, promoting the use of cigarettes for the relief of various respiratory conditions (Source: http://en.wikipedia.org/wiki/History_of_smoking)

automotive emissions, appearance and control of the HIV/AIDS epidemic, a growing reluctance to accept childhood vaccinations, and the rapid spread of infections by international air travel.

9.4.7.1 Recognition of the Toxicity of Cigarette Smoke

In the Edwardian Era, cigarette manufacturers had promoted their wares as the cure for various respiratory conditions such as asthma and hay fever (Fig. 9.23). As early as 1912 CE, an American physician, Isaac Adler (1849–1918 CE), pointed to the growing incidence of lung cancer, and speculated that the abuse of tobacco and alcohol might be possible causes (Adler 1912). Anti-smoking groups developed in Germany following World War I, and a magazine (*Deutsche Tabakgegner; German Tobacco Opponents*) was published from 1919 to 1935 CE (Lickint 1929). The Nazi regime was opposed to smoking, with Hitler declaring it a waste of money. In particular, women who smoked were considered as unsuitable to be German wives and mother, and Werner Huttig of the *Rassenpolitisches Amt* (*Office of Racial Politics*) pointed out that a smoking mother's breast milk contained nicotine (Proctor 1999). Nazism was in part a movement of health-conscious, muscular men, and during World War II, much propaganda was made from the fact that the three Fascist leaders (Hitler, Franco and Mussolini) were all non-smokers, whereas Churchill, Roosevelt and Stalin were all heavy users of tobacco (Proctor 2001).

Evidence of the toxicity of tobacco products accumulated during the Modern Era. In 1929 CE, Fritz Linkint (1898–1960 CE) of Dresden demonstrated an increased prevalence of lung cancers in smokers. He underlined the (then) 4–5

fold greater prevalence of lung cancer in men than in women, and he related this to the fact that the smokers were mostly men. His finding was confirmed in a case-control study by Franz Hermann Muller of Cologne in 1939 CE, and by Eberhard Schairer and Eric Schöniger at the University of Jena in 1943 CE (Proctor 2012). During the 1950s, Ernst Wynder (1922–1999 CE), a German *emigré* working at the Sloan-Kettering Institute in the United States, and Richard Peto and Bradford Hill at Oxford University in Britain advanced even more compelling evidence that cigarettes were carcinogenic. Hill concluded that consuming 35 cigarettes per day increased the odds of dying from lung cancer fortyfold (Doll and Hill 1954).

Other damning evidence came from cellular pathology, animal experimentation and the demonstration of toxic chemicals in cigarette smoke (Proctor 2012). However, for a substantial part of the Post-Modern Era, public health workers had to combat the deliberate campaign of cigarette manufacturers to confuse the general public. In secret documents, the manufacturers were well aware of the facts by the early 1950s, but after a dip of sales in 1953 CE, their misleading propaganda was able to increase U.S. cigarette sales through the 1960s and 1970s, to a peak of 630 bullion units in 1982 CE. As late as 1960 CE, the American Cancer Society found that only a third of U.S. doctors considered smoking as "*a major cause of cancer*," and 43 % of physicians were still smoking on a regular basis. Tobacco manufacturers were glad to discover that their 1972 film "*Smoking and health: The need to know*" had reduced the certainty of viewers about the dangers of cigarettes from 75 to 57 % (Proctor 2012).

Nevertheless, beginning in the mid 1970s, there was a dramatic decrease in the social acceptability of cigarette smoking, and growing restrictions were placed upon the areas where smoking was permitted. This came about in part from demonstrations that passive exposure to cigarette smoke gave rise to small but significant increases in the risks of chronic respiratory disease and asthma in childhood, and carcinoma of the lungs and cardiovascular disease in adults, and in part from public polls showing a rising acceptance of public health measures to control smoking (Shephard 1982b). As with the direct effects upon smokers, cigarette manufacturers went to great pains to obfuscate the risks of passive exposure to cigarette smoke, but adverse effects were clearly demonstrated during the 1980s, not only by epidemiological research, but also by the exposure of volunteers to machine-generated cigarette smoke while exercising in closed chambers (Shephard et al. 1983; Urch et al. 1985).

Public health workers continue to face many challenges in the area of tobacco control, with manufacturers doggedly resisting measures designed to reduce consumption, such as price increases, prohibition of sponsorships, and plain packaging, and ever seeking methods of creating new addicts through such tactics as flavoured and electronic cigarettes.

9.4.7.2 Control of Automotive Emissions

Although the Modern Era saw a dramatic drop in the sulphur/large particulate smog associated with coal fires, at least in developed societies (Chap. 8), air pollution

problems continued from automotive exhaust in most major cities, particularly during periods of thermal inversion.

Detailed studies of the urban carbon monoxide exposure of cyclists and pedestrians were undertaken during the 1970s. Substantial concentrations of carbon monoxide were recorded on congested streets, particularly if air movement was impeded by tall buildings, but in healthy individuals any build-up of carboxyhaemoglobin was reversed quite quickly when the individual moved to a less polluted area. The only adverse clinical effect was a somewhat earlier onset of angina if a person with coronary atherosclerosis exercised on a heavily polluted street (Shephard 1983b).

During the 1970s, chamber experiments sought to document acceptable exposures to ozone, which had been formed by the action of sunlight upon the nitrogen oxides from vehicle exhaust. Investigators included Steve Horvath and colleagues in Santa Barbara, California (Horvath et al. 1979) and Larry Folinsbee and associates in Toronto (Folinsbee et al. 1977). The threshold concentration of ozone causing a minor disturbance of respiratory function in healthy exercisers was found to be around 0.75 p.p.m, a level encountered in some cities on heavily polluted days.

To date, improved emission controls have done little more than match the increase in vehicle registrations, and at some times of the year, several cities such as Paris and Beijing have needed to forbid the access of drivers to the centre of cities on alternating days. The issue of ozone exposure has also raised concern at several Olympic Games (Folinsbee and Schelegle 2000), particularly Los Angeles (1984 CE) and Beijing (2008 CE). Since ozone levels show a marked diurnal cycle, one immediate remedy for the athlete is to exercise at less heavily polluted times of day (early morning or late at night). The ultimate solution to the problem of automotive exhaust probably lies in the replacement of gasoline-driven by electric vehicles.

9.4.7.3 The Epidemic of HIV/AIDS

The virus responsible for HIV/AIDS was transmitted from primates to humans in sub-Saharan Africa, probably in the late nineteenth or early twentieth century. Because the incubation period is long, the exact date of arrival of the infection in the North America mainland is uncertain, but it was probably transmitted via Haiti, in the late 1960s (Gilbert et al. 2007). The epidemic officially began in the U.S. in 1981 CE, when the Centers for Disease Control reported a clustering of cases of *Pneumocystis pneumonia* in homosexual men in Los Angeles. The concentration among homosexual individuals suggested the possibility of a sexually-transmitted disease (Centers for Disease Control 1982) and the syndrome was initially named GRID (gay-related immune disorder). However, it was quickly realized that the condition was not limited to homosexual individuals, but was seen also in intravenous drug users, haemophiliacs and others receiving blood transfusions. Thus, in

August 1982, CDC coined the new term AIDS. The virus responsible for the disease was discovered the following year by Luc Montagnier and his associates at the Pasteur Institute in Paris (Barré-Sinoussi et al. 1983).

Much effort has since been devoted not only to finding highly effective anti-retroviral agents, beginning with zidovudine (1987 CE), but also in devising measures to reduce transmission of the disease. Particular emphasis has been placed upon the wearing of condoms during sexual intercourse, in providing sterile needles for drug users through programmes of needle exchange and supervised injection sites, and in ensuring sterility in drug injection treatments of tropical diseases. Nevertheless, success in controlling the epidemic has as yet been only partial. In the U.S. the disease had already claimed 575,000 lives by 2006 CE; a further million were living with the disease, and 56,000 fresh cases were diagnosed in that year. In rural Africa, the situation is even worse, with as many as a third of young adults currently infected.

9.4.7.4 Decreasing Acceptance of Childhood MMR Vaccinations

During the early part of the Post-Modern Era, successful childhood vaccination campaigns brought the incidence of mumps, measles and rubella (MMR) to a very low level in most developed countries. In the U.S., the prevalence of rubella dropped from 58 cases per 100,000 children in 1969 CE to 0.5 cases per 100,000 in 1983 CE (CDC 2014c), and in Europe, the WHO has set the year 2015 CE for the elimination of measles and rubella from the European region.

However, the percentage of children being vaccinated has decreased recently in North America, with parents weighing the low current risk of MMR infections relative to the supposed dangers of meningo-encephalitis and autism associated with vaccination. Fears about causing autism stemmed from a paper published in the Lancet in 1998 CE by a British physician named Andrew Wakefield. Extensive research by CDC, the U.S. National Academy of Science, the British National Health Service, and the Cochrane library found no evidence to support his claims. There were numerous problems with the original article, including the manipulation of data. The paper was described as fraudulent by the British Medical Journal (Godlee et al. 2011) and in 2010 CE it was withdrawn by the Lancet. Godlee commented (Godlee 2011):

> *The original paper has received so much media attention, with such potential to damage public health, that it is hard to find a parallel in the history of medical science. Many other medical frauds have been exposed but usually more quickly after publication and on less important health issues*

The British General Medical Council found Wakefield found guilty of serious professional misconduct, and he was struck from the Medical Register. There have been small outbreaks of measles consequent upon the decrease in vaccinations (Jansen et al. 2003), and despite extensive research, many of the general public remain convinced that vaccination can cause autism.

9.4.7.5 International Spread of Infections Through Air Travel

Acute infectious disease can now spread very rapidly from one country to another, due to growing global air travel. This is well exemplified by the epidemic of SARS (severe acute respiratory syndrome). The disease appears to have begun in mainland China in November of 2002, and in part due to delayed reporting by the Chinese authorities, it spread rapidly, with the WHO issuing a global health alert on April 11th 2003. Fortunately, application of rigid quarantine measures to all travellers with signs of infection contained the epidemic, with relatively few deaths in North America. There were a few isolated cases subsequently, but by July 5th 2003, the WHO was able officially to declare the SARS epidemic as contained.

9.5 Fitness and Training

The Post-Modern Era has seen a renewed interest in physical fitness, with the development of test and screening protocols, repeated National surveys, the introduction of new training techniques, the design of fitness programmes for workers and the elderly, the setting of occupational fitness requirements, the development of motivational programmes, and vindication of the hunter-gatherer lifestyle as a means of sustaining health and fitness.

9.5.1 Factors Stimulating and Sustaining a Renewed Interest in Physical Fitness

The military demands of World War II and the poor fitness of young men attending recruiting depots stimulated a temporary interest in enhancing fitness in both the general population and in recruits to the Armed Services in North America. However, with the cessation of hostilities, enthusiasm quickly waned. In the U.S., fitness concerns were rekindled by the Kraus-Weber studies showing poor test results in American schoolchildren (Chap. 8), and in Canada the renewed focus upon fitness can be traced to criticisms of the physical condition of Canadians made by the Duke of Edinburgh (below).

9.5.1.1 United States

The *American Association for Health, Physical Education & Recreation* hosted 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) directed

American thinking towards endurance fitness, as he introduced his aerobic test (the 12-min run) and the associated *Aerobics* training programme in an attempt to enhance the fitness of U.S. Air Force personnel (Cooper 1968) (Chap. 8). However, the Physical Education Departments at many American High Schools continued to focus upon the success of their sports teams, rather than upon the fitness of the entire student body.

An appreciation of the importance of increasing the fitness of the general population began to develop through the efforts of the *President's Council on Fitness,* founded in 1965 CE (Chap. 8). The funding of this Council was relatively modest, and it operated largely by persuasion rather than the operation o/f specific programmes, encouraging major industrial corporations to develop fitness programmes for their employees and School Boards to increase their interest in fitness programming for school children.

Much of the new American interest in fitness was sustained by individual Physicians and Sports Scientists. Cooper opened a large up-scale fitness and health facility in the suburbs of Dallas in 1970 CE, and he began to collect an enormous volume of data on relationships between habitual physical activity and laboratory measurements of fitness and health. He set up a research wing to his facility, and a team of epidemiologists led by Steve Blair established much convincing evidence on the benefits of regular exercise in the prevention and treatment of various clinical conditions (Blair et al. 1989). Several other major longitudinal studies further encouraged the fitness movement, including the Framingham study (begun in 1947 CE, and directed throughout much of its course by Arthur Kannel; Oppenheimer 2005) (Fig. 9.24) and the Harvard Alumni study (initiated by Ralph Paffenbarger in 1977 CE (Chap. 8), and continued by I-M Lee; Sesso et al. 2000).

Other important influences sustaining the U.S. interest in fitness over the past 40 years have included the American College of Sports Medicine (Chap. 8), the American Heart Foundation, the Office of the U.S. Surgeon General (U.S. Department of Health and Human Services 1996) and the Centers for Disease Control and Prevention.

Fig. 9.24 U.S. interest in the benefits of physical activity and fitness during the post-Modern Era was stimulated by a number of major longitudinal studies, such as that examining activity and health outcomes in the community of Framingham, MA (Source: http://en.wikipedia.org/wiki/Framingham,_Massachusetts)

9.5.1.2 Canada

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 CE. More recently, the *5 BX plan* (Orban 1961) offered personnel of the *Royal Canadian Air Force* an 11-min daily exercise plan that could be completed "*beside your bed in the barracks*." However, the defining moment for a resurgence of interest in health and fitness in Canada came in 1959 CE, 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 (below). His remarks were widely publicized, and they provoked a flurry of activity in the Canadian legislature, in the University sector and among the general populace.

The Canadian Federal government began to play a substantial role in directing and funding new fitness initiatives. An early response was seen in 1963 CE, 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 regarded as a junior ministry, the incumbent Minister 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 Cabinet appointment. 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 around the world, there were also frequent changes of name and administrative organization. In 1971 CE, 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 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. *Recreation Canada* was renamed *Fitness and Recreation Canada* in 1977 CE, and two additional Directorates (*Programme Operations* and *Administration, and Planning, Research and Evaluation)* were created. The responsibilities of *Recreation Canada* now included programming for sport and recreational 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 CE from the fitness and recreation branches of the *Fitness and Amateur Sports Directorate*. In 1979 and 1980 CE, responsibility oscillated with alarming rapidity between *National Health & Welfare*, the *Secretary of State* and the *Minister of Labour*. By 1993 CE, *Fitness and Amateur Sport* comprised three divisions, entitled *Sport Canada*, *Fitness Canada*, and *International Relations and Major Games*. A final reorganization occurred in 1993 CE. 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 CE, with enactment of the new *Physical Activity and Sport Act*.

The *Fitness and Amateur Sport Directorate* began its life with an annual budgetary allocation of $5 million. This allowed, among other initiatives, the creation of three University-based *Fitness Research Units* in 1963–1964 CE. 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 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. Doctoral programmes in the Exercise Sciences were quickly launched in both Toronto and in Edmonton, with Terence Anderson in Toronto becoming the first Canadian Ph.D. Exercise Science graduate, in 1966 CE. Another early initiative of the Toronto Fitness Research Unit, with the support of Fitness Canada, the Canadian Heart and Stroke Foundation, the Ontario Heart Association and the Canadian Medical Association, was the hosting of the world's first *International Symposium on Physical Activity and Cardiovascular Disease*. This event took place in October of 1966 CE 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 1967a).

The Canadian Medical Association and the Federal and Provincial Heart Associations continued to maintain a strong interest in fitness in the years following this landmark conference. Other factors stimulating Canadian interest in fitness during the Post-Modern Era included establishment of the motivational agency ParticipACTION in 1971 CE (below) and the fitness monitoring agency the Canadian Fitness and Lifestyle Research Institute (established in 1980 CE, under the direction of Cora Craig).

9.5.1.3 Other Countries

Other countries also developed mechanisms for the encouragement of fitness and physical activity during the Post-Modern Era. For example, in Great Britain, the Sports Council was established in 1972 CE, initially under the chairmanship of Roger Bannister; it set as its motto "*Sport for all*," and a substantial amount of funding began to flow to the development of sports centres and sports facilities. However, in 1994 CE, responsibility for mass participation was transferred to local authorities, and in 1997 CE a new Sports Council was established under Sebastian Coe, to focus the available National funds upon athletes and sports in which Britain judged it had a chance of winning Olympic medals.

In Australia, many of the fitness initiatives have been taken at a State rather than a Federal level. *Physical Activity Australia* began in Victoria in 1982 CE, with formation of the *Victorian Council on Fitness and General Health*, and in 1987 this body began registering Exercise Professionals. The group evolved into the nationwide *KinectAustralia* in 2005 CE, and it is now known as *Physical Activity*

Australia. New South Wales now has a Minister for Healthy Lifestyles, and will spend $70 million over the period 2013–2018 CE to promote healthy lifestyles in working adults. There is also a fitness industry-based group known as *Fitness Australia*.

9.5.2 Testing and Screening Protocols

Many nations became eager to measure fitness in representative samples of their populations during the Post-Modern Era, both to provide initial benchmark data and to monitor the effectiveness of fitness promoting initiatives. However, the standardization of testing and screening protocols was seen as a necessary preliminary to this endeavour.

9.5.2.1 Toronto Working Party

The newly publicized Canadian interest in health and fitness attracted an International Biological Programme/World Health Organisation *International Working Party* to standardize methods for the measurement of maximal oxygen intake and other aspects of fitness testing. This met at the University of Toronto for 3 months during the summer of 1966 CE (Shephard et al. 1968a, b, 1969). This initiative was seen as critical to the efforts of the Human Adaptability Project of the International Biological Programme, which planned to compare fitness levels between populations in terms of their habitat during the early 1970s (Shephard 1978). A good consensus on appropriate exercise test protocols was reached among those attending the working party, although unfortunately their findings were not implemented by some of the Exercise Scientists who did not attend the event. Too often, the latter group preferred to continue with their individual laboratory's pattern of testing, in part because they had already accumulated much data based on their own specific protocol.

9.5.2.2 WHO and IBP Involvement

In the fall of 1966 CE, following completion of the working party studies, the World Health Organisation convened a Committee to write a report on the *Fundamentals of Exercise Testing*, and I was summoned to Geneva to serve as the *Rapporteur* of this group (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 and fitness. Individual laboratories were generous

Fig. 9.25 The Human Adaptability Project of the International Biological Programme compared the fitness levels of populations living in many widely differing habitats, including the Easter Islands (Shephard 1978) (Source: http://en.wikipedia.org/wiki/Easter_Island)

in contributing data, and a comprehensive picture was established of fitness levels in many parts of the world (Fig. 9.25). Somewhat surprisingly, the effects of habitat upon fitness seemed relatively minor. It was speculated that in harsh environments, survival depended more upon accumulated hunting skills than upon the unusual development of aerobic power or muscular strength (Shephard 1978).

9.5.2.3 Laboratory Accreditation

Even when using a mutually agreed protocol, inter-laboratory differences in determinations of maximal oxygen intake could arise through systematic errors of technique, particularly in determining the concentrations of expired gas and the power output developed on laboratory cycle ergometers. Canadian interest in the standardization of laboratory testing thus continued throughout the 1970s. This was particularly critical in evaluating the fitness of Canadian athletes, who were tested in widely-separated parts of the country as they moved to different Provinces for training and competition.

A Canadian Laboratory Accreditation project was organized by Norm Gledhill and Art Quinney (Quinney et al. 1996), and the accuracy of values obtained on a panel of subjects by any given laboratory was carefully reviewed before that group of investigators was certified as an *Accredited Fitness Appraisal Centre*. Likewise, in preparation for the *Ontario Multi-Centre Exercise-Heart Trial* of tertiary cardiac rehabilitation (above), a team of investigators led by Norman Jones 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).

9.5.2.4 Procedures for Mass Field Testing

Until the mid 1960s, large-scale fitness surveys in the U.S. and Canada had relied largely 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 evaluations 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).

In 1967 CE *CAHPER* conducted a Nation-wide cluster survey of the fitness of Canadian children, taking cycle ergometers into selected schools (Howell and MacNab 1968). However, when a Nation-wide survey of fitness in adults. was being planned, it did not seem feasible to carry cycle ergometers to thousands of homes scattered widely across the country. 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 had originated with the *Toronto International Working Party* on aerobic fitness measurement, above (Shephard et al. 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 Inuit words for 1, 2, 3.... I discussed this finding with representatives of *ParticipACTION* and *Fitness Canada*, and in 1973 CE we decided to develop a *Home Fitness Test Kit* around an LP recording of music that set a stepping rhythm appropriate to a person's age and sex (Fig. 9.26). 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

Fig. 9.26 The Canadian Home Fitness Test, developed in 1973 CE around a step test with age and sex-specific pacing provided by an LP recording

player the speed of the music slowed as the centre of the LP disc was approached (this problem has since been overcome, as the use of tapes and CDs now provide a standard musical cadence for the test).

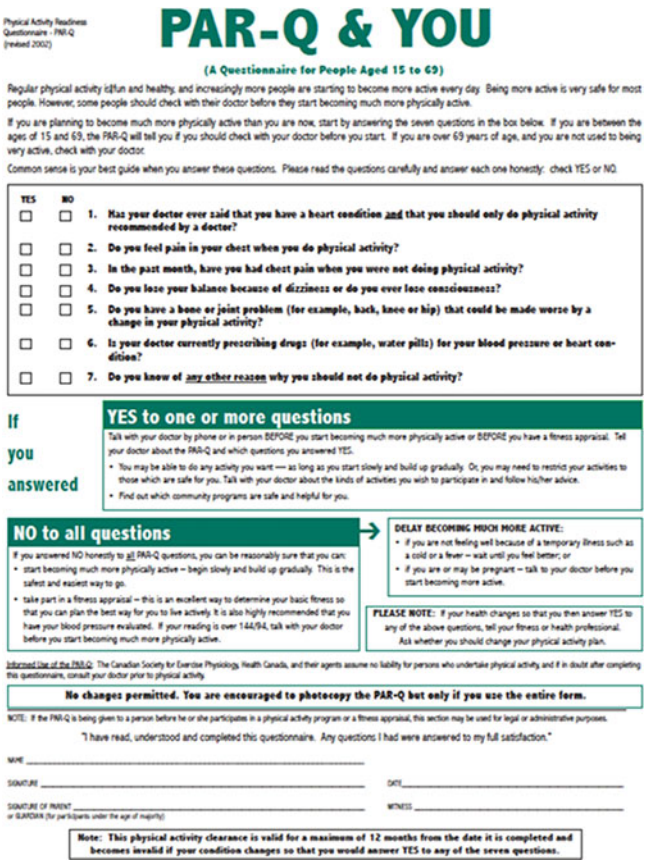
A detailed laboratory test manual for field testing of aerobic fitness, muscular strength, flexibility and obesity was developed by Norm Gledhill for the undergraduate programme at York University, and it forms the basis for the field test protocol currently outlined in the *Canadian Physical Activity, Fitness & Lifestyle Approach (CPAFLA)* (Gledhill and Jamnik 2003), used in the training of Canadian Certified Exercise Test Professionals.

9.5.2.5 Pre-test Screening

Before mass exercise testing could be carried out on older people in the home environment, there was a need for an agreed procedure to screen out high-risk individuals who required their exercise tests to be conducted under immediate medical supervision.

The U.S. approach to screening was developed during writing of the 1975 CE edition of *ACSM's Guidelines for Exercise Testing and Prescription* (American College of Sports Medicine 1975, 2013). The main focus was upon age and standard cardiac risk factors, using these indicators to decide whether medical examination and exercise testing was required prior to participation in an exercise programme, and whether Physician supervision of exercise testing was necessary. Successive editions of this popular resource have covered ever more potential contingencies in the screening of healthy individuals and those affected by a variety of clinical conditions.

The need for pre-test screening was recognized slightly earlier in Canada; potential 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 standard double-step test, and this approach seemed to provide a simple and relatively effective approach to exercise clearance. The clearance 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 (Fig. 9.27) failed to correct this problem (Thomas et al. 1992), and during the last 3 years Darren Warburton and his colleagues have 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 in clinical conditions where the safety of testing is still unclear (Warburton et al. 2011c).



Physical Activity Readiness Questionnaire - PAR-Q (revised 2002)

PAR-Q & YOU

(A Questionnaire for People Aged 15 to 69)

Regular physical activity is fun and healthy, and increasingly more people are starting to become more active every day. Being more active is very safe for most people. However, some people should check with their doctor before they start becoming much more physically active.

If you are planning to become much more physically active than you are now, start by answering the seven questions in the box below. If you are between the ages of 15 and 69, the PAR-Q will tell you if you should check with your doctor before you start. If you are over 69 years of age, and you are not used to being very active, check with your doctor.

Common sense is your best guide when you answer these questions. Please read the questions carefully and answer each one honestly: check YES or NO.

YES	NO	
☐	☐	1. **Has your doctor ever said that you have a heart condition and that you should only do physical activity recommended by a doctor?**
☐	☐	2. **Do you feel pain in your chest when you do physical activity?**
☐	☐	3. **In the past month, have you had chest pain when you were not doing physical activity?**
☐	☐	4. **Do you lose your balance because of dizziness or do you ever lose consciousness?**
☐	☐	5. **Do you have a bone or joint problem (for example, back, knee or hip) that could be made worse by a change in your physical activity?**
☐	☐	6. **Is your doctor currently prescribing drugs (for example, water pills) for your blood pressure or heart condition?**
☐	☐	7. **Do you know of any other reason why you should not do physical activity?**

If you answered

YES to one or more questions

Talk with your doctor by phone or in person BEFORE you start becoming much more physically active or BEFORE you have a fitness appraisal. Tell your doctor about the PAR-Q and which questions you answered YES.

- You may be able to do any activity you want — as long as you start slowly and build up gradually. Or, you may need to restrict your activities to those which are safe for you. Talk with your doctor about the kinds of activities you wish to participate in and follow his/her advice.
- Find out which community programs are safe and helpful for you.

NO to all questions

If you answered NO honestly to all PAR-Q questions, you can be reasonably sure that you can:

- start becoming much more physically active – begin slowly and build up gradually. This is the safest and easiest way to go.
- take part in a fitness appraisal – this is an excellent way to determine your basic fitness so that you can plan the best way for you to live actively. It is also highly recommended that you have your blood pressure evaluated. If your reading is over 144/94, talk with your doctor before you start becoming much more physically active.

DELAY BECOMING MUCH MORE ACTIVE:

- if you are not feeling well because of a temporary illness such as a cold or a fever – wait until you feel better; or
- if you are or may be pregnant – talk to your doctor before you start becoming more active.

PLEASE NOTE: If your health changes so that you then answer YES to any of the above questions, tell your fitness or health professional. Ask whether you should change your physical activity plan.

Informed Use of the PAR-Q: The Canadian Society for Exercise Physiology, Health Canada, and their agents assume no liability for persons who undertake physical activity, and if in doubt after completing this questionnaire, consult your doctor prior to physical activity.

No changes permitted. You are encouraged to photocopy the PAR-Q but only if you use the entire form.

NOTE: If the PAR-Q is being given to a person before he or she participates in a physical activity program or a fitness appraisal, this section may be used for legal or administrative purposes.

"I have read, understood and completed this questionnaire. Any questions I had were answered to my full satisfaction."

NAME _____

SIGNATURE _____ DATE _____

SIGNATURE OF PARENT or GUARDIAN (for participants under the age of majority) _____ WITNESS _____

Note: This physical activity clearance is valid for a maximum of 12 months from the date it is completed and becomes invalid if your condition changes so that you would answer YES to any of the seven questions.

Fig. 9.27 The 1991 modification of the PAR-Q questionnaire, developed for the preliminary screening of exercise test and programme participants aged 18–65 years

9.5.3 Population Surveys of Fitness and Physical Activity

With the new interest in fitness during the 1960s, Exercise Scientists in many countries faced demands to conduct representative surveys of population fitness and habitual physical activity. Such data were required to provide a benchmark of current status against which the success of health promotional initiatives might be judged. There was also the unexpressed hope that negative findings on North American fitness such as the Kraus/Weber surveys in the U.S., and alarming comparisons of maximal oxygen intake between Swedish and Canadian populations might be proven wrong.

9.5.3.1 U.S. Surveys

In the United States, preparations for a series of National Health and Nutrition Examination Surveys (NHANES) began in the 1960s. The first survey, in 1971 CE,

ranged over many areas of health, including anthropometry, spirometry, resting electrocardiograms, chest radiographs, assessments of bone health and biochemical tests, but there were no measures of physical activity or fitness. NHANES II (1976–1980 CE) and NHANES III (1988–1994 CE) included estimates of food intake, and allowed estimates of the prevalence of obesity, but again there was no direct measure of fitness. Beginning in 1999 CE, these surveys were conducted on an annual basis.

The Behavioral Risk Factor Surveillance System conducted telephone interviews with large samples of the U.S. population, beginning in 1984 CE. These annual surveys provided subjective reports on nutritional behaviour and physical activity patterns, but again no information on fitness levels was obtained. The weakness in this approach is that self-reports of physical activity are notoriously unreliable, and many respondents undoubtedly exaggerated their activity levels.

Many individual U.S. laboratories have reported on the maximal oxygen intake of their subjects (Hawkins and Wiswell 2003), but this data provides little guidance concerning population fitness, since the samples tested were non-representative.

9.5.3.2 Canadian Fitness Surveys

Given the concerns of the Canadian government for baseline data, I had spent a fair part of 1966 CE 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 1966a). The values which had been reported by the Åstrands for residents of Stockholm far exceeded those for people from most other countries. Close examination of their publication suggested that the high Swedish figures might be due at least in part to a selective sampling of the Stockholm population. However, in 1971 CE the Canadian motivational agency *ParticipACTION* began "selling" the Canadian need for physical fitness by airing TV cartoons that showed a 60-year old Swede walking past a 20-year-old Canadian jogger, a haunting image that has long challenged Canadian egos, and stimulated the desire for representative data on the fitness of Canadians and those of other nationalities.

In 1980 CE, the Canadian Federal government created the *Canadian Fitness and Lifestyle Research Institute (CFLRI)*, under Cora Craig. Two years later, she directed a first *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 1986a). This first Survey was conducted in 1982 CE (Canada Fitness Survey 1983; Shephard 1986a). Despite the high costs of sending health professionals to make domiciliary measurements in a country as large as Canada, data on height, body mass, skin folds, grip strength, predicted maximal oxygen intake, and back flexibility were obtained on a large and representative stratified sample of the Canadian population over a summer of home visits.

Because of costs, several subsequent CFLRI surveys such as the 1988 *Campbell Survey on Well-Being in Canada* used physical activity questionnaires rather than direct physiological measurements. However, because of the systematic errors in questionnaire estimates, pedometer measurements 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). The pedometer data suggested that most people were taking substantially less physical activity than they had been reporting in traditional questionnaires.

9.5.3.3 Population Surveys of Habitual Physical Activity

When making direct measurements of habitual physical activity, one critical issue is the number of days of observation that are needed to provide a representative indication of a person's habitual behaviour. In the early 1960s, the *International Biological Programme* considered that recording physical activity patterns on two weekdays and two week-end days (Weiner and Lourie 1969) was adequate to obtain representative data. However, this necessarily ignored seasonal effects, which can be quite large in some climates. More recent studies, where recording has 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). Although not always easy to organize, it has been demonstrated that the most economical method of obtaining representative data is to randomize observations in terms of both day of the week and month of the year.

Pedometer/accelerometers now allow the collection of information about the physical activity patterns of quite large populations, and the findings generally 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 artefacts arising from travel in a vehicle over rough terrain.

9.5.3.4 Levels of Habitual Physical Activity in the General Population

Most indicators currently point to a widespread prevalence of low levels of habitual physical activity in all age groups, at least in developed societies. Because of changes in the structure of dwellings and the introduction of labour-saving devices, 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). The *U.S. Bureau of Labor Statistics* has also drawn attention to 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.). The U.S. analysis is based upon the changing distribution of employment, 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 typical 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 CE, but represented less than 2 % of workers in 2000 CE (migrant workers were excluded from this comparison, although they are now the main source of field workers in the U.S. and Canada). In all, Brownson and colleagues estimated that 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.

More general 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 obtain repeated self-reports of leisure-time activities in very large population samples, beginning in 1986 CE. Such data 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 CE, the reported 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 CE, leading to a 7.4 % decrease in active commuting, and daily television viewing increased steadily by 36 min per decade between 1950 and 2000 CE.

Estimates of physical activity patterns in Canada are almost equally discouraging. *Canada's Physical Activity Guides for Children and Youth* reported that over half of Canadian children and youth aged 5–17 were not active enough for optimal growth and development (Statistics Canada 2007–2009); moreover, 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.

Nevertheless, those responsible for the promotion of physical activity in Canada, 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 CE (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, the interpretation of secular trends in the Canadian data is complicated by changes in methodology and questionnaire wording from one survey to another.

Most other developed nations have also experienced adverse trends. Thus, in Finland, a study of 59,028 men and women showed that between 1972 and 2002 CE, 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 to 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 CE (Norman et al. 2003). The proportion of men in England and Wales who were active for at least 30 min per week declined from 1994 to 1998 CE (Prior 1999). In Catalonia (Southern Spain), residents showed decreases in both active employment and active commuting from 1992 to 2002 CE, 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 CE (Food and Agriculture Organisation 2009), and urbanization reduced the average total energy expenditure by 1.2–1.6 MJ/day (James 2008).

9.5.4 New Training Techniques

Several new techniques of conditioning became popular over the Post-Modern Era, including *Fartlek*, eccentric and plyometric training. Much more attention has also been directed to the issue of over-training.

9.5.4.1 Fartlek Training

The term *Fartlek* means "*speed play*." This type of conditioning comes from Sweden. It combines periods of continuous and interval training, for instance moderately paced running interspersed with 50–60 m sprints. It was originally

introduced in 1937 CE by the Swedish decathlete and track coach Gösta Holmér (1891–1983), and was intended to develop both aerobic and anaerobic performance (McArdle et al. 2010). It lacks the precision of continuous or interval training, but is probably a good method of improving general physical condition, and maintaining fitness between competitive seasons.

9.5.4.2 Eccentric Training

Eccentric exercise implies contraction of the muscle as it is undergoing lengthening, one common example being the person who is running downhill. Eccentric activity tends to produce muscle soreness. However, progressive training with this form of exercise may reduce the severity of such symptoms, either prophylactically or therapeutically. The concept of eccentric training was first introduced in 1953 CE by the Muscle Physiologist and Physician to the Danish Poliomyelitis Rehabilitation Centre, Erling Asmussen (1907–1991 CE). It is often used in the treatment of chronic tendinitis (Stanish et al. 1986; Alfredson et al. 1998).

9.5.4.3 Plyometric Training

Plyometric training has become a preferred method of conditioning for the gymnast. The jumping exercises that are required increase relaxation of the antagonist muscles, with an improvement of coordination and leg strength, while possibly avoiding the muscle bulking that some gymnasts fear (Taktak et al. 2013). Introduction of the concept of plyometrics in the late 1960s is credited to the Russian track and field coach and trainer Yuri Verkhoshansky, originally a physical education teacher at the Moscow Institute of Aeronautic Engineers (Verkhoshanski 1967). The idea was brought to North America during the early 1980s by Fred Wilt (1920–1994 CE), a U.S. long-distance runner and subsequently an F.B.I. agent, and Michael Yessis (who has popularized a number of Russian training techniques) (Wilt and Yessis 1984).

9.5.4.4 Over-Training

In the 1950s, international athletes such as Roger Bannister (Chap. 8) achieved world records with a surprisingly light training programme. However, the level of competition has increased steeply over the Post-Modern Era, and some athletes and their coaches have adopted the maxim that if a little training is good, more is undoubtedly better. This has not always proven to be the case. Sometimes, performance has deteriorated as weekly training schedules have been increased, and in some instances there have also been adverse clinical manifestations such as an increased vulnerability to upper respiratory infections (MacKinnon and Hooper 1994; Shephard 1997b). The affected competitors are said to be over-reaching,

or over-trained. Over-reaching is usually cured by a few weeks relaxation of training, but over-training may impair exercise performance for many months.

Coaches and Sports Scientists in North America spoke of "staleness" among athletes during the Modern Era (Griffith 1926; Morehouse and Rasch 1958), and European investigators began to speak of over-training in the early 1970s (Kereszty 1971; Mellerowicz and Barron 1971). More serious and widespread attention was directed to this question beginning in 1987 and 1988 CE (Morgan et al. 1987), but over-training has remained a clinical syndrome with no generally accepted single cause (Rowbottom et al. 2000). Moreover, there seem few reliable indicators of excessive training other than a deterioration in the individual's mood state (Verde et al. 1992).

9.5.5 Enhancing Fitness by Work-Site Programmes

Occasional far-sighted employers instituted work-site fitness breaks and even built work-place athletic facilities many years ago, but comprehensive work-site fitness programmes first became common-place during the 1970s. Assessments of their efficacy remain controversial, with a search for more broadly based and/or cheaper alternatives.

9.5.5.1 Fitness Breaks

One of the earliest proponents of a work-site fitness break seems to have been John G. Fitzgerald (1882–1940 CE) the first Director of the *University of Toronto School of Hygiene*. When he moved into the Rockefeller funded Fitzgerald building (Fig. 9.28), he urged his staff to spend 45 min each lunch-time playing deck tennis on the roof of the building. This was an unusual recommendation for his time. In the period before World-War II, many jobs required hard physical labour, and the

Fig. 9.28 John Fitzgerald, first Director of the University of Toronto's School of Hygiene (1927–1940 CE), recommended that his staff spent 45 min each day playing deck tennis on the roof of the Fitzgerald building (Source: http://en.wikipedia.org/wiki/Dalla_Lana_School_of_Public_Health)

attitude of Russian occupational hygienists was more typical. They argued that the demands of daily physical labour already imposed a dangerously heavy physiological load on a large proportion of Russian workers, and any added exercise might cause irreparable damage to health (Cantelon 1982).

After World War II, some studies from Europe began to show that quite brief "*relaxation breaks*" could enhance industrial output. In heavy types of work, a rest interval gave the best results. In stressful management positions, benefit was also seen in deliberate relaxation (Peters et al. 1977). But in many of the newer sedentary occupations such as telephone operators, the problem was boredom rather than physical fatigue, and in such situations performance was restored more readily by 5–10 min of exercise than by a corresponding period of passive relaxation (LaPorte 1966, 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 a formal 8-min *fitness break*. This was usually taken at the employee's immediate work-station, with a volunteer leading a scripted 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.

9.5.5.2 Comprehensive Work-Site Fitness Programmes

A few major corporations have for long recognized the benefits of a physically active labour force. In 1893 CE, the Quaker chocolate manufacturer George Cadbury bought a very pleasant 120 acre tract of land some 6 km outside of Birmingham. There, he developed a model village for his employees (Fig. 9.29). He was particularly concerned to maintain the health and fitness of his work force,

Fig. 9.29 A pleasant recreational area in the model village developed by George Cadbury, English chocolate manufacturer, beginning in 1893 CE (Source: http://en.wikipedia.org/wiki/Bournville)

ensuring that park and recreation areas were incorporated into plans for the village; he encouraged swimming, walking and outdoor sports, and laid out football and hockey pitches together with a running track (Tolman 1901). Likewise, in the U.S., the Pullman railcar company, established an athletic association for its employees as early as 1879 CE, and in the 1880s, the president of National Cash Register (NCR) was reputed to meet with his employees for horseback rides before work; later, NCR instituted twice-daily exercise breaks, built an employee gym, and constructed a 325-acre recreation park for its workers. Hershey Foods built a recreation complex, complete with a swimming pool, in the 1930s, and in the 1950s and 1960s Texas Instruments, Rockwell and Xerox Corporations all instituted employee fitness programmes (Chenoweth 2006).

During the 1970s, many larger companies in both the United States and Canada began to introduce comprehensive work-site fitness, health and worker assistance programmes. In the U.S., some employers saw such programmes as a response to the first oil crisis (1973–1974 CE), which had brought a sudden halt to two decades of rapidly expanding production. Russian reports also suggested that "worker-athletes" enrolled in the *GTO Organization* (Chap. 8) had a higher level of productivity than their sedentary peers (Pravosudov 1978), and the high productivity of Japanese industry was thought to result in part from massed work-site exercise programmes that many employers were offering to their staff (Okada and Iseki 1990).

In Canada, a community-wide fitness programme in the city of Saskatoon conducted by *ParticipACTION* in 1972 CE had proven both expensive and relatively ineffective in augmenting the physical activity of the population (Jackson 1975). The Canadian government thus welcomed the potential of work-site fitness initiatives as a low-cost and focussed alternative that could address the needs of the working population. A key stimulus to this new governmental initiative was a conference on *Employee Fitness,* convened in Ottawa in 1974 (Collis 1976). Papers presented at this meeting suggested that the costs of such work-site programmes would usually be borne by the employer and/or the worker rather than the government, and that the sponsoring companies might reap such dividends as an enhanced corporate image, the recruitment of premium employees, greater productivity, less absenteeism, and reduced health insurance costs.

One expression of the surging interest in employee fitness during the 1970s was formation of the *American Association of Fitness Directors in Business and Industry*. This organization was subsequently renamed the *Association for Worksite Health Promotion (AWHP)*, reflecting a shift of its objectives from simple fitness programming to more broadly-based wellness initiatives that addressed such issues as work-place stress, low back-problems, obesity and addictions. By the early 1990s, the U.S. group was boasting a membership of some 2,500. But around this time, many companies undertook a critical reappraisal of the loudly touted fiscal benefits of worksite wellness programmes; finding only limited evidence for their efficacy, funding was slashed, and this led to a rapid demise of the *AWHP*. Nevertheless, 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 their support of worksite health promotion.

9.5.5.3 The Issue of Blue-Collar Employees

One major criticism of most work-site fitness facilities was that they did not attract blue-collar workers; indeed, the facilities were sometimes only open to upper echelon employees. Even if admission was technically open to all classes of employee, programmes often 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 blue collar employees (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.

9.5.5.4 Assessing Programme Efficacy

It proved difficult to provide either Exercise Scientists or industrial management with convincing evidence of the postulated economic benefits of work-site fitness programmes, in part because of problems in organizing appropriate controlled studies in an industrial setting, and in part because the person charged with collecting subjective data on employee attitudes 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 when findings were reported dispassionately, the responses of workers were thus vulnerable to a fallacious "Hawthorne" effect (a favourable response kindled by a perception of greater management interest in their welfare). But often the observers, anxious to keep their own jobs, made over-optimistic assessments of programme success. During the 1980s, 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!

In 1977–1978 CE, a controlled, quasi-experimental study of work-site fitness programming was undertaken in downtown Toronto, 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,* Fig. 9.30) before and in the year following 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

Fig. 9.30 A quasi-experimental evaluation of an employee fitness programme was conducted at the Canada Life Assurance Company in downtown Toronto, beginning in 1977–1978 CE

relative to the control site. But the 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 at experimental and control companies (Shephard 1986b). Some sceptics had argued that a fitness programme would increase immediate medical costs, particularly for the treatment of musculo-skeletal injuries and for cardiac problems. However, the OHIP data showed small decreases in doctor and hospital visits by employees at the experimental work-site once the programme was in operation. Not only was the overall number of 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 of over 1,000 employees was sufficiently large to assess the overall success of a work-site fitness programme in a white/pink collar environment. 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 first year of observation. We were also able to obtain information on long-term adherence, and 12 years after initiation of the programme only a very small group of employees were actively using the exercise facility (Shephard 1992). One major problem, probably generic to large cities, was that long commuting distances limited the involvement of many employees in exercise programmes before or after work. From the viewpoint of population health, the downtown exercise facility also did not cater either to the families of employees or to the growing number of people who worked from home. In terms of enhancing National fitness, a further limitation of work-site fitness programmes is that for logistic reasons such initiatives

are largely restricted to companies with more than 100 employees (Linnan et al. 2008), and companies of this size are in the minority, particularly in Canada. One potential alternative, recently adopted by some small organisations, has been to subsidize membership of a commercial fitness club (Lucove et al. 2007).

9.5.5.5 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 1986b). In many operations, productivity had become a function of advanced technology rather than human physical input, so that the potential for a greater physical working capacity to augment output was necessarily reduced. Partly for this reason, the emphasis of many work-site programmes shifted from the development of physical abilities to the enhancement of overall employee function, including mental and psychological health. Some altruistic companies have seen the provision of a broadly-based health service as a worthy goal in its own right, and in the U.S., others have hoped that such an emphasis might counter ever-rising medical insurance premiums, a management cost still included in many union contracts.

New low cost initiatives to improve fitness at the work-site have included campaigns to encourage use of the staircase rather than the elevator, and the provision of bicycle lockers and showers to promote active commuting (Transport Canada 2014). In the case of staircase use, a spike in choosing this alternative has too often proven rather short-lived (Cohen 2013).

9.5.6 Fitness Requirements of Physically Demanding Occupations

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 apparent strength and stamina of a candidate. However, in recent years, the issue of denying employment on the basis of inadequate physical fitness has become a Human Rights concern, as a trend to elimination of mandatory retirement has highlighted the inherent conflict between the age-related decline in fitness and the unchanging physical requirements of demanding employment. Conflicts between management

and individual workers or their unions have been referred to the Equal Employment Opportunities Commission in the United States, and the Canadian Human Rights Commission north of the border.

9.5.6.1 The Legal Framework

John Kennedy established the *President's Committee on Equal Opportunity* in 1961 CE, to ensure that people were employed without regard to their race, creed, color, or national origin. In 1965 CE, this body was renamed the *Equal Employment Opportunity Commission,* with the broader mandate to investigate discrimination in employment based upon an individual's race, color, national origin, religion, sex, age, disability, genetic information, or retaliation for reporting, participating in, and/or opposing a discriminatory practice. Occupations that have received detailed physiological scrutiny under this legislation include not only the military, the police, and jail workers (Shephard 1990, 1991b), but also postal carriers (Shephard 1982a), bus drivers (Shephard et al. 1988a), and marine surveyors (Shephard 1983a).

The *Canadian Human Rights Commission* was established in 1977 CE. In 1982 CE, 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) of the legislation does not apply where age is a *bona fide* occupational requirement (BFOR). In other words, if age is affecting your ability to be a capable firefighter, then you can indeed lose your job because of your age. The issue was appealed to the Canadian Supreme Court. In 1999 CE, this body ruled that a BFOR must be "*objectively reasonable*," and it set specific guidelines to evaluate BFOR tests and standards. This judgment prompted extensive research by Occupational Physiologists, particularly a group at York University led by Norman 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 to determine the physical competence of 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 CE; it forced an equally careful consideration of the fitness capabilities of female employees.

9.5.6.2 Issues in the Design of Occupational Fitness Tests

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 average 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 question concerned the relative merits of task simulation vs. fitness-based testing (Bonneau 2001). In the Canadian Armed Forces, minimum criteria shifted frequently, suggesting that no test was entirely satisfactory. Normative referencing prevailed during the 1960s, firstly with an emphasis upon performance of the 5BX and 10 BX tests (1960s and 1970s), then on achievements in the 2.1 km run (1972–1980 CE), the BFOR (1978 CE), and a fitness test battery (1984 CE). An *Occupational Physical Selection Standard* was adopted from 1980 to 1984 CE, followed by the *Battle Efficiency Test* (1985 CE), an indoor obstacle course (1986 CE), the *Land Force Command Physical Fitness Standard* (1991 CE) and the *Basic Military Qualification* (2002 CE). Specific additional qualifications are now required for tasks such as parachuting or diving.

9.5.7 Fitness and Aging

As the proportion of older citizens has increased in developed societies, there has been growing interest in the potential to enhance their fitness and to design programmes suited to their specific needs. Research has shown that regular physical activity continues to prevent many types of chronic disease in the elderly. However, an enhanced quality of life and an extended period of independent living become more important objectives than simply preventing chronic disease. A 20 % increase in maximal oxygen intake or muscular strength can in some instances reduce a person's biological age by 10–20 years, with a corresponding delay in the age at institutionalization (Shephard 1997a). Indeed, many physically active individuals seem likely to die without the need for prolonged institutional care.

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 take place approximately every 4 years. The most recent (8th) Conference was held in Glasgow (2012 CE). The *Journal of Physical Activity & Aging,* now in its 22nd year, has become the official organ of this coalition. The specific 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 CE (Canadian Public Health Association 1983).

A 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 (Shephard 1997a; Radak et al. 2010).

9.5.8 Motivational Awards

Many countries seek to encourage physical activity and sports through motivational awards. Most commonly these are given to children, but in some countries (for example, the U.S.), awards have also been given to adults.

9.5.8.1 U.S.

The original Presidential Fitness Awards, established in 1966 CE, were based on passing empirical standards set for 6 criteria (a 50-yard dash, a 600 yard walk-run, a standing broad jump, pull-ups, sit-ups and a soft-ball throw). Recognizing that test failure could have a negative impact on the students concerned, the U.S. moved to a percentile-based fitness award system in 1991 CE. A *Presidential Award* was given to students scoring at or above the 85th percentile on all six criteria; a *National Physical Fitness Award* was presented to students who scored above the 50th percentile on all criteria, and students who participated, but fell below the 50th percentile on one or more tests still received a *Participant Physical Fitness Award*. This programme ended with the 2012–2013 school year; it has been replaced by the *Presidential youth fitness programm*e with a FITNESSGRAM® assessment. Relatively low standards are now set, on the hypothesis that children gain substantial benefit from even modest increases in their habitual physical activity.

In 1997 CE, the U.S. introduced a *Presidential Active Lifestyle Award*. For adults, the requirements were to undertake physical activity for 30 min 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 min of physical activity a day, for at least 5 days a week, during 6 out of 8 weeks, or to maintain a pedometer count $>$ 12,000 steps/day, plus attaining healthy eating goals. Finally, a *Presidential Champions' Award* was introduced for those who were successful in raising their level of physical activity, with bronze, silver, gold and platinum levels, based on the magnitude of the self-reported increases that were attained.

One setback for the Presidential programme was the hacking of its web-site in 2012 CE. This released personal information on some of the programme participants. The site was shut down for several days, and users were advised to change their passwords.

9.5.8.2 Canada

Fitness and Amateur Sport launched the *Canada Fitness Award Programme* in 1970 CE. The basis of assessment was similar to that in the U.S. Participants were required to perform six tests: a 2.4 km endurance run, a shuttle run (4 trips back and forth, picking up and dropping objects), pushups, 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 CE, 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 CE. As in the U.S., critics argued that it discouraged those who failed to achieve even the minimum grade, yet these were the children who most needed encouragement to become more active.

9.5.9 Motivational Agencies

The governments of many countries have engaged in short-term local campaigns intended to boost the physical activity of the population, and TAFISA (the Trim and Fitness International Sports Association) now claims to represent some 153 countries. On a more local basis, Viktor Matsudo and the Centro de Estudos do Laboratório de Aptidão Física de São Caetano do Sul (Celafiscs) in a suburb of Sao Paulo have aggressively sought to promote physical activity in the Brasilian metropolis for some 40 years. However, the Canadian Crown Corporation *ParticipACTION* is relatively 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 over the past 43 years.

9.5.9.1 TAFISA and Other International Organizations

The IOC established a "Sport for All" programme in 1985 CE. TAFISA traces its origins back to European TRIM movements as early as 1969 CE, but it assumed its present format in 1991 CE (Masteralexis et al. 2009). It focusses on lobbying for "*Sport for all,*" providing global programmes, events, and networking facilities. It holds a *World Challenge Day,* when communities from around the world compete to motivate as many as possible of their citizens to walk for at least 15 min. It also hosts international congresses every 2 years, allowing the Directors of National motivational agencies to meet and exchange ideas.

Fig. 9.31 Example of the type of advertising used by ParticipACTION in its Canada-wide motivational campaign to avoid using a car over distances < 1 km

9.5.9.2 Origins of ParticipACTION

Sport ParticipACTION Canada was formed as a not-for-profit company in 1971 CE, with Lester B. Pearson as its first Chairman, and Philippe de Gaspé Beaubien, the Chair of the *Canadian Council for Physical Fitness & Amateur Sport,* as its first President. The organization was later rechristened with the bilingual name of *ParticipACTION* (Lagarde 2004) (Fig. 9.31). The new title was intended to steer diplomatically around 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, above), 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 *ParticipACTION* from 1978 CE until his retirement in 2001 CE. 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).

9.5.9.3 Major Initiatives of ParticipACTION

The nature of *ParticipACTION* and its commercial partnerships can be judged from a brief sketch of its diverse initiatives. During 1972 CE, the first television and radio "*public service*" advertisements were launched, and through the local connections of Russ Kisby, a pilot fitness project was launched in the city of Saskatoon. The latter campaign 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 CE.

ParticipACTION's controversial "*60-year-old Swede*" television advertisement appeared in 1973 CE. McKerracher created a 15-s film that showed a 60-year-old Swede jogging effortlessly beside a puffing 30-year-old Canadian. This message was shown only six times, during breaks in Canadian Football League games. However, the public outcry was immediate and the advertisement even sparked a debate in the Canadian Federal parliament. Other memorable publicity slogans were posted in buses and subway cars, including "*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*."

In 1974 CE, *ParticipACTION* launched its own newspaper, and two years later the *Sun Life Assurance Company* and the *Kinsman Clubs of Canada* were persuaded to build activity trails (*Participarks*) in 100 Canadian communities. In 1979 CE, 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 1980–1981 CE an employee fitness booklet with the title

"*Fitness: The facts*" was directed to 100,000 workers and their families, and the total media support for *ParticipACTION* was valued at $8 M.

In 1982 CE, *PartcipACTION* Saskatoon challenged the residents of 100 towns across Canada to exceed the level of physical activity found in their community. In 1984 CE, cooperation between *ParticipACTION* with *Fitness Ontario* and the *Milk Marketing Board* launched "*APEX*," an action programme focussed upon improved eating and increased 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 CE, *ParticipACTION* and *Petro-Canada* became involved in the *Olympic Torch Relay* across 1730 Canadian communities, and *Exprès* (the training plan that *PartcipACTION* had developed for the Canadian Forces) was marketed to the general public. In 1989 CE, 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.

9.5.9.4 Demise of ParticipACTION

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 to be used in the workplace. In 1992 CE, 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 CE, 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* concluded that by the turn of the twenty-first century, funding had shrunk to a level where they lacked the resources to maintain an effective 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 operations in December of 2000 CE.

9.5.9.5 Rebirth of ParticipACTION

The hiatus created by the demise of *ParticipACTION* was quickly perceived by those who were concerned with Health Promotion in Canada, and the organization was revived in 2007 CE, under the direction of Kelly Murumets. She is now placing increased emphasis upon social media as a means of raising the public's awareness of the need for physical activity, and she is 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.

9.5.10 Physical Demands of a Hunter-Gatherer Lifestyle

A number of Exercise Scientists have long argued that the health problems of modern society have arisen largely because humans have abandoned the hunter-gatherer lifestyle to which they are genetically adapted (Shephard 2011, Chap. 1). The *IBP Human Adaptability Programme* that was initiated in 1964–1965 CE (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.

9.5.10.1 Fitness and Physical Activity in the Arctic Habitat During the Early 1970s

One of the agreed North American and Scandinavian contributions to the IBP Human Adaptability 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 (Milan 1980). 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 (Fig. 9.32). 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 CE), repeatedly collecting extensive data on all willing villagers from primary school to old age. When our observations began, in 1969/70 CE, the fitness levels of the Inuit population were very high relative to people living in Southern Canada in terms of such criteria as maximal oxygen intake, muscle strength and obesity levels. Moreover, data

Fig. 9.32 Location of Igloolik, Nunavut, site of the demonstration of fitness associated with a hunter-gatherer lifestyle, and its loss with acculturation (Source: http://en.wikipedia.org/wiki/Igloolik)

collected during summer and winter hunting expeditions documented the very high daily energy expenditures that were required when the Inuit engaged in many of the community's traditional hunting activities (Chap. 1).

9.5.10.2 Changes Associated With Acculturation

Andris Rode, a Toronto Exercise Physiologist, was able to remain in the Igloolik community for some 25 years, from 1969 to 1994 CE, collecting longitudinal data on many aspects of lifestyle and fitness. Over this period, he noted a progressive deterioration of physical condition among the Inuit, as most of the local community made a transition from their traditional hunter-gatherer lifestyle to the sedentary habits and eating patterns typical of Southern Canada (Shephard and Rode 1996). By 1989/90 CE, the fitness of most Inuit villagers had dropped to levels that would have been 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 CE (Rode and Shephard 1993). This longitudinal study thus provides 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.

9.6 Physical Education Programmes

In North America, the Post-Modern Era has seen physical education instructors replacing the rote gymnastics and sports instruction of an earlier period by classes that include information about health and nutrition. There has also been a

down-playing of the importance of coaching sports teams, and a growing emphasis upon the teaching of a wide range of activities. This new approach seems more likely to satisfy children with differing abilities, create long-lasting positive attitudes towards physical activity, and teach 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). The last 40 years has also seen an unusual opportunity to evaluate both the short and long-term impact of modern physical education in the community of Trois Rivières, in the Province of Quebec.

9.6.1 Physiological Impact

During the 1960s, it was widely believed that preadolescent children did not respond to either aerobic or resistance training (Shephard 1982b). The initial phase of the Trois Rivières regional study was led by Hugues Lavallée (Fig. 9.33), over the period 1969–1977 CE. It made a unique scientific contribution in disproving such negative ideas; both aerobic power and muscle strength could in fact be increased in response to a sustained daily programme of vigorous physical education. The Trois Rivières study evaluated the effects upon fitness, health and academic attainment of incorporating five hours per week of professionally taught physical education into the primary school curriculum for a period of six years.

Similar experiments in the United States lasted for only one or two years, but the Trois Rivières intervention continued throughout the child's enrolment in primary school. Unlike most other studies, a quasi-experimental design was 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 h of

Fig. 9.33 Hugues Lavallée, initial leader of the Trois Rivières quasi-experimental study of daily physical education for primary school students (1969–1977 CE)

weekly exercise were of an adequate intensity and duration to enhance aerobic and muscular fitness, and questionnaires checked that there had been no compensatory reductions in the leisure activity of participants outside of school hours. The total sample 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 (Shephard and Lavallée 1993).

9.6.2 Academic Performance

A major area of continuing discussion by Pediatric Work Physiologists in many 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 thus demand the inclusion an hour per day of quality physical education into the normal school curriculum. However, those teaching in other disciplines counter that the devotion of more time to physical education will inevitably have a negative impact on a child's academic grades (Trudeau and Shephard 2008).

An early study of this question was conducted in Vanves, France, during the 1950s. Children who spent mornings in the classroom and afternoons performing physical activities were said to have a better academic performance than their peers, who followed a standard programme with little time devoted to physical activity (Fourestier 1962). However, few details of this trial were published. In the Trois Rivières study, conducted from 1969–1977 CE, 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 % less time learning academic material (Shephard et al. 1984). 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, an increase of attention and better classroom 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).

The observations made in Trois Rivières were confirmed some 20 years later by a 2-year quasi-experimental study of Californian students in Grades 5 and 6; again, those children who were allocated to the physical activity programme did at least as well as their peers in the academic part of the curriculum, although allocating less hours per week to academic subjects (Sallis et al. 1999).

9.6.3 *Long-Term Impact of Enhanced Physical Education*

Little is known about the long-term impact of physical education programmes upon adult attitudes and lifestyle; in some instances, traditional gymnastics and sports centred programmes seem to have had a negative effect upon the attitudes of less well-endowed pupils when they reached adult life.

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 CE. 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 CE, British pupils were divided between separately housed academic ("*Grammar School*") and trade ("*Secondary School*") streams, based on a standardized test that was written at the age of 11 years. The Labour Government abolished this policy in 1965 CE (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 better-equipped schools). Since 1988 CE, such social selection has been exacerbated, as parents with cars have gained the right to send their children to a school other than the one nearest to their home.

Because population mobility is low in the Trois Rivières area, François Trudeau and his associates were able to collect important data on the long-term effects of physical education some 3 decades after completion of their initial controlled study of daily physical education in primary schools. Their follow-up observations continued on the same group of subjects until they had reached the age of 40–45 years. The data showed a modest persistence into adulthood of health benefits derived from the enhanced primary school physical education programme, including a greater continuing involvement of the experimental subjects in physical activity and their avoidance of cigarette smoking as adults (Shephard and Trudeau 2005).

9.7 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 have been dramatic changes in the nature of major international competitions such as the Olympic Games.

9.7.1 Governmental Involvement

Governments have seen success in Olympic sport and other forms of international competition as important to their image, and indeed a major part of the "cold war" between Russia and the United States was fought on the sports field.

9.7.1.1 Communist States

The Soviet Union and the communist satellite states began to invest an ever-increasing fraction of their resources into producing athletes who could excel on the international sports field, beginning in the 1950s. Success in this arena was rewarded with cars and luxury apartments, items not available to the general population, but in return the athletes were entirely subservient to state coaches, submitting to dangerous doping practice (below) and other abuses, One potential quantitative measure of the ever-increasing governmental interest and investment in high performance sport was a growing output of stamps commemorating the feats of Soviet athletes (Shephard 1983c) (Fig. 9.34).

9.7.1.2 United States

The U.S. has now established three Olympic training centers and 15 Olympic training sites at a cost of "millions of dollars," in order to provide American athletes with the best available training. The Colorado Springs facility is the primary resource. It opened its doors in 1978 CE, on the site of a former U.S. Air Force Base. It offers facilities to competitors in 15 disciplines, including a state of the art Sports Medicine and Sports Science laboratory, and space to accommodate more than 500 athletes at any one time.

Fig. 9.34 The massive investment of the Soviet Union in athletic training during the 1950s was accompanied by a major surge in the printing of postage stamps celebrating the achievements of Russian athletes

9.7.1.3 Britain

In Britain, what previously had been a "*Sport for All*" programme was transformed into the UK Sports Council in 1997 CE, with the objective of offering enhanced training to competitors in some 30 sports where there seemed a prospect of winning Olympic medals. Funding comes from a National lottery. Since 2002 CE, the Council has also funded the U.K. Institute of Sport; this provides services to elite Olympic and Paralympic athletes through 15 high performance centres.

9.7.1.4 Canada

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 CE, 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 CE. 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 core services at a low cost.

The *Olympic Trust of Canada* was formed in 1970 CE, with the responsibility of raising funds to meet the objectives of the *Canadian Olympic Committee*. In 1973 CE, *Loto Canada* was 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 twenty-first 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 CE, a *National Recreation Statement* attributed primary responsibility for such activities to the Provinces and Territories, although it 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 CE. 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 CE, 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 CE, the Federal government passed a new *Physical Activity and Sport Ac*t, to replace the legislation of 1961 CE. 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 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 recreational 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, stated:

> *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*

Stimulated by the award of the Winter Olympic Games to Vancouver in 2012, a final Canadian governmental initiative, begun in 2004 CE, was entitled "*Own the podium*." The group was chaired by Roger Jackson, a former Olympic rower, and it set as its objective the provision of sufficient support for Canadian athletes that they would contend for number one spot in the 2014 Olympic Winter Games (total medals), a place in the top three in the gold medal count at the 2014 Paralympic Winter Games, a place in the top 12 nations in medal count at the 2012 Olympic Games, and a place in the top eight in the gold medal count at the 2012 Paralympic Games. The subsequent performance of Canadian athletes was substantially improved, but none of these ambitious goals has yet been met (see below).

9.7.2 Sports Participation

In general, the progressive diversion of governmental interest from programmes for the general public to a search for international medals has been associated with a decline in overall sports participation, as can be seen from Canada statistics.

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 (Statistics Canada 2005). Nevertheless, over the last two decades there has been a drastic decline of sport participation among those >15 years of age, from 45.1 % of the population in 1992 CE to 34.2 % in 1998 CE and only 28 % in 2005 CE. A further survey was undertaken in 2010 CE, and this showed the main interests were golf, ice-hockey and soccer, with a further decline in overall participation to 26 % (men 35 %, women 16 %). On any given day in 2010 CE, 12 % of the population claimed to be walking or jogging, 8 % exercising, and only 5 % reported participating in any type of sport (Canadian Heritage 2013). Aging might explain some of the decreased sport participation of the adults, but even in teenagers aged 15–18 years, the participation rate declined from 77 % in 1992 to 59 % in 2005 CE, and girls showed a further 13 % decline in participation by 2010 CE.

As in many countries, certain segments of the Canadian population remain under-represented in sport. There are fewer women than men participating. Only 9.4 % of those >15 years of age are from households with incomes under $30,000, compared with 23.9 % from households with incomes > $80,000. Finally, 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. Among its activities, 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.

9.7.3 Professional Associations and Journals

In many countries, Professional associations associated with Sport and Exercise Science had already been established during the Modern Era (Chap. 8). However, there were new developments in Britain and in Canada, and new Associations began to serve a variety of sub-specialties, with the appearance of a substantial number of new scientific journals

9.7.3.1 Developments in Britain

In Britain a growing tension developed between Medically-qualified Sports Physicians and Physiologically-oriented Sports Scientists within the British Association for Sports Medicine (BASM). Some Physicians within BASM were unwilling to give full recognition to those lacking a Medical qualification. The dispute came to a head in 1984 CE, and Exercise Scientists without a Medical qualification decided to form a parallel organization called the *British Association of Sports Sciences* (BASS). Recognizing the growing scientific interest in exercise unrelated to athletic competition, in 1993 CE the name was changed to the *British Association of Sport and Exercise Sciences (BASES)*. BASM quickly followed suit, becoming known as the *British Association for Sport and Exercise Medicine (BASEM)*.

9.7.3.2 Developments in Canada

For a long time, the development of Professional Associations in Canada was hampered by a small and widely scattered population. Until the mid-1960s, the 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 CE, 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 CE. The *Canadian Association of Sport Sciences* (*CASS*) was inaugurated at a scientific meeting held in conjunction with the Winnipeg *Pan American Games* of 1967 CE. The formation of *CASS* had followed long discussions between the *Canadian Medical Association* and the *Canadian Association for Health, Physical Education and Recreation;* it was initially hoped that CASS would provide a useful bridge between the two established bodies.

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 CE) 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 Annual Conferences was further compromised by simultaneous translation of most of sessions into French. Moreover, 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 had long been a major goal, the establishment of 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 CE the group was rebranded as the *Canadian Society for Exercise Physiology*. The new and more focussed format attracted a growing attendance. Currently, the Annual Meeting includes 2–3 days of scientific papers, and a final day when topics of interest to *Certified Exercise Professionals* are also presented.

In 1978 CE, 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 establishment of the Sports Medicine Council of Canada.

9.7.3.3 Emergence of Sub-specialties

Interest in the athletic performance of children stimulated formation of the *Pediatric Work Physiology Group*. This organization was founded in 1968 CE, by Josef Rutenfranz, a Physiologist at the Max Planck Institute in Dortmund. The name of the group reflects its 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 CE.

9.7.3.4 Journals in Sports Medicine and Exercise Science

Journals dedicated to 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 has expanded rapidly during the Post-Modern Era, particularly since the advent of on-line publications.

In addition to *Applied Physiology, Nutrition & Metabolism (below)*, we may note (with respective dates of first publication) other journals with high citation indices such as the *British Journal of Sports Medicine* (1964 CE), the *Journal of Athletic Training* (1966 CE), the *American Journal of Sports Medicine* (1972 CE), the *International Journal of Sports Medicine* (1980 CE), the *Journal of Sports*

Sciences (1983 CE), the *Clinical Journal of Sports Medicine* of CASM and the *Scandinavian Journal of Medicine & Science in Sports* (both 1991 CE). On-line initiatives include the *International Journal of Behavioural Nutrition & Physical Activity* (1994 CE), the Australian-based *Journal of Science & Medicine in Sport* (1998 CE), and *PHEnex* (2009 CE), launched by PHE Canada.

The increasing specialization of investigators in Sports Medicine and Exercise Science is high-lighted by the appearance of such journals as *Pediatric Exercise Science* (1989 CE, the house journal of NASPEM), the *Journal of Physical Activity & Aging* (1991 CE), the *Adapted Physical Activity Quarterly* (1984 CE, the official journal of the *International Federation of Adapted Physical Activity*), and the *Exercise Immunology Review* (1995 CE) 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 CE) and the *Health & Fitness Journal of Canada* (2008 CE). *Exercise and Sports Science Reviews* began to offer in-depth reviews of topics in Exercise Science in 1973 CE, and from 1979 to its final edition in 2013 CE the *Year Book of Sports Medicine* provided critical commentary on some 250 of each year's top papers. *Sports Medicine* has offered systematic reviews and meta-analyses since 1984 CE.

Canadian Sports Scientists were for some time content to read journals published in other countries, but in 1976 CE 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 as *Applied Physiology Nutrition and Metabolism*. It is now a prominent journal in the fields of Exercise Science and Sports Nutrition, with an ever-increasing citation index. It has also published some important *Position Stands* on key issues in Exercise Physiology. A number of special supplements have summarized current evidence on the appropriate dosage and safety of therapeutic exercise, both for those who are healthy and for those with chronic conditions.

9.7.4 Introduction of New Sports

During recent years, the tendency among the younger segment of the population has been to engage in ever more dangerous extreme sports. High risk has apparently been a part of their motivation to participate, perhaps as a reaction against what seems an ever safer urban environment (Heggie and 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 possibilities for outdoor physical activity. However, the management of some more traditional sports facilities have been concerned that younger individuals are not patronizing their venues. This is particularly true of golf courses, where there has recently been a move to provide 8 in or even 18 in holes in an attempt to make the game less time consuming and thus more appealing to busy younger patrons.

9.7.4.1 Mountain Biking

The origins of mountain biking are disputed. Some have traced the idea to a group known as the "*Buffalo soldiers;*" in 1896 CE, they customized their bicycles to carry goods over rough terrain, and made a rugged cross-country journey from Missoula to Yellowstone and back (Sorensen 2000). Others cite the *Velo Cross Club Parisien*, who developed a competition similar to mountain biking in the period 1951–1956 CE. In England, the "*Rough-Stuff Fellowship*" began off-road cycling in 1955 CE. A further historical contender is John Finley Scott, who built a "*woodsie bike*" on a Schwinn frame in 1953 CE (Berto 2008). By the early 1970s, a substantial group known as the *Cupertino Riders* were using modified bicycles in Northern California (Amici Designs 1999).

By the late 1970s, companies were beginning to manufacture mountain bicycles on a substantial scale (Fig. 9.35), and ski facilities permitted mountain bikers to take their bicycles up the mountain-side during the summer months, using the gondola or ski lift. Riders then followed extremely rugged trails back to base at

Fig. 9.35 Although many people improvised off-road bicycles from the beginning of the twentieth century, the commercial manufacture of off-road machines began in the late 1970s (Source: http://en.wikipedia.org/wiki/Mountain_biking)

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 mountain bikers.

Over a five-month season, a total of 898 cyclists presented to the Whistler 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 unable to obtain details on the number of gondola tickets sold to cyclists over the 5 months, but the injury rate appears to be very high, particularly as the bicycle path is served by only a single gondola. Mountain biking accounted for 5 % of all visits to the Whistler Health Centre. Currently, a general rule of thumb at the clinic 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.

9.7.4.2 Himalayan Trekking

Bill Tilman of the Royal Geographic Society's Himalayan Committee was first given permission to explore the peaks of Nepal in 1949 CE (O'Connor 1989). However, Himalayan trekking was popularized by Arlene Blum and the travel and adventure writer Hugh Swift when they completed a 4500 km Himalayan traverse in 1982 CE (Blum 2005). As many as 100 million people per year now explore high peaks such as the Himalayas, and the number of commercial mountain trekking expeditions is steadily increasing (Weinbruch and Nordby 2010). The total of climbers visiting Nepal grew by 450 % between 1994 and 2000 CE.

A recent estimate of risk for those climbing Nepalese peaks >8,000 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 much older outdoor adventure of downhill skiing in the Alps, where there are only 1.1 death per million days of exposure (Burtscher 2012).

9.7.4.3 Snowboarding

Boys have for long slid down steep snow-covered slopes with their feet tied to wooden boards. In 1965 CE, 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 CE, and snowboarding became a Winter Olympic Sport in 1998 CE.

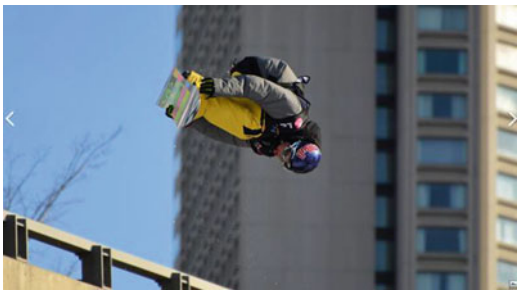


Fig. 9.36 Sebastien Toutant in the "big air" snowboard competition in Quebec City (Source: http://en.wikipedia.org/wiki/Snowboarding)

Ski resorts were slow to accept snowboarders, fearing that the boards would wipe snow from their slopes. In 1985 CE, boarders were accepted at only 7 % of U.S. ski resorts; however, by 2004 CE the sport claimed over 6 million participants. The injury rate remains high (Fig. 9.36), 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).

9.7.4.4 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 CE, an International Championship was being held. Rapid expansion of the sport began when steel wheels were replaced by polyurethane rollers (Hunter 2012). By 2002 CE, there were reputedly 18.5 million skateboarders, 85 % of this number being under the age of 18 years. Municipalities have now constructed a substantial number of skateboard rinks in public parks. Many skateboarders are keen to perform acrobatic tricks, and this has exacerbated their risk of injury (Hunter 2012).

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

9.7.4.5 Wind-Surfing and Kite-Surfing

Newman Darby claims to have begun the sport of wind-surfing on the Susquehanna River, PA, in 1948 CE. He began selling sailboards commercially in 1964 CE. However, at first this was not a very profitable venture. In the 1970s, a Californian (Hoyle Schweitzer) began mass-producing lower cost sailboards, and the sport became much more popular. Manufacturers also appeared in Europe, and it was

Fig. 9.37 Kite-surfing in the Philippines (Source: http://en.wikipedia.org/wiki/Kitesurfing#Speed_records)

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 CE and for women in 1992 CE. As with many recent sports, it has become progressively more dangerous with the introduction of extreme forms of wind-surfing.

Kite-surfing (Fig. 9.37) was first introduced in 1996 CE. 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). Competitors are now reaching speeds of more than 55 knots, and have covered total distances of over 2,000 km; in 2013 CE, a team of six kite-surfers completed the 3,500 km transatlantic crossing between the Canary Islands and Turks and Caicos. Racing-style kite-surfing will be included in the Rio de Janeiro Olympics in 2016 CE.

9.7.4.6 Parachuting, Bungee-Jumping and BASE-Jumping

André-Jacques Garnerin (1769–1823 CE) parachuted from a hot air balloon as early as 1797 CE. The procedure became an important component of training for 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 CE (Chap. 8). Parachute jumping is now performed recreationally, competitively and in displays (Shea-Simonds 1971). Depending on the altitude, the chute may be deployed immediately, or there may be a preliminary period of free-fall from an aircraft. The first deliberate free-fall jump was made by Leslie Irvin, in 1919 CE.

National associations such as the *Canadian Sport Parachuting Association* (founded in 1956 CE) 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 CE 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).

Fig. 9.38 Bungee jumping from the Victoria Falls Bridge in Rhodesia (Source: http://en.wikipedia.org/wiki/Bungee_jumping)

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 form of bungee-jumping dates from 1979 CE, when University students jumped from the Clifton suspension bridge in Bristol, UK. Several million jumps have occurred over the past three decades (Fig. 9.38), and despite industry-sponsored safety regulations there have been some fatalities.

BASE jumping is made from a building, antenna, or bridge span. Because of the dangers of this sport, many public buildings such as the Eiffel Tower have banned BASE jumping (Søreide 2012). Figures from Norway suggest one death per 2317 jumps.

9.7.4.7 Hang-Gliding and Para-Gliding

Otto Lillienthal (1848–1896 CE) (Fig. 9.39) of Anklam, Prussia, began the sport of ridge soaring in the 1890s, but unfortunately he fractured his neck when his glider stalled. The Parisian Jan Lavezzari (1876–1947 CE) piloted a double-sail hang-glider off Berck Beach, in France, in 1904 CE. The modern form of hang-gliding began with the Americans Francis and Gertrude Rogollo (1912–2009 CE). They developed a predecessor of the flexible wing hang-glider in 1948 CE. The construction of hang-gliders was greatly facilitated by the introduction of the synthetic fabric Mylar, in 1952 CE.

Fig. 9.39 Otto Lillienthal began ridge soaring in the 1890s, but unfortunately broke his neck when his glider stalled (Source: http://en.wikipedia.org/wiki/Hang_gliding#History)

Initially, the sport was regarded as quite dangerous, but with greater training, the fatality rate has fallen; in the U.S., there is currently about one death per 1,000 participants per year, and in the U.K. there is currently one death per 116,000 flights.

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; it was patented in 1963 CE (Rekand 2012).

From around 1967 CE, 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 CE, and the first National championship was held at Vernon, BC, in 1977 CE. The International organization for this sport is known as the *Commission Internationale de Vol Libre*. In 2012 CE, 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 CE.

9.7.4.8 Rock Climbing

Some rock- and ice-climbing was inherent in Victorian Alpine expeditions, but during the twentieth century rock climbing gradually evolved into a more deliberate athletic activity, with extensive use of artificial hand- and foot-holds. This development allowed ascents in the Yosemite Valley that previously would have been considered impossible. In 1991 CE, a few countries participated in the first *World Sport-climbing Championship*, but by 2005 CE 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 CE, 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) (Fig. 9.40).

Fig. 9.40 Rock-climbing in Joshua Tree National Park, CA (Source: http://en.wikipedia.org/wiki/Rock_climbing#History)

9.7.4.9 Motorized Off-Road Sports

Moto-cross has a relatively long history, evolving from "scrambles" organized in England during the early part of the twentieth century, but the popularity of this activity increased as vehicle suspensions were improved. A World Championship was organized in 1957 CE, and the sport reached North America in the 1960s, when Japanese motor cycles became widely available. The racing of all-terrain vehicles became common during the 1980s. The physical demands of controlling a recreational 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. 2013).

9.7.4.10 Marathon Runs

The first Boston marathon run dates back to 1897 CE. The initial course 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) (Fig. 9.41). The Boston event grew steadily from an initial field of 15 entrants to 210 runners in 1955 CE. The number of participants then surged rapidly. By 1970 CE, registrants had become so numerous that competitors were required to certify that they had "*trained sufficiently to finish the course in less than four hours*."

Women were allowed to participate officially beginning in 1972 CE (although a few women had unofficially completed the course previously). A wheelchair

Fig. 9.41 Participants in the 2010 Boston Marathon running through Wellesley, having completed about a half of the event (Source: http://en.wikipedia.org/wiki/Boston_Marathon#2011_Boston_Marathon)

division was added in 1975 CE. By the 100th anniversary run of 1996, there were 36,748 entrants, and 35,868 people 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.

Unusual aspects of this contest were the run of Rosie Ruiz, in 1980 CE, who was the first past the tape in the women's race, but was later discovered to have joined the race about 1 km short of the finishing line, and the bombing of 2013 CE, when 3 spectators were killed and more than 200 were injured. There have been at least two deaths of competitors; a 62-year-old Swede succumbed to a heart attack in 1996 CE, and in 2002 CE a 28-year-old woman died, apparently due to hyponatraemia.

Vancouver hosted the first Canadian marathon (1972 CE). The Toronto marathon (originally called the Canadian international marathon) began in 1977 CE. The first Montreal marathon (other than the Olympic event of 1976) was held in 1979 CE, with about 9000 runners; the Montreal event died out in 1990, but returned in 2004 CE, boosted by the introduction of options other than running (including walking, cycling and wheelchair events). Other major cities developed their own major marathon races during this same era, including New York (1970 CE), Chicago (1977 CE; Suozzo 2006), and London (1981 CE; Bryant 2010).

Some runners, not content with the challenge of a 46 km distance, have participated in ultra-marathon runs. The oldest of these even longer events is the Comrades marathon (the 89 km run from Durban to Pietermaritzburg, RSA). This race began in 1921 CE, with 48 runners. The number of starters increased to 1,000 by 1971 CE, 3,000 in 1979 CE, and 3,961 by its 75th anniversary in 2000 CE. Seven runners have died in attempting the Comrades marathon (Bateman 2012).

9.7.4.11 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 CE, 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 CE, 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 CE (Myers 2011).

In many Canadian cities, the successor event to a *Miles for Millions* march has been the *Terry Fox Run*. The latter event was named after Terry Fox (1958–1981 CE), the man who attempted to run across Canada in 1980 CE 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 run in Thunder Bay, about half way across Canada, because of a recurrence of the tumour; this misfortune was likely precipitated by many weeks of strenuous physical effort and resulting immuno-suppression. 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 CE. It attracted over 60,000 entrants in 2011 CE and more than 45,000 in 2014 CE. In Sydney, the City-2-Surf fun run of 14 km began in 1971 CE with 2000 entrants, and it now draws up to 80,000 participants.

9.7.4.12 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 CE; in 1999 CE, it expanded into a week-long bike fest, and by 2011 CE it boasted over 17,000 participants. On the west coast of Canada, the *Gran Fondo* began in 2010 CE. This involved closing the recently rebuilt but hilly *Sea-to-Sky Highway* to motor traffic for an entire morning, thus allowing some 7000 cyclists to cover the 122 km distance between Vancouver and Whistler, BC.

Interest in such events has indeed exerted some pressure 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.

9.7.4.13 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 Hawaiian 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 first held near Joinville-le-Pont, the location of the French *School of Physical Education* (Tinley 1998). The initial North American triathlon took place at Mission Bay, San Diego, CA, in 1974 CE, with 46 participants. The Hawaiian Ironman triathlon made its debut in 1978 CE. 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 people.

9.7.4.14 Trail Walking

Long-distance wilderness trail 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 CE, and the trail was officially opened over its entire length in 1936 CE (Fig. 9.42). 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 % completed), 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 CE.

The idea of the *Bruce Trail*, spanning the entire 740 km of the Niagara escarpment in Southern Ontario was developed in 1960 CE by Richard Lowes and the well-known Canadian naturalist and wild-life artist Robert Bateman (1930-). Seven years later, a cairn at the northern terminus of the trail, in Tobermory, ON, marked

Fig. 9.42 A section of the Appalachian Trail (Franconia Ridge, NH) (Source: http://en.wikipedia.org/wiki/Appalachian_Trail)

completion of the project. Sections of the Bruce Trail are currently 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 CE to facilitate the rescue of victims from the many ships wrecked on that stretch of 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; it will stretch right across Canada, and parts of the 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 local 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*."

9.7.4.15 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 CE, under the direction of the exiled German educator Kurt Hahn (Chap. 8). Hahn had previously founded the very Spartan *Gordonstoun School*, which was attended by the Duke of Edinburgh and Prince Charles. Hahn modelled his thinking 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 it 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 remote locations as the *West Coast Trail* and the Yukon River.

9.8 Olympic Games and Competitive Sport

During the Post-Modern Era, international competitions have faced scandals over the choice of site, with millions of dollar bribes paid to those responsible for choosing the host city, as in the current FIFA/Qatar scandal. One positive feature

of recent times 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 largely 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 physical activity in the general population consequent upon Olympic extravaganzas pales into insignificance beside the enormous costs of constructing present-day facilities and assuring their security. The traditional virtues of competitive sport can nevertheless still be found in less publicized events such as Masters competitions.

9.8.1 Female Participation in Competitive Sport

Failure to allow women equal access to sport has a long history, but during the Post-Modern Era it has become the subject of discussion at the United Nations and at the International Olympic Committee. In Canada, ice-hockey proved a strong bastion of male dominance, but the women's hockey contest has now become a very popular component of the Winter Olympics. In Canada, the Federal government has also worked hard to "level the playing field" for women.

9.8.1.1 United Nations and IOC Involvement

The issue of restrictions upon female participation in sport attracted attention at the *United Nations World Conference on Women*. At the 4th Conference in this series, held in Beijing in 1995 CE, a session on gender, development and sport discussed this problem, and 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 during the past two decades. The first IOC event was held at Brighton, U.K., in 1994 CE. One action of this meeting was to establish an *International Working Group on Women and Sport*. The 4th meeting in this series (2008 CE) 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.

9.8.1.2 The Specific Issue of Ice Hockey

Female ice-hockey provides one example of changing attitudes towards the involvement of women in sport. Throughout the 1950s and 1960s, ice-hockey was regarded as a uniquely male pursuit, in part because of its physicality, and women's 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 Abigail (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. She later went on to become a track star, participating in four Olympic Games (1964–1976 CE), and from 1981 to 1991 CE she was Canada's first female Director General of Sport Canada. In 1982, she supported the first women's National ice-hockey championship, and the cup now awarded at that event is named in her honour.

The revival of Canadian female hockey clubs had begun 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 CE. An international breakthrough came in 1990 CE, 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.

9.8.1.3 Other Canadian Initiatives

The Canadian government has played a strong role in affirming female sports participation over the Post-Modern Era. The *Royal Commission on the Status of Canadian Women* (tabled in 1970 CE) quickly 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 CE, and a second conference (*The Female Athlete Conference*) was hosted at Simon Fraser University (Burnaby, BC) in 1980 CE. That same year, the *Canadian Women's Programme* became an integral part of *Fitness & Amateur Sport* (Vail 1983). It immediately 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 have 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).

9.8.2 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.

9.8.2.1 Current Policies

Now, most Western nations provide selected top athletes with substantial funding. This is sufficient to pay for coaching, travel, and equipment, and it also reduces the need for competitors to engage in other forms of gainful employment when they are training. With its "*Own the Podium*" programme, Canada spent $100 M on the support of promising athletes during the 3-year period leading up to the London Games of 2012 CE. 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 CE, the Canadian bob-sled team were not government supported, and the participants reportedly put the cost of their sled ($50,000) on their credit cards, hoping that a win and subsequent sponsorships would pay off this considerable debt!

9.8.2.2 Cash Prizes

Many countries now offer cash prizes to competitors who win medals at the Olympics. In 2012 CE, 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 financial inducements. In contrast, Italy (with 8 gold medals) had to pay out a total of $> \$1$ M, despite the difficult current financial circumstances faced by that country. In the U.S., President Obama is now discussing the possibility of removing Olympic cash prizes from taxable income.

9.8.2.3 Commercial Sponsorship

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.

9.8.3 The 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 talents and skills 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 prohibited pharmaceuticals and procedures.

9.8.3.1 Distortion of Judging and the Bribery of Officials

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 CE, few people could believe that the Russian team had out-performed the Canadians, and at a subsequent inquiry conducted 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 a promise of favourable rating 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 CE, several top Italian soccer teams were implicated in a match-rigging scandal. Telephone transcripts showed that managers had engaged in discussions with senior officials to ensure the appointment of referees favourable to their team. CBC Television also reported wire-tap evidence from a German court-room showing that the Canadian Soccer League had suffered from a match-fixing incident; it was alleged that several semi-professional players from the *Toronto Croatia Football Club had* received a total of $15,000 in order to lose a match against the

Trois Rivières team *Attak* in September of 2009 CE. The German trial suggested that a crime syndicate had manipulated domestic league games in many countries including Canada, Germany, Switzerland, Austria, Belgium, Turkey, Hungary, Slovenia and Croatia.

Cricket has also suffered from game-throwing abuses. In 2000 CE, Delhi police accused the South African cricket captain Hansie Cronje of match-throwing, and subsequent investigations 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 CE was disqualified (Cooper 2012).

In a unique incident at the London Olympics, a British contestant was allowed a second attempt at a dive 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 attempt.

Other scandals have involved the bribery of the officials organizing international events. There were persistent rumours that in 1998 CE the Salt Lake Organizing Committee had bribed IOC officials in order to secure the Winter Games for their city, and the U.S. Department of Justice found the evidence sufficiently persuasive that criminal charges were laid. The bid committee were later acquitted, but several IOC members were expelled. Moreover, it was discovered that several members of the IOC had received substantial gifts prior to decisions regarding the sites of the 1998 Winter Olympics and the 2000 Summer Games (Mallon 2012). A similar scandal has recently surfaced over the decision to award the 2022 CE FIFA World Cup to Qatar.

9.8.3.2 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 (Fig. 9.43). Tonya Harding's ex-husband, Jeff Gillooly, was charged with attacking Nancy Kerrigan - Harding's closest rival for a spot on the 1994 CE 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

Fig. 9.43 The Olympic Figure-Skater Tonya Harding was stripped of her U.S. National titles for participating in a deliberate physical attack upon one of her rivals, Nancy Kerrigan (Source:http://en.wikipedia.org/wiki/Tonya_Harding#Attack_on_Nancy_Kerrigan)

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.

9.8.3.3 Inappropriate Age Categorization

The Romanian gymnast Nadia Comãneci (1961-) was only 14 years old when she won three Gold medals at the Montreal Olympic Games of 1976 CE. This was entirely permissible in that era. However, in 1996 CE a new IOC rule specified that Olympic gymnasts must reach an age of 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 has accepted the ages of the contestants, as shown on their passports, ID cards and family registers.

9.8.3.4 Deceit Over Gender

The earliest issue of deceit over gender occurred at the Los Angeles Games of 1932 CE. 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 CE, but she was forced to return for the Berlin Olympics of 1936 CE, because the IOC were requiring Hitler to field Jewish athletes; the Nazis threatened reprisals against her family if she did not compete for the German team. 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 CE. 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 CE) called for an examination of all female athletes following the Berlin Games, having watched the performance of a Czech runner Zdenka Koubkova and the 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 CE, 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 that she had 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 CE 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 CE. Poland's Ewa Klobukowska (Fig. 9.44) became the first woman to fail an Olympic 'gender' test; she had won a Gold medal at the Tokyo Games of 1964 CE 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

Fig. 9.44 Ewa Klobukowska, the first woman to fail an Olympic 'gender' test (Source: http://en.wikipedia.org/wiki/Ewa_K%C5%82obukowska)

mosaicism, and was subsequently banned from competition. Erik Schinegger, the 1966 CE 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 international competitors are unfortunately not infallible (Ballantyne et al. 2012; Simpson et al. 1993). Eight athletes failed these tests at the Atlanta Olympics of 1996 CE, 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 CE, and the IOC voted to ban the practice in 1999 CE, 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 m at the 2009 *World Athletic Championships* in Berlin. However, in 2010 CE, 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.

9.8.3.5 Doping

Doping and other illegal practices intended to enhance performance have blighted international sport throughout the Post-Modern Era. Despite the efforts of control groups from many 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."

French police discovered massive amounts of performance enhancing drugs at the 1998 *Tour de France*, and this stimulated the IOC to organize a World Conference on Doping in Sport in 1999 CE. One outcome of this conference was the formation of the *World Anti-Doping Agency* (WADA), with the mandate of fighting against doping in sports. Nevertheless, as recently as 2009, a survey of elite professional cyclists in Italy reported a high prevalence of the use of banned substances (Loraschi et al. 2014).

Canada's first doping control programme was initiated and chaired by Norm Gledhill, at York University in Toronto. He was succeeded by an Ottawa Physician,

Andrew Pipe, who was appointed as Chair of the Canadian Doping Control Review Board in 2000 CE. The latter individual has devoted many years to his task, and is continuing as Chair of the Board for the period 2013–2017 CE.

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, 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.

Unfortunately, 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 busy 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-) (Fig. 9.45) Ben Johnson was a Jamaican-born sprinter. He began training under the notorious Canadian coach Charlie Francis, and competed for Canada in various track events during the 1980s. Johnson won two silver medals at the Commonwealth Games in Brisbane, Australia in 1982 CE, and two bronze medals at the Los Angeles Olympics of 1984 CE. In 1985 CE,

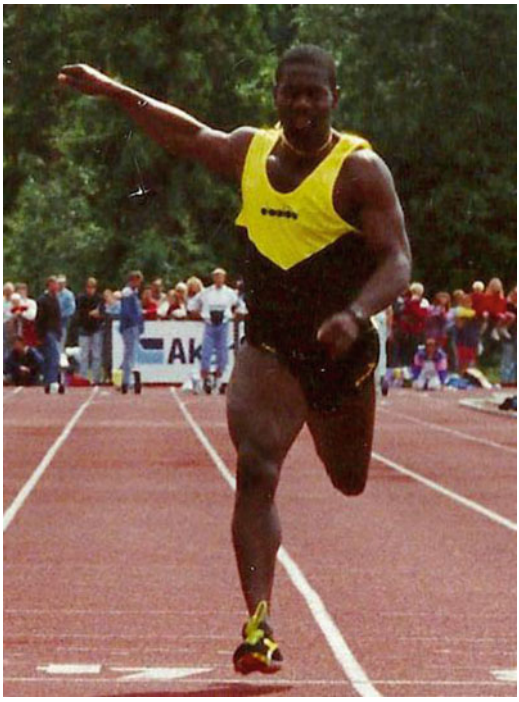


Fig. 9.45 The Canadian sprinter Ben Johnson, repeatedly found guilty of steroid abuse (Source: http://en.wikipedia.org/wiki/Ben_Johnson_(sprinter))

he succeeded in beating his American rival Carl Lewis, and in 1986 CE he covered the 100 m sprint in the time of 9.95 s. He was invested as a *Member of the Order of Canada*, and was soon receiving $400,000 a month in commercial endorsements. At the Olympic Games in Seoul (1988 CE), he set a world record of 9.79 s for the 100 m distance, but his gold medal was quickly 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 career come-back in 1991 CE, but at a race in Montreal in January of 1993 CE, 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 this decision was rescinded in 1999 CE. Nevertheless, no other athlete was willing to run against Johnson, and at one event in Kitchener, ON, he was forced to run a lone race against the clock. In late 1999 CE, his urine again tested positive, this time containing hydrochlorothiazide, a banned substance used to mask the administration of steroids. Johnson then emigrated 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 CE, 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 CE, 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. 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 CE, Conte appeared on ABC television, and admitted giving Jones five different illegal performance-enhancing drugs before, during and after the Sydney Olympic Games (2000 CE). 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 CE, 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*

Fig. 9.46 Lance Armstrong, winner of many distance cycling events, was accused of blood doping and the use of testosterone, growth hormone and erythropoietin to enhance his performance

Jones had made multi-million dollar endorsement deals, but by 2006 CE she was in financial trouble, and a bank foreclosed on her $2.5 M mansion in 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-) (Fig. 9.46) 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 CE. A testicular cancer was detected in 1996 CE, 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 CE Armstrong was able to undertake serious race training once more. He won the *Tour de France* again in 1999 CE, continued to compete until 2005 CE, and had a further period of competition 2009–2011, finally retiring from road-racing in 2011 CE.

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 CE 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 CE, 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 CE, but that the *UCI* chose to suppress this information, although they accepted 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 CE. 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 CE may reflect an elimination from 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*. The 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 CE. In Dubin's report, released in June 1990 CE, 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 CE 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 London 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 CE, 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 CE, but sampling was not scheduled on a random basis.

The *Mitchell Report* was established by baseball commissioner Bud Selig later in 2006 CE, 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 CE, many of the players were said to have 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 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 season of 2012 CE, 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 CE, the Director-General of the World Anti-Doping Agency, David Howman, still singled out the NBA for gaps in its testing programme.

Doping of Show-Jumping Horses The doping of horses at racetracks has long been a significant problem, but doping was also identified in Olympic show-jumping mounts in 2004 CE. 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 an agent 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 the animal's performance. The drug may have been used in earlier competitions, but it was not until 2008 CE that an appropriate test became available.

9.8.3.6 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 an athlete's disability, and the boosting of blood pressure immediately prior to competing.

Following the Sydney Games of 2000 CE, a Spanish basketball player alleged that only 2 of the 12-person "*intellectually-disabled*" Spanish basketball team met the required criteria of mental impairment. 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 CE.

Some competitors have sought an advantage in paraplegic sport by inducing a rise of blood pressure immediately before competing. 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 competitive 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 boosting in 1994 CE. 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 CE a figure of 30 % was estimated.

The use of steroids has also become a concern in Paralympic 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 CE three power lifters and a basketball player were banned after their urine tested positive for steroids.

9.8.4 Current Economic Costs and Benefits of Olympic Competition

Concerns over the security of the Olympic Games were greatly heightened by events in Munich in 1972 CE. However, precautionary measures have now become so costly as to preclude many nations from hosting future competitions, and any benefits to the health and fitness of the general population are completely dwarfed by the magnitude of these expenses.

9.8.4.1 Tragedy at the Munich Games

The Munich Olympics of 1972 CE were well-prepared, and were designed as a carefree event, in an attempt to reverse the militaristic image of the Nazi-organized

Berlin Games of 1936 CE. It was alleged that many people avoided check-points when entering the Munich athletes' village, simply climbing over a 2-m-high chain-link security 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 the *Black September* group included the release not only of 234 Palestinian prisoners held in Israeli jails, but also of Andreas Baader and Ulrike Meinhof, leaders of the *German Red Army Faction* who were currently being 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 organizing committee of the Munich Games suggested cancelling the remaining competitions, but Avery Brundage insisted (Reeve 2011):

> *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*."

The Israeli Premier, 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 who were suspected of any involvement in the hostage-taking incident. During the killing of Ali Hassan Salameh, the leader of the *Black September* movement, Israeli agents killed one innocent person in Norway and four by-standers in Lebanon, also injuring 18 other people.

Fig. 9.47 Olympic costs become ever larger. The Sochi Winter Games of 2014 CE cost over $51 billion, due largely to security precautions (Source: http://en.wikipedia.org/wiki/2014_Winter_Olympics#Measures)

9.8.4.2 Current Security Costs of Olympic Competition

A more long-term consequence 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 $900 million despite an initial budgetary estimate of $175 million, with Canadian and U.S. jet fighters threatening to shoot down any commercial or private aircraft that had the bad luck to wander into a large "exclusion zone" around Whistler. Apparently, those involved in ensuring a secure Games had little thought for either the hapless crew of an errant aircraft or civilians such as myself who were living down below (Fig. 9.47).

At the London Summer Olympics of 2012 CE, the proposed number of security personnel was so large that even the world's largest security company fell 3600 personnel short of their 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, the total costs of the event rose to $51 B, $39 billion in excess of initial estimates; much of this cost was attributable to rigid security precautions, with some 40,000 police and army personnel in attendance. The entire Sochi area became a "ring of steel," and in order to enter the controlled zone, visitors were required to pass through security checkpoints with x-ray machines, metal detectors and explosive material scanners. Despite these precautions, the U.S. ski and snowboard teams also hired their own security staff, and there were indeed two suicide bombings in the railway station at Volvograd, with the death of 34 travellers.

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

9.8.4.3 Impact upon the Health and Fitness of the General Population

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. However, personal experience

of the Whistler/Vancouver event of 2010 CE, and analysis of information for Athens and London do not provide convincing evidence of such benefits.

In Greece, sport participation rates for 2009 CE, following the Athens Games, 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*

The most impressive structure constructed for the Winter Games of 2010 CE was the vast ice-skating oval in Richmond, BC. However, far from being available to the general public following the Games, 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, apparently because it was feared that the new skating area would offer too much competition for another speed-skating facility in Calgary, AL, more than 1,000 km to the east. The Oval has since 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 agitating for it to be converted to a Convention Centre. The sports interest of the 18,500 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 set 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 what he hoped would be achieved by the London Olympics of 2012 CE (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*

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, a careful analysis that was made following the Manchester Commonwealth Games of 2002 CE 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*

9.8.5 Other Competitive Games

Other competitive games, particularly the age-classified Masters Games, have as yet avoided some of the problems currently plaguing Olympic sport.

9.8.5.1 Masters Games

The World Masters Games were inaugurated in Toronto, ON, in 1985 CE. 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 event, other major cities have hosted the Masters Games at 3–4 year intervals, attracting some 25,000 participants in Brisbane (1994 CE) and Melbourne (2002 CE) and nearly 29,000 in Sydney (2009 CE). In Sydney, the largest overseas delegation came from Canada (2,242 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 financial support from the host Nation. 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 upon population health of Masters competition as a whole, and the feats of individual participants 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).

9.8.5.2 Other Games

Many countries continue to establish lower level National and regional sports competitions. Canadian examples include the *Arctic Winter Games* (initiated in Yellowknife in 1970 CE) and the *Canadian Maccabiah Games Association* (formed in 1972 CE, to promote participation in the Israeli event).

Conclusions

New forms of technology such as the metabolic cart, signal averagers and echocardiograms, force platforms, isokinetic torque recorders, needle biopsy, automated cell sorting and counting and gene sequencers have speeded research in many areas of Exercise Science during the Post-Modern Era. Several recent American Presidents have played team sports, but in Canada some politicians have shown greater interest in outdoor recreation than in sport. The increasing longevity of Western populations speaks to better overall health. The 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 all underlined the need to focus upon prevention rather than the treatment of disease. Relationships between physical activity and disease prevention are now better understood, and several new journals discuss such issues. Occupational health and cardiac rehabilitation programmes have attracted growing interest, and the U.S. finally has a scheme for Nation-wide health insurance. Important developments in the study of fitness have included the standardization of exercise test methodology, and the development of appropriate tools for population screening and field-testing. National surveys have provided benchmarks of current health and fitness status. Quasi-experimental studies have demonstrated the benefits of enhanced physical education for school children, and the costs and benefits of worksite fitness programmes. The minimum fitness needed in physically demanding occupations has been defined in the context of human rights legislation, and the importance of regular physical activity has been demonstrated in the context of an aging population. Attempts to enhance physical activity in the general population through Fitness awards and government-sponsored agencies such as ParticipACTION have had only limited success. The emphasis in School Physical Education programmes has shifted from the promotion of sports teams to the teaching of physical activities that will carry over into adult life, and many Universities now offer doctoral programmes in Exercise Sciences and Kinesiology. 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 grown in popularity. International competitions now cater to women, para-athletes and the elderly, but the Olympic Games have lost their earlier idealism. Back-room laboratories are pitted against one another in a search for legal or illegal means to enhance performance. Doping, sex and age scandals, physical attacks on opponents and biased judging sully top-level competition, and cheating is a concern even in the Paralympic Games. The costs of international competition have also become enormous, and claims that such expenses are offset by a beneficial impact upon public health and fitness seem highly doubtful.

References

Abernethy P, Wilson G, Logan P (1995) Strength and power assessment: issues, controversies and challenges. Sports Med 19(5):401–417

Abrams HK (1992) Some hidden history of occupational medicine. Environ Res 59(1):23–25

Abrams HK (2001) A short history of occupational health. J Public Health Policy 22(1):34–80

ACSM (2014) ACSM certification. http://certification.acsm.org/acsm-certified-health-fitness-specialist. Accessed 25 June 2014

Adler I (1912) Primary malignant growths of the lungs and bronchi. Longmans, London, UK

Aitken J (1996) Nixon: a life. Regnery Publishing, Washington, DC

Alfredson H, Pietila T, Johnson P et al (1998) Heavy-load eccentric calf muscle training for the treatment of chronic Achilles tendinitis. Am J Sports Med 26(3):360–366

Ambrose SE (1987) The education of a politician 1913–1962. Simon & Schuster, New York, NY

American College of Sports Medicine (1975) ACSM's guidelines for exercise testing and prescription (1st edn). Lippincott, Williams & Wilkins, Philadelphia, PA

American College of Sports Medicine (2013) ACSM's guidelines for exercise testing and prescription, 9th edn. Lippincott, Williams & Wilkins, Philadelphia, PA

American Thoracic Society and European Respiratory Society (1999) Skeletal muscle dysfunction in chronic obstructive pulmonary disease. A statement of the American Thoracic Society and the European Respiratory Society. Am J Respir Crit Care Med 59(4 Part 2):S1–S40

Andermann A, Blancquaert I, Beauchamp S et al (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 KL, Shephard RJ, Denolin H et al (1971) Fundamentals of exercise testing. World Health Organisation, Geneva, Switzerland

Anderson P (1998) The origins of postmodernity. Verso, London, UK

Anderson TW, Le Riche WH (1970) Ischemic heart disease and sudden death, 1901-1961. Br J Prev Soc Med 24(1):1–9

Anderson TW, Shephard RJ (1968) The effects of hyperventilation and exercise upon the pulmonary diffusing capacity. Respiration 25(6):465–484

Aoyagi Y, Shephard RJ (2009) Steps per day- the road to senior health? Sports Med 39(6):423–438

Aoyagi Y, Shephard RJ (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(9):695–708

Ashton JR (2006) Virchow misquoted, part-quoted and the real McCoy. J Epidemiol Community Health 60:671

Ashwell Z, McKay MP, Brubacher JR et al (2012) The epidemiology of mountain bike park injuries at the Whistler Bike Park, British Columbia (BC), Canada. Wilderness Environ Med 23(2):140–145

Åstrand I (1967) Degree of strain during building work and its relationship to individual aerobic work capacity. Ergonomics 10(3):293–303

Australian Government (2010) Sydney 2009 World Masters Games: final report. Australian Government, Canberra, Australia

Bailey DA, Shephard RJ, Mirwald R (1976) Validation of a self-administered home test of cardio-respiratory fitness. Can J Appl Sport Sci 1(1):67–78

Ballantyne KN, Kayser M, Grootegoed JA (2012) Sex and gender issues in competitive sports: investigation of a historical case leads to a new viewpoint. Br J Sports Med 46(8):614–617

Bamberger M, Yaeger D (1997) Over the edge. Sports Illustrated 14:62–70

Barach AL, Bickerman HA, Beck G (1952) Advances in the treatment of non-tuberculous pulmonary disease. Bull NY Acad Med 28(6):353–384

Barilleaux RJ, Rozell MJ (2004) Power and prudence: the Presidency of George H. W. Bush. Texas A&M University Press, Austin, TX

Barnard RJ, Edgerton VR, Furukawa T et al (1971) Histochemical, biochemical and contractile properties of red, white and intermediate fibers. Am J Physiol 220(2):410–414
Barnes RM (1963) Motion and time study. Wiley, London, UK
Baron DA, Martin DM, Magd SA (2007) Doping in sports and its spread to at-risk populations: an international review. World Psychiatr 6(2):118–123
Barré-Sinoussi F, Chermann JC, Rey F et al (1983) Isolation of a T-lymphotropic retrovirus from a patient at risk for acquired immune deficiency syndrome (AIDS). Science 220(4599):868–871
Bateman C (2012) Marathon deaths 'potentially preventable'. S Afr Med J 97(7):492–498
Bauman A (2000) Precepts and principles of mass marketing media evaluations in Australia. Health Promot J Austr 10(1):89–92
Bauman A, Craig MJ, Craig C et al (2004) ParticipACTION. This mouse roared, but did it get the cheese? Can J Public Health 95(Suppl 2):16–21
Beaubien PD (2004) Foreword. Can J Public Health 95(Suppl 2):54
Belman MJ (1986) Exercise in chronic obstructive pulmonary disease. Clin Chest Med 7(4):585–597
Bennell K, Wajswelner H, Lew P et al (1998) Isokinetic strength testing does not predict hamstring injury in Australian rules footballers. Br J Sports Med 32(4):309–314
Benson M (2004) Bill Clinton. Lerner, Minneapolis, MN
Bergh U, Forsberg A (2000) Cross-country ski racing. In: Shephard RJ, Åstrand P-O (eds) Endurance in sport. Blackwell Scientific, Oxford, UK
Bernstein I (1991) Promises kept: John F. Kennedy's new frontier. Oxford University Press, New York, NY
Berto FJ (2008) The birth of dirt: origins of mountain bike riding. Van der Plas Publications, San Francisco, CA
Bingham E (1992) On the need for reform of the OSH Act. Am J Ind Med 21:891–893
Blair SN, Kohl HW, Paffenbarger RS et al (1989) Physical fitness and all-cause mortality: a prospective study of healthy men and women. JAMA 262(17):2395–2401
Blessinger J, Sawyer B, Davis C et al (2009) Reliability of the VmaxST portable metabolic measurement system. Int J Sports Med 30(1):22–26
Blum A (2005) Breaking trail: a climbing life. Simon & Schuster, New York, NY
Bøggild H, Knuttson A (1999) Shift work, risk factors and cardiovascular disease. Scand J Work Environ Health 25(2):85–99
Bonjer FH (1966) Relationships between physical working capacity and allowable caloric expenditure. In: Rohmert W (ed) Colloquium on muscular exercise and training. Gentner Verlag, Darmstadt, Germany
Bonneau J (2001) Evaluating physical competencies. Fitness related tests. Task simulation or hybrid? In: Gledhill N, Bonneau J, Salmon A (eds) Bona fide occupational requirements. Proceedings of the consensus forum on establishing BONA FIDE requirements for physically demanding occupations. York University, Toronto, ON
Bornø A, Aachmann-Andersen NJ, Munch-Andersen T et al (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(3):537–543
Borodulin K, Laatikainen T, Juolevi A et al (2007) Thirty year trends of physical activity in relation to age, calendar time and birth cohort in Finnish adults. Eur J Public Health 18(3):339–344
Bouchard C, Lortie G, Simoneau J-A et al (1984) Submaximal power output in adopted and biological siblings. Ann Hum Biol 11(4):303–309
Bouchard C, Lesage R, Lortie G et al (1986) Aerobic performance in brothers, dizygotic and monozygotic twins. Med Sci Sports Exerc 18(6):639–646
Bouchard C, Shephard RJ, Stephens T et al (1990) Exercise, fitness & health. Human Kinetics, Champaign, IL
Bouchard C, Shephard RJ, Stephens T (1994) Physical activity, fitness & health. Human Kinetics, Champaign, IL

Bouchard C, Wolfarth B, Rivera MA et al (2000) Genetic determinants of endurance performance. In: Shephard RJ, Åstrand P-O (eds) Endurance in sport. Blackwell Scientific, Oxford, UK
Bouchard C, Sarzynski MA, Rice TR et al (2011) Genomic predictors of the maximal O2 response to standardized exercise training programs. J Appl Physiol 110(5):1160–1170
Bourne PG (1997) Jimmy Carter. A comprehensive biography from Plains to Postpresidency. Scribner, New York, NY
British Association of Sport and Exercise Sciences (2014) Accreditation. http://www.bases.org.uk/Accreditation. Accessed 25 June 2014
Brownson RC, Boehmer TK, Luke DA (2005) Declining rates of physical activity in the United States: what are the contributors? Annu Rev Public Health 26:421–443
Bruck K, Olschewski H (1987) Body temperature related factors diminishing the drive to exercise. Can J Physiol Pharmacol 65(6):1274–1280
Bryant J (2010) The London marathon. Random House, London, UK
Buckley WE, Yesalis CE, Friedl KE et al (1988) Estimated prevalence of anabolic steroids use by male adolescents. JAMA 260(23):3441–3445
Buckley JD, Bourdon PC, Woolford SM (2003) Effect of measuring blood lactate concentrations using different automated lactate analysers on blood lactate transition thresholds. J Sci Med Sport 6(4):408–421
Buick F, Gledhill N, Froese AB et al (1980) Effect of induced erythrocythemia on aerobic work capacity. J Appl Physiol 48(4):636–642
Burke ER (1998) Precision heart rate training. Human Kinetics, Champaign, IL
Burr J, Montelpare WJ, Shephard RJ (2013) Does adventure sport have a role in health promotion? Can Fam Phys 59: 1311–1313
Burtscher M (2012) Climbing the Himalayas more safely. BMJ 344(7863):9
Bush GW (2010) Decision points. Random House Canada, Toronto, ON
Butz T, van Buuren F, Mellwig KP et al (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 Imaging 27(1):91–100
Caballero B (2007) The global epidemic of obesity: an overview. Epidemiol Rev 29(1):1–5
Campbell K (1997) Time and chance: the political memoirs of Canada's first woman prime minister. Seal Books, Toronto, ON
Campbell D (2012) London's Olympic public health legacy: will it turn to dust? BMJ 344:e4207
Camus G, Deby-Dupont G, Duchateau C et al (1994) Are similar inflammatory factors involved in strenuous exercise and sepsis? Intensive Care Med 20(8):602–610
Canada Fitness Survey (1983) Fitness and lifestyle in Canada. Fitness Canada, Ottawa, ON
Canadian Association for Physical Education and Recreation (1966) Fitness performance manual. Canadian Association for Physical Education and Recreation, Toronto, ON
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. Canadian Heart Foundation, Ottawa, ON
Canadian Heritage (2013) Sport participation 2010. Author, Ottawa, ON
Canadian Institute for Health Information (2012) Canada's health care spending slows. http://www.cihi.ca/cihi-extportal/internet/en/document/spending+and+health+workforce/spending/release_30oct12. Accessed 25 June 2014
Canadian Public Health Association (1979) Employee fitness project 1978. Minister of State, Fitness & Amateur Sport, Ottawa, ON
Canadian Public Health Association (1983) National conference on fitness in the third age, Government Conference Centre, Ottawa, November 8-10, 1982. Canadian Public Health Association, Ottawa, ON
Cantelon H (1982) The "Proletarian Culture" movement and its influence on the International Workers' Sports Organisations in the 1920s. In: Kidd B (ed) Proceedings of the 5th Canadian Symposium on the History of Sport and Physical Education. University of Toronto School of Physical & Health Education, Toronto, ON

Casaburi R, Patessio A, Ioli F et al (1991) Reductions in exercise lactic acidosis and ventilation as a result of exercise training in patients with chronic obstructive lung disease. Am Rev Respir Dis 143(1):9–18
CDC (2014a) NHANES. http://www.cdc.gov/nchs/nhanes/nhanesi.htm. Accessed 25 June 2014
CDC (2014b) Overweight and obesity. http://www.cdc.gov/obesity/data/adult.html. Accessed 25 June 2014
CDC (2014c) Vaccines and immunizations. http://www.cdc.gov/vaccines/pubs/pinkbook/rubella.html. Accessed 27 June 2014
Centers for Disease Control (1982) A cluster of Kaposi's sarcoma and Pneumocystis carinii pneumonia among homosexual male residents of Los Angeles and Orange Counties, California. MMWR Morb Mortal Wkly Rep 31(23):305–307
Centers for Disease Control and Prevention (2009) Healthier worksite initiative. Author, Atlanta, GA
Chagnon YC, Allard C, Bouchard C (1984) Red cell genetic variation in Olympic endurance athletes. J Sports Sci 2(2):121–129
Chelly J, Montarras D, Pinset C et al (1990) Quantitative estimation of minor mRNAs by cDNA-polymerase chain reaction application to dystrophin mRNA in cultured myogenic and brain cells. Eur J Biochem 187(3):691–698
Chenoweth DH (2006) Worksite health promotion. Human Kinetics, Champaign, IL
Chisholm DM, Collis ML, Kulak LL et al (1975) Physical activity readiness. Br Col Med J 17:375–378
Chodo R, Hamovitch E, Murphy R (1998) Paul Martin : a political biography. Lorimer, Toronto, ON
Chrétien J (1986) Straight from the heart. McClelland & Stewart/Bantam, Toronto, ON
Church TS, Thomas DM, Tudor-Locke C et al (2011) Trends over 5 decades in U.S. occupation-related physical activity and their associations with obesity. PLoS One 6(5):e19657
Clark LC, Wolf R, Granger D et al (1953) Continuous recording of blood oxygen tensions by polarography. J Appl Physiol 6(3):189–193
Clark RA, Bryant AL, Pua Y et al (2010) Validity and reliability of the Nintendo Wii balance board for assessment of standing balance. Gait Posture 31(3):307–310
Coalter F (2004) London, 2012- a sustainable sporting legacy? In: Vigor A, Mean M (eds) After the Goldrush – a sustainable Olympics in London. Institute for Public Policy Research, Demos, London, UK
Cohen A (2008) Lester B. Pearson. Penguin Books, Toronto, ON
Cohen SM (2013) Examining the effects of a health promotion intervention on the use of stairs. J Artic Support Null Hypothesis 10(1):17–24
College of Kinesiologists of Ontario (2014). Practice standards and practice guidelines. http://www.collegeofkinesiologists.on.ca/professional-conduct/standards-practice-guidelines/. Accessed 25 June 2014
Colley RC, Garriguet D, Janssen I et al. (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(6):524
Collis ML (1976) Employee fitness. Fitness & Amateur Sport, Ottawa, ON
Conway JF (2014) The rise of the new west: the history of a region in Confederation. Lorimer, Toronto, ON
Cooley JK (1973) Green March, Black September: the story of the Palestinian Arabs. Frank Cass, London, UK
Cooper KH (1968) A means of assessing maximal oxygen intake. Correlation between field and treadmill testing. JAMA 203(3):201–204
Cooper CE (2012) Run, swim, throw, cheat: the science behind drugs in sport. Oxford University Press, Oxford, UK

Cooper R, Cutler J, Desvigne-Nickens P et al (2000) Trends and disparities in coronary heart disease, stroke, and other cardiovascular diseases in the United States. Circulation 102(25):3137–3147
Corrado D, Basso C, Pavei A et al (2006) Trends in sudden cardiovascular death in young competitive athletes after implementation of a preparticipation screening program. JAMA 296(13):1593–1601
Corrado D, Pelliccia A, Heidbuchel H et al (2010) Recommendations for interpretation of 12-lead electrocardiogram in the athlete. Eur Heart J 31(2):243–259
Costill DL, Cote R, Miller E et al (1975) Water and electrolyte replacement during repeated days of work in the heat. Aviat Space Environ Med 46(6):795–800
Craig CL, Russell SJ, Cameron C et al (2004) Twenty-year trends in physical activity among Canadian adults. Can J Public Health 95(1):59–63
Crary B, Hauser SL, Borysenko M et al (1983) Epinephrine-induced changes in the distribution of lymphocyte subsets in peripheral blood of humans. J Immunol 131(3):1178–1181
Crouter SE, Antczak A, Hudak JR et al (2006) Accuracy and reliability of the ParvoMedics TrueOne 2400 and Medgraphics VO2000 metabolic systems. Eur J Appl Physiol 98(2):139–151
CSEP (2014) CSEP certified exercise physiologist® certification guide. CSEP, Gloucester, ON
Cumming GR, Glenn J (1977) Evaluation of the Canadian home fitness test in middle-aged men. Can Med Assoc J 117(4):346–3490
Cumming GR, 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(18):1262–1269
Cunningham DA, Rechnitzer PA, Jones NL et al (1990) The issue of poor compliance in exercise trials: a place for post-hoc analyses? Sports Med Train Med Rehabil 2(2):131–139
Czeisler CA, Johnson MP, Duffy JF et al (1990) Exposure to bright light and darkness to treat physiological maladaptations to night work. N Engl J Med 322(18):1253–1259
Dallek R (2005) Lyndon B. Johnson: portrait of a President. Oxford University Press, New York
Dallek R (2011) John F. Kennedy. Oxford University Press, New York, NY
Das P, Samarasekera U (2012) The story of GBD 2010: a "super-human" effort. Lancet 380(9859):2067–2070
Davis TRA (1961) Chamber cold acclimatization in man. J Appl Physiol 16(6):1011–1015
Davis JA, Whipp BJ, Wasserman K (1980) The relation of ventilation to metabolic rate during moderate exercise in man. Eur J Appl Physiol 44(2):97–108
Daynes H, Shakespear G (1920) The theory of the katharometer. Proc R Soc Lond 97:273–286
deGaray A, Levine L, Carter JEL (1974) Genetic and anthropological studies of Olympic athletes. Academic Press, New York, NY
DeJong JR (1967) The contribution of ergonomics to work study. Ergonomics 10(5):579–588
Dekker DL, Piziali RL, Dong ER (1974) A system for ultrasonically imaging the human heart in three dimensions. Comput Biomed Res 7(6):544–553
Derderian T (1996) Boston Marathon: the first century of the world's premier running event. Human Kinetics, Champaign, IL
Designs A (1999) Fat tire. A celebration of the mountain bike. Chronicle Books, San Francisco, CA
Doll R, Hill AB (1954) The mortality of doctors in relation to their smoking habits. BMJ 1(4877):1451–1453
Doran DA, Reay M (2000) Injuries and associated training and performance characteristics in recreational rock climbers. In: Messenger N,W, Patterson W, Brook D (eds) The science of climbing and mountaineering. Human Kinetics, Champaign, IL
Drake V, Jones G, Brown JR et al (1968) Fitness performance tests and their relationship to maximum oxygen uptake. Can Med Assoc J 99(17):844–848
Dubois AB, Fowler RC, Soffer A et al (1952) Alveolar CO2 measured by expiration into the rapid infrared gas analyser. J Appl Physiol 4(7):526–534
Eastman CI (1992) High intensity light for circadian adaptation to a 12-hour shift of the sleep schedule. Am J Physiol 263:R428–R436

Eastman CI, Liu L, Fogg LF (1995) Circadian rhythm adaptation to simulated night shift work: effect of nocturnal bright light duration. Sleep 18(6):399–407
Edholm OG, Bacharach AL (1965) The physiology of human survival. Academic Press, London, UK
Edler I, Lunstorm K (1954) History of echocardiography. Ultrasound Med Biol 30(12):1565–1644
Edwards P (2004) No country mouse. Thirty years of effective marketing and health communications. Can J Public Health 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: Gledhill N, Bonneau J, Salmon A (eds) Bona fide occupational requirements. Proceedings of the consensus forum on establishing BONA FIDE requirements for physically demanding occupations. York University, Toronto, ON, pp 53–61
Eisenberg M (2006) Bernard Lown and defibrillation. Resuscitation 69(2):171–173
Eisenmann JC, Brisko N, Shadrick D et al (2003) Comparative analysis of Cosmed Quark b2 and K4b2 gas analysis systems during submaximal exercise. J Sports Med Phys Fitness 43(2):150–155
Ekblom B, Greenleaf CJ, Greenleaf JE et al (1970) Temperature regulation during exercise dehydration in man. Acta Physiol Scand 79(4):475–483
Engel WK (1998) The essentiality of histo- and cytochemical studies of skeletal muscle in the investigation of neuromuscular disease. Neurol 51(3):778–784
European Union (2008) EU physical activity guidelines. European Union, Brussels, Belgium
Fagard R, Bielen E, Amery A (1991) Heritability of aerobic power and anaerobic energy generation during exercise. J Appl Physiol 70:352–362
Feigenbaum H (1996) Evolution of echocardiography. Circulation 93:1321–1327
Fiatarone MA, Marks EC, Ryan ND et al (1990) High-intensity strength training in nonagenarians: effects on skeletal muscle. JAMA 263(22):3029–3034
Fitch KD, Morton AR (1971) Specificity of exercise in exercise-induced asthma. BMJ iv (5787):577–581
Fitch KD, Sue-Chu M, Anderson SD et al (2008) Asthma and the elite athlete: summary of the international Olympic Committee's consensus conference, Lausanne, Switzerland, January 22–24, 2008. J Allergy Clin Immunol 122(2):254–260
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). Benno Schwabe & Co, Basel, Switzerland
Floyer J (1698) A treatise of the asthma. R Wilkin, London, UK
Folinsbee LJ, Schelegle ES (2000) Air pollutants and endurance performance. In: Shephard RJ, Åstrand P-O (eds) Endurance in sport. Blackwell Scientific, Oxford, UK, pp 628–638
Folinsbee LJ, Silverman F, Shephard RJ (1977) Decrease of maximum work performance following ozone exposure. J Appl Physiol 42(4):531–536
Food and Agriculture Organisation (2009) The double burden of malnutrition: case studies from six developing countries. Author, Geneva, Switzerland
Fort E, Stevens D (2010) Sporting scandals: doping scandals, including Ben Johnson, Marion Jones, USC Steroid, BALCO, the Mitchell Report, and the 2007 Tour de France. Bibliobazaar, Charleston, SC
Fourestier M (1962) Les expériences scolaires de Vanves (School studies in Vanves). Int Rev Educ 8(1):81–85
Fowler RC (1949) A rapid infra-red gas analyzer. Rev Sci Instrum 20(3):175–178
Franklin JL (2000) A comparison of the Yellow Springs Instruments and the Accusport portable lactate analyzer for measuring blood lactate in cold environments. M.S. thesis, University of Wisconsin (LaCrosse), LaCrosse, WI
Gabriel H, Kindermann W (1995) Flow cytometry. Principles and applications in exercise immunology. Sports Med 20(5):302–320

Garber CE, Blismer B, Deschenes M et al (2011) Quantity and quality of exercise for developing and maintaining cardiorespiratory, musculoskeletal and neuromotor fitness in apparently healthy adults. Guidelines for prescribing exercise. Med Sci Sports Exerc 43(7):1334–1359
Garvican LA, Eastwood A, Martin DT et al (2010) Stability of hemoglobin mass during a 6-day UCI Pro tour cycling race. Clin J Sport Med 20(3):200–204
Geva T (2006) Magnetic resonance imaging: historical perspective. J Cardiovasc Magn Reson 8 (4):573–580
Gherman B (2003) Jimmy Carter. Twenty-first Century Books, Minneapolis, MN
Gibson R, Singh JP (2010) The battle over health care: what Obama's reform means for America's future. Rowman & Littlefield, Lanham, MD
Gilbert MT, Rambaut A, Wlasiuk G et al (2007) The emergence of HIV/AIDS in the Americas and beyond. Proc Natl Acad Sci U S A 104(47):18566–18570
Gisolfi CV, Spranger KJ, Summers RW et al (1991) Effects of cycle exercise in intestinal absorption in humans. J Appl Physiol 71(6):2518–2527
Glaser EM, Shephard RJ (1963) Simultaneous experimental acclimatization to heat and cold. J Physiol 169(3):592–602
Gledhill N, Jamnik V (2003) Canadian physical activity, fitness and lifestyle approach, 3rd edn. Canadian Society for Exercise Physiology, Ottawa, ON
Gledhill N, Froese AB, Dempsey JA (1977) Ventilation to perfusion distribution during exercise in health. In: Dempsey JA, Reed CE (eds) Muscular exercise and the lung. University of Wisconsin Press, Madison, WI
Gledhill N, Bonneau J, Salmon A (2001) Bona fide occupational requirements. Proceedings of the consensus forum on establishing BONA FIDE requirements for physically demanding occupations. York University, Toronto, ON
Gleeson M (2000) Mucosal immune response and risk of respiratory illness in elite athletes. Exerc Immunol Rev 6:5–42
Gochfeld M (2005) Chronologic history of occupational medicine. J Occup Environ Med 47(2):96–114
Godfrey S, Silverman M, Anderson SD (1973) Problems of interpreting exercise induced asthma. J Allergy Clin Immunol 52(4):199–209
Godin G, Shephard RJ (1990) Use of attitude-behaviour models in exercise promotion. Sports Med 10(2):241–250
Godlee F (2011) The fraud behind the MMR scare. BMJ 342 (Jan 06 1): d22–d22
Godlee F, Smith J, Marcovitch H (2011) Wakefield's article linking MMR vaccine and autism was fraudulent. BMJ 342:c7452
Goetzel RZ, Ozminkowski RJ (2008) The health and cost benefits of work site health promotion programs. Annu Rev Public Health 29:303–323
Goldman MR, Pohost GM, Ingwall JS et al (1980) Nuclear magnetic resonance imaging: potential cardiac applications. Am J Cardiol 46(7):1278–1283
Goodwin JE, Levitt P (1962) Telemetering heart rate during exercise. Proc Can Fed Biol Soc 5:45
Gormley B (2000) President George W. Bush: our forty-third president. Simon & Schuster, New York, NY
Greene JR (1885) The presidency of Gerald R. Ford. University of Kansas Press, Lawrence, KS
Griffith CR (1926) Psychology of coaching. Charles Scribner Sons, New York, NY
Grimby G, Saltin B, Wilhelmsen L (1971) Pulmonary flow-volume and pressure-volume relationship during submaximal and maximal exercise in young well-trained men. Bull Physiopathol Respir 7(1):157–172
Hammel HT, Elsner RW, Le Messurier DH et al (1959) Thermal and metabolic responses of the Australian aborigines to moderate cold in summer. J Appl Physiol 14:605–615
Harrington JM (2001) Health effects of shift work and extended hours of work. Occup Environ Med 58(1):68–72
Harris JF (2006) The survivor: Bill Clinton in the white house. Random House, New York, NY
Hart P (2004) Windsurfing. Crowood, Ramsbury, Wilts, UK
Hattenhauer M, Neill WA (1975) The effect of cold air inhalation on angina pectoris and myocardial oxygen supply. Circulation 51(6):1053–1058

Hausswirth C, Bigard AX, Chevalier JM (1997) The Cosmed K4 telemetry system as an accurate device for oxygen uptake measurements during exercise. Int J Sports Med 18(6):449–453
Hawkes RC, Holland GN, Moore WS et al (1981) Nuclear magnetic resonance (NMR) tomography of the normal heart. J Comput Assist Tomogr 5(5):605–612
Hawkins SA, Wiswell RA (2003) Rate and mechanism of maximal oxygen consumption decline with aging. Sports Med 33(12):877–888
Heath D, Williams DR (1989) High altitude medicine and pathology. Butterworths, London, UK
Heck H, Mader A, Hess G et al (1985) Justification of the 4-mmol/l lactate threshold. Int J Sports Med 6(3):117–130
Heggie TW, Caine DJ (2012) Epidemiology of injury in adventure and extreme sports. Karger, Basel, Switzerland
Hermansen L, Wachtlova M (1971) Capillary density of skeletal muscle in well-trained and untrained men. J Appl Physiol 30(6):860–863
Hettinger TH (1961) Physiology of strength. C.C. Thomas, Springfield, IL
Hoffer EC, Meador CK, Simpson DC (1969) Correlation of whole-body impedance with total body water volume. J Appl Physiol 27(4):531–534
Hoffman-Goetz L, Kubes P, Shephard RJ (1998) Immune responses to inflammation and trauma: a physical training model. Can J Physiol Pharmacol 76(5):469–597
Holmgren A (1967) Vaso-regulatory asthenia. Can Med Assoc J 96(12):853
Hong SK, Rennie DW, Park YS (1987) Humans can acclimatize to cold: a lesson from Korean women divers. APS Physiol 2:79–82
Horvath SM, Horvath EC (1973) The Harvard Fatigue laboratory: its history and contributions. Prentice-Hall, Englewood Cliffs, NJ
Horvath SM, Gliner JA, Matsen-Twisdale JA (1979) Pulmonary function and maximum exercise responses following acute ozone exposure. Aviat Space Environ Med 50(9):901–905
House of Commons Select Committee on Culture, Medicine and Science (2007) 2012 Olympic Games and Paralympic Games: funding and legacy. H.M. Stationery Office, London, UK
Howell ML, MacNab RBJ (1968) The physical work capacity of Canadian children 7-17 years. Canadian Association of Health. Physical Education and Recreation, Ottawa, ON
Hsu AR, Barnholt KE, Grundmann NK et al (2006) Sildenafil improves cardiac output and exercise performance during acute hypoxia, but not normoxia. J Appl Physiol 100 (6):2031–2040
Humphreys DL (1978) Joe Clark: a portrait. Deneau & Greenberg, Ottawa, ON
Hunter JA, Stacy RW, Hitchcock FA (1949) A mass spectrometer for continuous gas analysis. Rev Sci Instrum 20(5):333–336
Hurlock GS, Higashino H, Mochizuki T (2009) History of cardiac computed tomography: single to 320-detector row multislice computed tomography. Int J Cardiovasc Imaging 2009 Apr 25(Suppl 1):31–42
Huston TP, Puffer JC, Rodney WM (1985) The athletic heart syndrome. N Engl J Med 313 (1):24–32
Interim Staff (1990) Kim Campbell: Bill C-43 is woman's entitlement. The Interim, May 31st issue.
International Olympic Committee (2009) Sport as a vehicle for social change: 4th world conference on women and sport. International Olympic Committee, Lausanne, Switzerland
Jackson SS (1975) Diffusion of an innovation. An exploratory study of the consequences of sport participation: Canada's campaign at Saskatoon. University of Alberta, Edmonton, AL
James WP (2008) The fundamental drivers of the obesity epidemic. Obes Res 9(Suppl 1):6–13
Jansen VA, Stollenwerk N, Jensen HJ et al (2003) Measles outbreaks in a population with declining vaccine uptake. Science 301(5634):804
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. Ben Johnson Enterprises, Markham, ON
Jonas S, Nissenson M (1994) Going, going, gone: vanishing Americana. Chronicle Books, San Francisco, CA

Jones NL, Kane M (1979) Quality control of exercise test measurements. Med Sci Sports 11(4):368–372
Jones PRM, Pearson J (1969) Anthropometric determination of leg fat and muscle plus bone volumes in young female and male adults. J Physiol 204(1):64P
Jonson B, Werner O, Jansson L (1976) A system for computer-assisted ECG recording at rest and exercise. Scand J Clin Lab Invest 145(Suppl):7–21
Karpovich PV (1944) Physical training for flyers. Air Surg Bull 1:24–25
Katzmarzyk PT (2011) The economic costs associated with inactivity and obesity in Ontario. Health Fit J Can 4(4):31–40
Kavanagh T (1970) A cold weather jogging mask for angina patients. Can Med Assoc J 103(12):1290–1291
Kavanagh T (1976) Heart attack? Counter attack! Van Nostrand, Toronto, ON
Kavanagh T, Shephard RJ (1977) On the choice of fluid for the hydration of middle-aged marathon runners. Br J Sports Med 11(1):26–35
Kavanagh T, Shephard RJ, Pandit V (1974) Marathon running after myocardial infarction. JAMA 229(12):1602–1605
Kavanagh T, Lindley LJ, Shephard RJ et al (1988) Health and socio-demographic characteristics of the Masters competitors. Ann Sport Med 4(1):55–64
Keilani M, Krall C, Lipowec L, et al. (2010) Skateboarding injuries in Vienna: location, frequency, and severity. PMR 2(7): 619–624
Kereszty A (1971) Overtraining. In: Larson LA (ed) Encyclopedia of sport sciences and medicine. Macmillan, New York, NY, pp 218–222
Kesaniemi FA, Danforth E, Jensen MD et al (2001) Dose-response issues concerning physical activity and health: an evidence based symposium. Med Sci Sports Exerc 33(Suppl 6):S351–S358
Killian KJ, Campell EJM (1974) Dyspnea and exercise. Annu Rev Physiol 45:465–479
King GA, McLaughlin JE, Howley ET et al (1999) Validation of Aerosport KB1-C portable metabolic system. Int J Sports Med 20(5):304–308
Kingisepp P-H (2011) Alfred Fleisch (1892-1973), professor of physiology at the university of Tartu, Estonia. J Med Biogr 19(1):34–37
Kinsella W (2007) The war room: political strategies for business, NGOs, and anyone who wants to win. Dundurn Press, Toronto, ON
Kirkendall DT (2011) Complete guide to soccer fitness and injury prevention: a handbook for players, parents, and coaches. University of North Carolina Press, Chapel Hill, NC
Kissebah AH, Vydelingum N, Murray R et al (1982) Relation of body fat distribution to metabolic complications of obesity. J Clin Endocrinol Metab 54(2):254–260
Klissouras V (1971) Hereditability of adaptive variation. J Appl Physiol 31: 338-344
Klissouras V (1972) Genetic limits of functional ability. Int Z Angew Physiol 30(2):85–94
Klissouras V, Pirnay F, Petit JM (1973) Adaptation to maximal effort: Genetics. J Appl Physiol 35:288–293
Kossek EE, Michel JS (2014) Flexible work schedules. In: Zedeck S (ed) APA handbook of industrial and organizational psychology, vol 1. American Psychological Association, Washington, DC
Kraus H, Hirschland R (1954) Minimum muscular fitness tests in school children. Res Q 25(2):178–188
Krishnamoorthy VK, Sengupta PP, Gentile F et al (2007) History of echocardiography and its future applications in medicine. Crit Care Med 35(8 Suppl):S309–S313
Ladenheim ML, Kotler TS, Pollock BH et al (1987) Incremental prognostic power of clinical history, exercise electrocardiography and myocardial perfusion scintigraphy in suspected coronary artery disease. Am J Cardiol 59(4):270–277
Lagarde F (2004) The challenge of bilingualism. ParticipACTION campaigns succeeded in two languages. Can J Public Health 95(Suppl 2):32–34
LaGerche A, Connelly KA, Mooney DJ et al (2008) Biochemical and functional abnormalities of left and right ventricular function after ultra-endurance exercise. Heart 94(7):860–866

Lalonde M (1974) A new perspective on the health of Canadians. A working document. Government of Canada, Ottawa, ON
Landry F, Landry M, Yerlès M (1991) Sport, the third millennium: proceedings of the international symposium, Quebec City, Canada, May 21-25, 1990. Presses Université Laval, Quebec City, QC
LaPorte W (1966) The influence of a gymnastic pause upon recovery following post-office work. Ergonomics 9(6):501–506
LaPorte W (1970) La gymnastique de pause dans l'entreprise (The gymnastic pause in industry). Editions de l'Administration de l'Education Physique des Sports. Brussels, Belgium
Larsson B, Svardsudd K, Welin L et al (1984) Abdominal adipose tissue distribution, obesity, and risk of cardiovascular disease and death: 13 year follow-up of participants in the study of men born in 1913. BMJ 288(6428):1401–1404
Lawler D (2012) Frequently asked questions on bribery and corruption. John Wiley, Chichester, UK
Lawrence M (2003) Iron man : the defiant reign of Jean Chrétien. Viking, Toronto, ON
Lawrie RA (1953) The activity of the cytochrome system in muscle and its relation to myoglobin. Biochem J 55(2):298–305
Laxer J, Laxer R (1977) The liberal idea of Canada: Pierre Trudeau and the question of Canada's survival. Lorimer, Toronto, ON
LeBlanc J (1975) Man in the cold. C.C. Thomas, Springfield, IL
Lemco J (1994) National health care: lessons for the United States and Canada. University of Michigan Press, Ann Arbor, MI
Levine BD, Stray-Gundersen J (1997) "Living high-training low": effect of moderate-altitude acclimatization with low-altitude training on performance. J Appl Physiol 83(1):102–112
Levy B (2005) Social injustice and public health. Oxford University Press, New York, NY
Lickint F (1929) Tabak und Tabakrauch als ätiologischer Factor des Carcinoms. (Tobacco and tobacco consumptionas an aetilogical factor for carcinoma). Z Krebsforsch 30:349–365
Linnan L, Bowling M, Childress J et al (2008) Results of the 2004 national worksite health promotion survey. Am J Public Health 98(6):1503–1509
Litt P (2011) Elusive destiny : the political vocation of John Napier Turner. UBC Press, Vancouver, BC
Loraschi A, Galli N, Cosentino M (2014) Dietary supplement and drug use and doping knowledge and attitudes in Italian young elite cyclists. Clin J Sports Med 24(3):238–244
Lothian F, Farrally MR, Mahoney C (1993) Validity and reliability of the Cosmed K2 to measure oxygen uptake. Can J Appl Physiol 18(2):197–206
Louhevaara V, Ilmarinen J, Oja P (1985) Comparison of three field methods for measuring oxygen consumption. Ergonomics 28(2):463–470
Lucia A, Fleck SJ, Gotshall KW et al (1993) Validity and reliability of the Cosmed K2 instrument. Int J Sports Med 14(7):380–386
Lucove JC, Huston DSL, Evenson KR (2007) Workers' perceptions about worksite policies and environments and their association with leisure-time physical activity. Am J Health Prom 21(3):196–200
Lukaski HC (2013) Evolution of bioimpedance: a circuitous journey from estimation of physiological function to assessment of body composition and a return to clinical research. Eur J Clin Nutr 67(1):52–59
MacIntosh BR, Gardiner PF, McComas AJ (2006) Skeletal muscle: form and function. Human Kinetics, Champaign, IL
Mackey L (2005) The pilgrimage of Stephen Harper. ECW Press, Toronto, ON
MacKinnon LT, Hooper SL (1994) Mucosal (secretory) response to exercise of varying intensity and during overtraining. Int J Sports Med 15(Suppl 3):S179–S182
Mackinnon LT, Ginn E, Seymour G (1991) Temporal relationship between exercise-induced decreases in salivary IgA concentration and subsequent appearance of upper respiratory illnesses in elite athletes. Med Sci Sports Exerc 22(5):S125
Macklem PT (1979) Discussion of "inspiratory muscle fatigue" as a factor limiting exercise. Bull Eur Physiopathol Respir 15(1):111–115

Maes H, Beuen G, Vlietinck R et al (1993) Heritability of health- and performance-related fitness: data from the Leuven longitudinal twin study. In: Duquet W, Day JAP (eds) Kinanthropometry IV. Spon, London, UK, pp 140–149
Mallon B (2012) The Olympic bribery scandal. J Olymp Hist 8(2):11–27
Mansfield S (2004) The faith of George W. Bush. Penguin, New York, NY
Maraniss D (2008) Barack Obama: the story. Simon & Schuster, New York, NY
Marcus BH, OwenN FLH et al (1998) Physical activity interventions using mass media, print media, and information technology. Am J Prev Med 15(4):362–378
Maron BJ, Thompson PD, Ackerman MJ et al (2007) Recommendations and considerations related to preparticipation screening for cardiovascular abnormalities in competitive athletes: 2007 update: a scientific statement from the American Heart Association Council on nutrition, physical activity, and metabolism: endorsed by the American College of Cardiology Foundation. Circulation 115(12):1643–1655
Maron BJ, Doerer JJ, Haas TDS et al (2009) Sudden death in young competitive athletes. Analysis of 1866 deaths in the United States, 1980-2006. Circulation 119(8):1085–1092
Martin PP, Weaver DA (2005). Social security: a program and policy history. Soc Sec Bull 66 (1) (Online document). Accessed 1 Sept 2012
Martino M, Gledhill N, Jamnik V (2002) High VO2max with no history of training is primarily due to high blood volume. Med Sci Sports Exerc 34:966–971
Masteralexis LP, Barr CA, Hums MA (2009) Principles and practice of sport management. Jones and Bartlett, Sudbury, MA
McArdle WD, Katch F, Katch VL (2010) Exercise physiology, nutrition, energy and human performance. Lippincott, Williams & Wilkins, Philadelphia, PA
McFarlane DJ (2001) Automated metabolic gas analysis systems. Sports Med 31(12):841–861
McKenzie DC, Fitch KD (2011) The asthmatic athlete: Inhaled beta-2 agonists, sports performance and doping. Clin J Sports Med 21(1):46–50
McLaughlin JE, King GA, Howley ET et al (2001) Validation of the COSMED K4 b2 portable metabolic system. Int J Sports Med 22(4):280–284
Mellerowicz H, Barron DK (1971) Overtraining. In: Larson LA (ed) Encyclopedia of sport sciences and medicine. Macmillan, New York, NY, pp 1310–1312
Mertens DM, Kavanagh T, Shephard RJ (1978) Exercise rehabilitation for chronic obstructive lung disease. Respiration 35(1):96–107
Meyers JH (1987) Decreasing barriers- a blueprint for workplace health in the nineties. American Heart Association, Dallas, TX
Milan FA (1980) The human biology of circumpolar populations. Cambridge University Press, Cambridge, UK
Milledge JS (1986) The ventilatory response to hypoxia: how much is good for a mountaineer? Postgrad Med J 63(737):169–172
Milledge JS (1994) High altitude. In: Harries M, Williams C, Stanish WD et al (eds) Oxford textbook of sports medicine. Oxford University Press, New York, NY, pp 217–230
Mohme-Lundholm E, Svedmyr N, Vamos N (1965) Enzymatic micromethod for determining the lactate content of finger-tip blood. Scand J Clin Lab Invest 17(5):501–502
Moldoveanu AI, Shephard RJ, Shek PN (1995) Exercise elevates plasma levels but not gene expression of IL-1β, IL-6, and TNF-α in blood mononuclear cells. J Appl Physiol 89(4):1499–1504
Moores JE (1990) A meta-analysis of the effects of compressed work weeks. Appl HRM Res 1(1):8–14
Morehouse LE, Rasch PJ (1958) Scientific basis of athletic training. Saunders, Philadelphia, PA
Morgan WP, Dr B, Raglin JS et al (1987) Psychological monitoring of overtraining and staleness. Br J Sports Med 21(3):107–114
Morrison T (1998, October issue) Clinton as the first Black President. The New Yorker, New York, NY
Moss RL, Diffee GM, Greaser ML (1995) Contractile properties of skeletal muscle fibers in relation to myofibrillar protein isoforms. Springer, New York, NY
Mundel ME (1950) Motion and time study. Prentice-Hall, New York, NY

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(1):245–275
National Department of Health and Welfare (1986) Achieving health for all: a framework for health promotion. National Dept. of Health & Welfare, Ottawa, ON
National Institute for Health and Clinical Excellence (2010) Chest pain of recent onset: assessment and diagnosis of recent onset. NICE Clinical Guideline 95. NICE, London, UK
National Institute for Occupational Safety and Health (2012) Total worker health. Author, Atlanta, GA
Neilan TG, Januzzi JL, Lee-Lewandrowski E et al (2006) Magnetic resonance imaging of myocardial injury and ventricular dysfunction related to training levels among nonelite participants in the Boston marathon. Circulation 114(22):2325–2333
Newman P (2006) The secret Mulroney tapes: unguarded confessions of a Prime Minister. Vintage Canada, Toronto, ON
Ng M, Fleming T, Robinson M et al (2014) Global, regional, and national prevalence of overweight and obesity in children and adults during 1980–2013: a systematic analysis for the global burden of disease study 2013. Lancet. doi:10.1016/S0140-6736(14)60460-8
Noakes TD (2008) How did A.V. Hill understand the VO2 max and the "plateau phenomenon"? Still no clarity. Br J Sports Med 42(7):574–580
Noakes TD (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(6):475–477
Noakes TD, Marino FE (2009) Maximal oxygen intake is limited by a central nervous system governor. J Appl Physiol 106(1):338–339
Noakes TD, Speedy DB (2007) Lobbyists for the sports drink industry: an example of the rise of "contrarianism" in modern scientific debate. Br J Sports Med 41(2):107–109
Noakes TD, Peltonen JE, Rusko HK (2001) Evidence that a central governor regulates exercise performance during acute hypoxia and hyperoxia. J Exp Biol 204(Pt. 18):3225–3234
Nolan M (1978) Joe Clark : the emerging leader. Fitzhenry & Whiteside, Don Mills, ON
Norman A, Bellocco R, Vaida F et al (2003) Age and temporal trends of total physical activity in Swedish men. Med Sci Sports Exerc 35(4):617–622
Northoff H, Enkel S, Weinstock C (1995) Exercise injury and immune function. Exerc Immunol Rev 1:26–48
Notghi A, Low CS (2011) Myocardial perfusion scintigraphy: past, present and future. Br J Radiol 84(Suppl):S229–S236
Novacheck TF (1998) The biomechanics of running. Gait Posture 7(1):77–95
Nowak MR, Kirkpatrick AW, Bouffard JA et al (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(1):25–29
Nyboer J (1970) Electrorheometric properties of tissues and fluids. Ann NY Acad Sci 170(2):410–420
Oborne DJ (1982) Ergonomics at work. Wiley, Chichester, UK
O'Connor B (1989) The trekking peaks of Nepal. Mountaineers, Seattle, WA
O'Dowd A (2012) Olympic drug testing centre will house new $10 m research facility. BMJ 345:e5233
O'Hara WJ, Allen C, Shephard RJ et al (1979) Fat loss in the cold. A controlled study. J Appl Physiol 46(5):872–877
Okada K, Iseki T (1990) Effect of a ten-year corporate fitness program on employee's health. In: Kaneko M (ed) Fitness for the aged, disabled and industrial worker. Human Kinetics, Champaign, IL
Oldridge N (2012) Exercise-based rehabilitation in patients with coronary heart disease: meta-analysis outcomes revisited. Future Cardiol 8(5):729–751
Oppenheimer GM (2005) Becoming the Framingham Study 1947–1950. Am J Public Health 95(4):602–610
Orban WR (1961) The Royal Canadian Air Force 5BX program for men. The Queen's Printer, Ottawa, ON

Ory M, Kinney-Hoffman M, Hawkins M et al (2003) Challenging aging stereotypes: strategies for creating a more active society. Am J Prev Med 25(3 Suppl 2):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: Savery J, Gilbert K (eds) Sustainability and sport. Common Ground Publishing, Chicago, IL
Park H, Togo F, Watanabe E et al (2007) Relationship of bone health to yearlong physical activity in older Japanese adults: cross-sectional data from the Nakanojo Study. Osteoporosis Int 18(3):285–293
Park H, Park S, Aoyagi Y et al (2010) Yearlong physical activity and sarcopenia in older adults: the Nakanojo Study. Eur J Appl Physiol 109(5):953–961
Parker JJ (2007) Lyndon Johnson. XLibris Corporation, Bloomington, IN
Patel K, Ruchefsky ME (2006) Health care politics and policy in America, 3rd edn. M.E. Sharpe, Armonk, NY
Paterson DH, Jones GR, Rice CL (2007) Ageing and physical activity: evidence to develop exercise recommendations for older adults. Appl Physiol Nutr Metab 32(Suppl 2E):S69–S108
Pedersen BK, Toft AD (2000) Effects of exercise on lymphocytes and cytokines. Br J Sports Med 34(4):246–251
Pedersen BK, Steensberg A, Fischer C et al (2004) The metabolic role of IL-6 produced during exercise: is IL-6 an exercise factor? Proc Nutr Soc 63(2):263–267
Pelliccia A, Maron MS, Maron BJ (2012a) Assessment of left ventricular hypertrophy in a trained athlete: differential diagnosis of physiologic athlete's heart from pathologic hypertrophy. Prog Cardiovasc Dis 54(5):387–396
Pelliccia A, Kinoshita N, Pisichio C et al (2012b) Long-term consequences of intense uninterrupted training in Olympic athletes. J Am Coll Cardiol 55(15):1619–1625
Perret C, Mueller G (2006) Validation of a new portable ergospirometric device (Oxycon Mobile®) during exercise. Int J Sports Med 27(5):363–367
Perrin DH (1993) Isokinetic exercise and assessment. Human Kinetics, Champaign, IL
Pérusse L, Rankinen T, Hagberg JM et al (2013) Advances in exercise, fitness, and performance genomics in 2012. Med Sci Sports Exerc 45(5):824–831
Peters RK, Benson H, Porter D (1977) Daily relaxation response breaks in a working population: 1. Effects on self-reported measures of health, performance, and well-being. Am J Public Health 67(10): 946-953.
Pett LB, Ogilvie GF (1956) The report on average Canadian heights, weights and skinfolds. Hum Biol 28:177–188
Petty TL, Nett LM, Fiunigan MM et al (1969) A comprehensive care program for chronic airway obstruction. Methods and preliminary evaluation of symptomatic and functional improvement. Ann Int Med 70(6):1109–1120
Pigalev SA (1963) Worksite gymnastics at the Votkinskii machine factory. Teor Prakt Fiz Koult 36(9):57–58
Pikora TJ, Braham R, Mills C (2012) The epidemiology of injury among surfers, kite surfers and personal watercraft riders: wind and waves. Med Sport Sci 58:80–97
Piwonka RW, Robison S, Gay VL et al (1965) Preacclimatization of men to heat by training. J Appl Physiol 20(3):379–383
Plamondon B (2009) Blue Thunder: the truth about Conservatives from Macdonald to Harper. Key Porter, Toronto, ON
Pollack SH, Landrigan PJ (1990) Child labor in 1990. Prevalence and health hazards. Annu Rev Public Health 11(1):359–375
Poor R (1970) 4 days, 40 hours. Bursk and Poor Publishing, Cambridge, MA
Pope HG, Katz DL, Champoux R (1988) Anabolic-androgenic steroid use among 1,010 college men. Phys Sports Med 16(7):75–81
Pravosudov VP (1978) Effects of physical exercises on health and economic efficiency. In: Orban WAR (ed) Physical activity and human well-being. Symposia Specialists, Miami, FL, pp 261–271

Prevost JL, Batelli F (1899) Sur quelques effets de décharge électrique sur les coeurs des mammifères (Some effects of electric discharge on the hearts of mammals). C R Acad Sci 129:1267–1268
Prince SA, Adamo KB, Hamel ME et al (2008) A comparison of direct versus self-report measures for assessing physical activity in adults: a systematic review. Int J Behav Nutr Activity 5:56
Prior G (1999) Physical activity. In: Erens B, Primatesta P (eds) Health survey for England & Wales. Cardiovascular Disease. Her Majesty's Stationery Office, London, UK
Proctor R (1999) The Nazi war on cancer. Princeton University Press, Princeton, NJ
Proctor R (2001) Commentary: Schairer and Schöniger's forgotten tobacco epidemiology and the Nazi quest for racial purity. Int J Epidemiol 30(1):31–34
Proctor R (2012) The history of the discovery of the cigarette lung cancer link: evidentiary traditions, corporate denial, global toll. Tob Control 21(1):87–91
Proudfit WL, Shirey EK, Sones FM (1966) Selective cine coronary arteriography. Correlation with clinical findings in 1,000 patients. Circulation 33(2):901–910
Public Services Health & Safety Association (2014) History of occupational health & safety legislation in Ontario. http://www.pshsa.ca/wp-content/uploads/2013/02/LHSFCAEN0106-History-of-OHS.pdf.pdf. Accessed 26 June 2014
Quinney HA, Petersen SR, Gledhill N et al (1996) Accreditation of elite athlete testing laboratories in Canada. In: Reilly T et al (eds) Kinanthropometry: proceedings of the VIII commonwealth and international conference on sport, physical education, dance, recreation and health, 3rd edn. EF & N Spon, London, UK
Rabi I, Zacharias J, Millman S et al (1939) A new method of measuring nuclear magnetic moments. Phys Rev 55:526–535
Radak Z, Hart N, Sarga L et al (2010) Exercise plays a preventive role against Alzheimer's disease. J Alzheimers Dis 20(3):777–783
Rechnitzer PA, Sangal S, Cunningham D et al (1975) A controlled prospective study of the effect of endurance training on the recurrence rate of myocardial infarction. Am J Epidemiol 102(5):358–365
Rechnitzer PA, Cunningham D, Andrew G et al (1983) The relationship of exercise to the recurrence rate of myocardial infarction in men- Ontario Exercise-Heart Collaborative Study. Am J Cardiol 51(1):65–69
Reddy KS, Yussuf S (1998) Emerging epidemic of cardiovascular disease in developing countries. Circulation 97(6):596–601
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. Arcade, New York, NY
Rekand J (2012) The epidemiology of injury in hang-gliding and paragliding. Med Sport Sci 58:44–56
Rietjens GJWM, Kuipers H, Kester ADM et al (2001) Validation of a computerized metabolic measurement system (Oxycon-Pro®) during low and high intensity exercise. Int J Sports Med 22(4):291–294
Rode A, Shephard RJ (1993) Acculturation and loss of fitness in the Inuit: the preventive role of active leisure. Arctic Med Res 52(3):107–112
Roden M (2001) Non-invasive studies of glycogen metabolism in human skeletal muscle using nuclear magnetic resonance spectroscopy. Curr Opin Clin Nutr Metab Care 4(4):261–266
Roe PG, Tyler CK, Tennant R et al (1987) Oxygen analyzers. An evaluation of five fuel cell models. Anaesthesia 42(2):178–181
Román-Viñas B, Serra-Majem L, Ribas-Barba L et al (2007) Trends in physical activity status in Catalonia, Spain (1992–2003). Public Health Nutr 10(11A):1389–1395
Rosen DM (2008) Dope: a history of performance enhancement in sports from the nineteenth century to today. Praeger Publications, Westport, CT
Roth HJ, Leithäuser RM, Doppelmayr H et al (2007) Cardiospecificity 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(6):359–364

Rowbottom DG, Morton AR, Keast D (2000) Monitoring for overtraining in the endurance performer. In: Shephard RJ, Åstrand P-O (eds) Endurance in sport. Blackwell Scientific, Oxford, UK, pp 486–504
Ryan AJ, Bleiler TL, Carter JE et al (1989) Gastric emptying during prolonged cycling exercise in the heat. Med Sci Sports Exerc 21(1):51–58
Sallis J, McKenzie T, Kolody B et al (1999) Effects of health-related physical education on academic achievement: Project SPARK. Res Q Exerc Sport 70(2):127–134
Saltin B, Hermansen L (1967) Glycogen stores and prolonged severe exercise. In: Blix G (ed) Nutrition and physical activity. Almqvist & Wiksell, Uppsala, Sweden
Sawatzky J (1992) Mulroney: the politics of ambition. McClelland & Stewart, Toronto, ON
Schneider PL, Crouter SE, Lukajic O et al (2003) Accuracy and reliability of 10 pedometers for measuring steps over a 400-m walk. Med Sci Sports Exerc 35(10):1779–1784
Schöffl V, Morrison A, Schöffl I et al. (2012) The epidemiology of injury in mountaineering, rock and ice climbing. Med Sport Sci 58:17–43
Scrivener L (2010) Terry Fox: his story. Random House, Toronto, ON
Sesso HD, Paffenbarger RS, Lee IM (2000) Physical activity and coronary heart disease in men: The Harvard Alumni Health Study. Circulation 102(9):975–980
Severinghaus JW, Bradley AF (1958) Electrodes for blood pO2 and pCO2 determination. J Appl Physiol 13(3):515–520
Sharratt MT, Hearst WE (2007) Canada's physical activity guides: background, process, and development. Appl Physiol Nutr Metab 32(Suppl 2E):S9–S15
Shave R, Oxbrough D (2012) Exercise-induced cardiac injury: evidence from novel imaging techniques and highly sensitive cardiac troponin assays. Prog Cardiovasc Dis 54(5):407–415
Shea-Simonds C (1971) Sport parachuting. Black, New York, NY
Shephard RJ (1955a) A critical examination of the Douglas bag technique. J Physiol 127(3):515–524
Shephard RJ (1955b) Pneumotachographic measurement of breathing capacity. Thorax 10(3):258–268
Shephard RJ (1966a) World standards of cardiorespiratory performance. AMA Arch Environ Health 13:664–672
Shephard RJ (1966b) Oxygen cost of breathing during vigorous exercise. Q J Exp Physiol 51(4):336–350
Shephard RJ (1967a) Guest Editor. Proceedings of the international symposium on physical activity & cardiovascular health. Can Med Assoc J 96(12):695–915
Shephard RJ (1967b) The maximum sustained voluntary ventilation in exercise. Clin Sci 32(2):167–176
Shephard RJ (1969) Endurance fitness. University of Toronto Press, Toronto, ON
Shephard RJ (1970) The validity of the oxygen conductance equation. Int Z Angew Physiol 28(1):61–75
Shephard RJ (1978) Human physiological work capacity. Cambridge University Press, Cambridge, UK
Shephard RJ (1981) Ischemic heart disease and exercise. Croom Helm, London, UK
Shephard RJ (1982a) The daily workload of the postal carrier. J Hum Ergol 11(2):157–164
Shephard RJ (1982b) The risks of passive smoking. Croom-Helm, London, UK
Shephard RJ (1982c) Physical activity and growth. Year Book Medical Publishers, Chicago, IL
Shephard RJ (1983a) Equal opportunity for a geriatric labor force. Some observations on marine surveying. J Occup Med 25(3):211–214
Shephard RJ (1983b) Carbon monoxide: the silent killer. C.C. Thomas, Springfield, IL
Shephard RJ (1983c) Philately – a possible tactic for the quantitative study of sports history. In: Kidd B (ed) Proceedings of 5th North American symposium on history of sport. University of Toronto, Toronto, ON, pp 237–248
Shephard RJ (1986a) Fitness of a nation: lessons from the Canada Fitness Survey. Karger, Basel, Switzerland
Shephard RJ (1986b) Economic benefits of enhanced fitness. Human Kinetics, Champaign, IL

Shephard RJ (1986c) Exercise in coronary heart disease. Sports Med 3(1):26–49
Shephard RJ (1990) Assessments of occupational fitness in the context of Human Rights legislation. Can J Sport Sci 15(2):89–95
Shephard RJ (1991a) A short history of occupational fitness and health promotion. Prev Med 20(3):435–445
Shephard RJ (1991b) Occupational demand and human rights: public safety and cardiorespiratory fitness. Sports Med 12(2):94–109
Shephard RJ (1992) Long term impact of a fitness programme – the Canada Life Study. Ann Acad Med Singap 21(1):63–68
Shephard RJ (1994) Aerobic fitness and health. Human Kinetics, Champaign, IL
Shephard RJ (1996) The athlete's heart: is big beautiful? Br J Sports Med 30(1):5–10
Shephard RJ (1997a) Aging, physical activity and health. Human Kinetics, Champaign, IL
Shephard RJ (1997b) Physical activity, training and the immune response. Cooper Publishing, Carmel, IN
Shephard RJ (2000a) Special feature for the Olympics: effects of exercise on the immune system: overview of the epidemiology of exercise immunology. Immunol Cell Biol 78(5):485–495
Shephard RJ (2000b) Problems of high altitudes. In: Shephard RJ, Åstrand P-O (eds) Endurance in sport. Blackwell Scientific, Oxford, UK, pp 614–627
Shephard RJ (2002) Whistler 2001: a Health Canada/CDC Conference on "Communicating physical activity and health messages- science into practice". Am J Prev Med 23(3):221–225
Shephard RJ (2003a) Limits to the measurement of habitual physical activity by questionnaires. Br J Sports Med 37(3):197–206
Shephard RJ (2003b) Regression to the mean. A threat to exercise science? Sports Med 33(8):575–584
Shephard RJ (2003c) What is the physical activity message, and how do we get it across? In: Shephard RJ, Alexander MJ, Cantu RC et al. (eds) Year Book of Sports Medicine 2003. Mosby/Elsevier, Philadelphi, PA, pp xvii–xxxvi
Shephard RJ (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 RJ (2009a) Is it time to retire the Central Governor? Sports Med 39(9):709–721
Shephard RJ (2009b) The future of Masters Games: implications for policy and research. In: Baker J, Horton S, Weir P (eds) The Masters athlete: understanding the role of sport and exercise in optimizing aging. Routledge, London, UK, pp 186–193
Shephard RJ (2010a) Present role of maximal oxygen intake measurements. In: Shephard RJ, Cantu RC, Feldman DE et al (eds) Year Book of Sports Medicine 2010. Elsevier/Mosby, Philadelphia, PA, pp xv–xxviii
Shephard RJ (2010b) The John Sutton Memorial Lecture, 2009. Conductance systems: an integrative approach to the physiology of extreme conditions. Appl Physiol Nutr Metab 35(2):113–124
Shephard RJ (2011a) Is electrocardiogram screening of North American athletes now warranted? Clin J Sport Med 21(3):189–191
Shephard RJ (2011b) Suppression of information on the prevalence and prevention of exercise-associated hyponatraemia. Br J Sports Med 45(15):1238–1242
Shephard RJ (2011c) Mandatory ECG screening of athletes. Is this question now resolved? Sports Med 41(12):981–1002
Shephard RJ (2011d) Body composition in biological anthropology. Cambridge University Press, Cambridge, UK
Shephard RJ (2014) History of exercise immunology. In: Tipton C (ed) History of exercise physiology. Human Kinetics, Champaign, IL
Shephard RJ, Aoyagi Y (2010) Objective monitoring of physical activity in older adults: clinical and practical applications. Phys Ther Rev 15(3):170–182

Shephard RJ, Aoyagi Y (2012) Measurement of human energy expenditure, with particular reference to field studies. An historical perspective. Eur J Appl Physiol 112(8):2785–2815
Shephard RJ, Âstrand P-O (2000) Endurance in sport. Blackwell Scientific, Oxford, UK
Shephard RJ, Kavanagh T (1975) Biochemical changes with marathon running-, observations on post-coronary patients. In: Poortmans JR, Howald H (eds) Metabolic adaptations to prolonged exercise. Birkhauser Verlag, Basel, Switzerland
Shephard RJ, Lavallée H (1993) Impact of enhanced physical education in the prepubescent child: Trois Rivières revisited. Pediatr Exerc Sci 5(2):177–189
Shephard RJ, Rode A (1996) The health consequences of 'modernization'. Cambridge University Press, Cambridge, UK
Shephard RJ, Trudeau F (2005) Lessons learned from the Trois-Rivières physical education study: a retrospective. Pediatr Exerc Sci 17(2):112–123
Shephard RJ, Allen C, Benade AJS et al (1968a) The maximum oxygen intake- an international reference standard of cardiorespiratory fitness. Bull WHO 38:757–764
Shephard RJ, Allen C, Benade AJS et al (1968b) Standardization of submaximal exercise tests. Bull WHO 38:765–776
Shephard RJ, Allen C, Bar-Or O et al. (1969) The working capacity of Toronto school children. Can Med Assoc J 100(12): 560–566, 705–714
Shephard RJ, Kavanagh T, Moore R (1975) Fluid and mineral balance of post-coronary distance runners. Studies on the 1975 Boston marathon. In: Ricci G, Venerando A (eds) Nutrition, dietetics and sport. Minerva Medica, Torino, Italy, pp 217–228
Shephard RJ, Urch B, Silverman F et al (1983) Interaction of ozone and cigarette smoke exposure. Environ Res 31(1):125–137
Shephard RJ, Volle M, Lavallée H et al. (1984) Required physical activity and academic grades: a controlled longitudinal study. In: Ilmarinen J, Valimaki L (eds) Children and sport. Springer, Berlin, Germany, pp 58–63
Shephard RJ, Prien E, Hughes G (1988a) Age restrictions on bus driver selection. J Human Ergol 17(2):119–138
Shephard RJ, Bouhlel E, Vandewalle H et al (1988b) Muscle mass as a factor limiting physical work. J Appl Physiol 64(4):1472–1479
Shephard RJ, Kavanagh T, Mertens DJ et al (1995) Personal health benefits of Master's competition. Br J Sports Med 29(1):35–40
Shephard RJ, Gannon G, Hay JB et al (2000) Adhesion molecule expression in acute and chronic exercise. Crit Rev Immunol 20(3):245–266
Shephard RJ, Rankinen T, Bouchard C (2004) Test-retest errors and the apparent heterogeneity of training response. Eur J Appl Physiol 91(2–3):199–203
Shephard RJ, Park H, Park S et al (2014) Objectively measured physical activity and calcaneal bone health in older Japanese adults: longitudinal data from the Nakonojo study. Calcif Tiss Int (in press)
Shield, M (2005). The obesity epidemic in Canada. Parliament of Canada, Ottawa, ON
Sidney K, Shephard RJ (1977) Maximum and submaximum exercise tests in men and women in the seventh, eighth, and ninth decades of life. J Appl Physiol 43(2):280–287
Simmons R, Shephard RJ (1971) Measurement of cardiac output in maximum exercise. Application of an acetylene rebreathing technique to arm and leg exercise. Int Z Angew Physiol 29(2):159–172
Simpson JL, Ljungqvist A, de la Chapelle A et al (1993) Gender verification in competitive sports. Sports Med 16(5):305–315
Simpson JL, Ljungqvist A, Ferguson-Smith MA (2000) Gender verification in the Olympics. JAMA 284(12):1568–1569
Sjödin B, Jacobs I (1981) Onset of blood lactate accumulation and marathon running performance. Int J Sports Med 2(1):23–26
Snellen J (1972) Set-point and exercise. In: Bligh J, Moore RE (eds) Essays on temperature regulation. North-Holland, Amsterdam, Netherlands, pp 139–148
Sonksen PH (2001) Insulin, growth hormone and sport. J Endocrinol 170(1):13–25

Søreide K (2012) The epidemiology of injury in bungee jumping, BASE jumping, and skydiving. Med Sport Sci 58:112–129
Sorensen GN (2000) Iron Riders – the story of the Buffalo Soldiers Bicycle Corps. Pictorial Histories Publishing Company, Missoula, MN
Southam N (2005) Pierre: colleagues and friends talk about the Trudeau they knew. McLelland & Stewart, Toronto, ON
Spriet LL, Gledhill N, Froese AB et al (1980) The effect of induced erythrocythemia on central circulation and oxygen transport during maximal exercise. Med Sci Sports Exerc 12(2):122–123
Spriet L, Gledhill N, Froese AB et al (1986) Effect of graded erythrocythemia on cardiovascular and metabolic responses to exercise. J Appl Physiol 61(5):1942–1948
Stahl L (1999) Reporting live. Simon & Schuster, New York, NY
Stanish WD, Rubinovich RM, Curwin RM (1986) Eccentric exercise in chronic tendinitis. Clin Orthop Relat Res 208(1):65–68
Starky S (2005) The obesity epidemic in Canada. Parliament of Canada, Ottawa, ON
Statistics Canada (2005) Sports participation in Canada. Statistics Canada, Ottawa, ON
Statistics Canada (2007–2009) Canadian Health Measures Survey. Statistics Canada, Ottawa, ON
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. Accessed 18 Aug 2012
Statistics Canada (2014) Life expectancy in the Inuit inhabited areas of Canada, 1989–2003. http://www.statcan.gc.ca/pub/82-003-x/2008001/article/10463/4149059-eng.htm. Accessed 25 June 2014
Stray-Gunderson J, Ch apman RF, Levine BD (2001) "Living high-training low" altitude training improves sea level performance in male and female elite runners. J Appl Physiol 91(3):1113–1120
Suozzo AG (2006) The Chicago marathon. University of Illinois Press, Urbana, IL
Sutton JR (1992) VO2max – new concepts on an old theme. Med Sci Sports Exerc 24(1):26–29
Taktak F, Taktak I, Shephard RJ (2013) Does plyometric training avoid muscle changing and adverse change in physical appearance of female physical education students? Health Fit J Can 6(4):3–9
Tharp GD, Barnes MW (1990) Reduction of saliva immunoglobulin levels by swim training. Eur J Appl Physiol 60(1):61–64
Thistle HG, Hislop HJ, Moffroid M et al (1967) Isokinetic contraction: a new concept of resistive exercise. Arch Phys Med Rehabil 48(6):279–282
Thomas S, Reading J, Shephard RJ (1992) Revision of the Physical Activity Readiness Questionnaire (PAR-Q). Can J Sport Sci 17(4):338–345
Timmins BW, Naylor P-J, Pfeiffer KA (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. Velo Press, Boulder, CO
Tolman WH (1901) A "Trust" for social betterment. In: Page WH, Page AW (eds) The world's work. Doubleday, Page & Co., New York, NY, pp II(3):924–928
Tomasi TB, Trudea FB, Czerwinski D et al (1982) Immune parameters in athletes before and after strenuous exercise. J Clin Immunol 2(3):173–178
Transport Canada (2014) Urban transportation showcase program. Issue Paper 53. http://www.tc.gc.ca/media/documents/programs/cs53e_allseason.pdf. Accessed 30 June 2014
Trudeau F, Shephard RJ (2008) Physical education, school physical activity and academic performance. Int J Behav Nutr Phys Act 5:10
Tudor-Locke C (2003) Manpo-Kei: the art and science of step counting. Trafford Publishing, Victoria, BC
Tulchinsky TH, Varavikova E (2009) The new public health. Academic Press, New York, NY
Turek FW, Gillette MU (2004) Melatonin, sleep, and circadian rhythms: rationale for the development of specific melatonin agonists. Sleep Med 5(6):523–532

Uher M (1963) Medical experience with physical training breaks. Telesna Vychova Prac Symposium 95, Prague, Czechoslovakia
Ulmer CV (1996) Concept of an extracellular regulation of muscular metabolic rate during heavy exercise in humans by psychophysiological feedback. Experientia 52(5):416–420
Urch B, Silverman F, Corey, P et al. (1985) Pulmonary function responses to passive cigarette smoke exposure. In: International conference on indoor air quality in cold climates: hazards and abatement measures. Ottawa, ON, April 28th–May 1st, 1985
U.S. Department of Health and Human Services. (1996) Report of the Surgeon General. National Center for Chronic Disease Prevention and Health Promotion. U.S. Dept. of Health & Human Services, Centers for Disease Control and Health Promotion, Atlanta, GA
Vague J (1956) The degree of masculine differentiation of obesities: a factor determining predisposition to diabetes, atherosclerosis, gout and uric calculous disease. Am J Clin Nutr 4(1):20–34
Vail S (1983) What the federal government is doing to promote women's sport. Can Wom Stud 4(3):75–76
Vandevalle H, Pérès G, Monod H (1987) Standard anaerobic exercise tests. Sports Med 4(4):268–289
Verde T, Thomas S, Shek PN et al (1992) Potential markers of heavy training in highly trained distance runners. Br J Sports Med 26(3):167–175
Verkhoshanski Y (1967) Are Depth Jumps Useful? Legkaya Atletika (Track and Field) 12:9
Vitola JV, Shaw LJ, Allam AH et al. (2009) Assessing the need for nuclear cardiology and other advanced cardiac imaging modalities in the developing world. J Nucl Cardiol 18:956–961
Waddington I (1996) The development of sports medicine. Soc Sport J 13(2):176–196
Wagner PD (1996) Determinants of maximal oxygen transport and utilization. Annu Rev Physiol 58(1):21–50
Walsh V, Golins GL (1976) The exploration of the Outward Bound process. Colorado Outward Bound School, Denver, CO
Warburton DER, Katzmarzyk PT, Rhodes RE et al (2007) Evidence informed physical activity guidelines for Canadian adults. Appl Physiol Nutr Metab 32(Suppl 2E):S16–S68
Warburton DER, Bredin SD, Charlesworth S et al (2011a) 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):S1–S35
Warburton DER, Bredin SD, Charlesworth S et al (2011b) 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 DRE, Jamnik V, Bredin SD et al (2011c) Executive summary: the 2011 Physical Activity Readiness Questionnaire for Everyone (PAR-Q+) and the Electronic Physical Activity Readiness Medical Examination (ePAR-med-X+). Health Fit J Can 4(2):24–25
Warburton DER, Charlesworth S, Foulds HA et al (2012) Qualified exercise professionals: best practice for work with clinical populations. Can Fam Physician 59(7):759–761
Wasserman K (1984) The anaerobic threshold measurement to evaluate exercise performance. Am Rev Respir Dis 129(2 Pt2): S35–S40
Wasserman K, McIlroy MB (1964) Detecting the threshold of anaerobic metabolism in cardiac patients during exercise. Am J Cardiol 14:844–852
Webborn AD (1999) "Boosting" performance in disability sport. Br J Sports Med 33(2):74–75
Weicker H, Werle E (1991) Interaction between hormones and the immune system. Int J Sports Med 12(Suppl 1):S30–S37
Weinbruch S, Nordby KC (2010) Fatal accidents among elite mountaineers: a historical perspective from the European Alps. High Alt Med Biol 11(2):147–151
Weiner JS (1964) Proposals for international research. Human Adaptability Project 5. Royal Anthropological Institute, London, UK
Weiner JS, Lourie JA (1969) Human biology: a guide to field methods. Blackwell Scientific, Oxford, UK

Weis JH, Tan SS, Maertin BK et al (1992) Detection of rare mRNAs by quantitative RT-PCR. Trends Genet 8(8):263–264
Whittlesey S (1963) U.S. Peace Corps: the challenge of good will. Coward-McCann, New York, NY
WHO (2004/2005) WHO Framework convention on tobacco control. Author, Geneva, Switzerland
WHO (2014) Global recommendations for physical activity and health. http://www.who.int/dietphysicalactivity/factsheet_recommendations/en/. Accessed 25 June 2014
Wilber RL, Pilsiladis YP (2012) Kenyan and Ethiopian distance runners: what makes them so good? Int J Sports Physiol Perform 7(2):92–102
Wilson JMG, Jungner G (1968) Principles and practice of screening for disease. WHO Chron (World Health Organisation, Geneva), 22(11): 473
Wilson M, O'Hanlon R, Prasad S et al (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(10):790–794
Wilt F, Yessis M (1984) Soviet theory, technique and training for running and hurdling, vol 1. Championship Books, Ames, Iowa
World Health Organisation (1985) Energy and protein requirements: report of a joint FAO/WHO/UNU expert consultation. Technical report series 724. World Health Organisation, Geneva, Switzerland
Wright GM (2001) Basil Martin Wright obituary. Br Med J 322(7297):1308
Wright GR, Shephard RJ (1978) A note on blood carboxyhemoglobin levels in police officers. Can J Public Health 69(5):393–398
Wright DM, Royle TJ, Marshall T (2001) Indoor rock climbing: who gets injured? Br J Sports Med 35(3):181–185
Wyndham CH, Strydom NB, Benade AJS et al (1973) The effect on acclimatisation of various salt and water replacement regimens. S Afr Med J 47(39):1773–1779
Yim ES, Corrado D (2012) Ultrasound in sports medicine. Relevance of emerging techniques to clinical care of athletes. Sports Med 42(8):665–680
Zang LH, Rothman DL, Shulman RG (1990) 1H NMR visibility of mammalian glycogen in solution. Proc Natl Acad Sci U S A 87(5):1678–1680
Zelizer JE (2010) The presidency of George W. Bush: a first historical assessment. Princeton University Press, Princeton, NJ
Zoico E, Roubenoff R (2002) The role of cytokines in regulating protein metabolism and muscle function. Nutr Rev 60(2):39–51