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HISTORICAL PERSPECTIVE

A brief history of exercise and physical activity participation clearance and prescription: 2. Canadian contributions to the development of objective, evidence-based procedures.

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Abstract

Part two of this series of articles considers the development of objective, evidence-based procedures for exercise and physical activity (PA) participation screening and prescription that began in the 1960s, with a particular emphasis upon the contributions of Canadian exercise scientists. A new interest in fitness and PA was sparked by a speech given to the Canadian Medical Association by the Duke of Edinburgh in 1959. This article begins by considering his comments and the reactions of the Federal government. It notes the resulting establishment of three Fitness Research Units across Canada, looking specifically at the Toronto Fitness Research Unit and its objectives. The goals of the Toronto unit included not only academic research and the establishment of doctoral and post-doctoral programmes in exercise science, but also many "applied" research tasks: increasing interest of the medical profession in PA, preparing for assessments of national fitness, benchmarking existing national levels of fitness, and clarifying the risks of vigorous exercise. These objectives led to the development of a simple and effective exercise and PA participation screening procedure (the PAR-Q test), and the development of procedures for mass fitness testing (particularly the Canadian Aerobic Fitness Test, CAFT). We conclude this segment of our history by documenting the evolution of both the PAR-Q and the Canadian Aerobic Fitness Test to their present objective, evidence-based and computerized format. **Health & Fitness Journal of Canada 2014;7(1):36-68.**

Keywords: Bill C-131; Canadian Aerobic Fitness Test; Epidemiology; Exercise testing and safety; Fitness Units; PAR-Q, Population testing; Test standardization

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Introduction

The aim of this two-part article is to provide a brief chronicle of the development of exercise and physical activity (PA) participation clearance and prescription procedures in Canada over the past century. Part 1 considered the era when medical interest in exercise and PA participation was limited. Because of constraints imposed upon physical educators by a lack of equipment and barriers set up by the medical profession, any advice that they gave in this era was based largely upon pulse rate recovery curves (Nsenga Leunkeu et al., 2014). Part two considers the development of objective, evidence-based procedures for exercise and PA participation clearance and prescription from their origins in the early 1960s, with particular emphasis upon the contributions of Canadian exercise scientists.

During the first half of the 20th century, physicians had made little attempt to encourage physical activity in the general population, and reliable objective procedures for screening and exercise and PA participation prescription were sadly lacking. Any attempts by physical educators to evaluate an individual's aerobic fitness were based largely upon an analysis of pulse-rate recovery curves. Physiological

factors underlying the form of such curves are necessarily complex, and the information obtained is hard to interpret or to convert into practical advice about exercising. Indeed, the aerobic fitness scores obtained during the early and mid-1900s varied widely from one laboratory to another, depending upon the timing of pulse measurements, and the intensity and duration of the preceding bout of physical activity. Our empirical data for one recovery procedure (the Ruffier test) showed that the scores obtained by a given observer were relatively consistent from day-to-day, but (probably because of inter-laboratory differences in technique) the average values that we obtained for a group of healthy subjects deviated quite widely from anticipated norms (Nsenga Leunkeu et al., 2014). Moreover, in our study, the ranking of aerobic fitness obtained from pulse recovery data bore little relationship to that provided by a more modern field test of aerobic fitness (the 20-m shuttle-run). It is plain that recovery curves offered little of practical value in terms of exercise or PA participation screening and prescription. Physical educators thus entered the second half of the 20th century badly needing reliable, objective and evidence-based procedures that would enable them to recommend safe, appropriate and effective doses of physical activity for a population that was rapidly becoming more sedentary.

A new interest in the habitual physical activity and aerobic fitness of Canadians was sparked by a speech that the Duke of Edinburgh gave to the Canadian Medical Association in 1959. We will here consider both his comments and the reactions of the Federal government, together with the resulting establishment of the Toronto Fitness Research Unit and

its objectives. Applied goals of this unit included increasing interest of the medical profession in the promotion of regular physical activity, preparing for national surveys of physical fitness, benchmarking existing fitness standards, clarifying any added risks of engaging in vigorous exercise, and developing effective tools for exercise and PA participation screening (the PAR-Q) and mass fitness testing (the Canadian Aerobic Fitness Test, CAFT). We conclude by documenting evolution of both the PAR-Q and the CAFT including the development of objective, evidence-based and computerized tools for qualified exercise and fitness professionals around the world.

The catalytic role of the Duke of Edinburgh

The first harbinger of a change in Canadian attitudes towards aerobic fitness was an address given by Duke of Edinburgh to the Canadian Medical Association in Toronto on June 30th, 1959. The occasion was his installation as President of this Association (Canadian Medical Association, 1959). With characteristic bluntness, the Duke castigated Canadians for their lack of physical fitness. Citing figures for hospital admissions, he noted:

"it would not be possible to conclude the general level of health was improving. The causes of this state of affairs...included urban living, lighter work, increased leisure, more sedentary occupations, a higher standard of eating..."

Turning to sport, he suggested:

"Canada's achievements in sports and games were hardly in keeping with a

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nation that claimed almost the highest standard of living in the world.... this very standard of living ...was having the same effect as a plaster cast had on the muscles of the body..."

After noting that in 1955, some 78% of U.S. children had failed the Kraus-Weber test of minimum muscular fitness, he turned to some comments by Dr. Doris Plewes, then consultant to the office of the Deputy Minister of Welfare in Canada. She had noted:

"...startling inadequacies as regards provision for physical education in Canadian schools... present day children lack the sturdiness and staying power of the pioneers."

He challenged the physicians attending the meeting; is the profession content:

"only to fight disease and disability and accept the negative definition of health....or is it going to take notice of the state of sub-health which exists?The first thing to do was to see that all children received regular physical instruction by properly qualified teachers....the provision of useful physical activities for adults was also essential...to reverse the trend of the statistics which at present showmore unfitness in children and adults."

Response of the Canadian Federal government

The Duke's forthright comments attracted considerable attention across Canada, particularly as they were reproduced in a newsletter circulated by the Royal Bank of Canada (RBC). Opinion-makers hoped to prove that his comments about poor fitness were wrong, but if not, they were eager to undertake measures

both to improve national physical fitness, and to increase Canada's standing in international athletic competition.

The issue reached the Federal parliament, where John Diefenbaker was serving as Prime Minister (Fig. 1). A fervent nationalist, Diefenbaker was particularly affronted by the criticism of Canadian athletic achievements. He had a strong interest in amateur sports. He had travelled at his own expense to watch the Berlin Olympics of 1936, as well as attending the Chicago Pan-American Games of 1959 in order to watch the participation of Canadian athletes. He noted the favourable international image that Nazi Germany had gained from the Berlin Olympic Games and he argued that in similar fashion amateur sport could become a source of national pride in a democratic country such as Canada, with the athletes serving as "*ambassadors of good will*" (House of Commons Debates, 27th May, 1958).

Figure 1: Prime Minister John Diefenbaker making the opening kick at a Grey Cup football game. Diefenbaker was an enthusiastic supporter of amateur sport, and his administration introduced Bill C-131 ("An act to encourage fitness and amateur sport") in September 1961.



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However, some politicians still held the puritan view that sport:

"...was a very frivolous thing on which to spend money." (Douglas Fisher, House of Commons Debates 21st December 1957: 2750)

Leading advocates of amateur sport such as J.R. Taylor had initially urged the establishment of a Canada Sports Council (House of Commons Debates, 16th February 1959: 1037). However, after much discussion, it was decided that the *modus operandi* for the promotion of fitness and sport should be a National Advisory Council. Diefenbaker thus introduced Bill C-131, "An act to encourage fitness and amateur sport," as formulated by his Minister of Health, Jay Waldo Monteith (Table 1). This measure received the Royal Assent on September 29th, 1961, and Monteith became the Minister of Amateur Sport on that same date. This Ministry began with an annual funding of \$5 million (MacIntosh et al., 1987).

Table 1: Cabinet recommendations to the Minister of National Health concerning the operationalization of Bill C-131.

- Establishment of a national fitness, recreation and amateur athletic program
- Establishment of an Advisory Council
- Provision through grants and training courses for the training of personnel and the conduct of research and surveys
- Federal assistance for the preparation of informational and educational material on fitness, recreation and athletics
- \$5 million in annual funding
- Establishment of a cabinet committee to consider the manner of presentation of the national fitness program

Many in the Diefenbaker administration cherished the dubious hope that the promotion of sport would increase the general fitness of the population, although given the limited sports facilities that were available in 1963, this seemed rather unlikely. The Diefenbaker government was defeated in April 1963, and implementation of Bill C-131 was left to the administration of his successor, Lester Pearson, with Judy LaMarsh as Minister of Amateur Sport.

The call for action on the promotion of positive health appears to have received the general endorsement of the medical establishment (see for example, the Canadian Medical Association Journal editorial of Godden, 1966), although interestingly Godden still suggested that fitness could be assessed using a recovery pulse-rate curve.

Establishment of the Toronto Fitness Research Unit

In response to item 3 of the cabinet recommendations (Table 1), one of the first practical initiatives arising from Bill C-131 was a plan to establish three Fitness Research Units, each with an annual budget of \$50,000. These were to be sited at the Universities of Alberta (Edmonton), Montreal and Toronto. In the early 1960s, Canada had a general shortage of faculty to teach in a rapidly expanding university system, and in particular there were as yet no doctoral programmes in Exercise Science. Thus, it was necessary to recruit faculty for these Fitness Research Units on the basis of an international search.

In 1964, I was working for the U.K. Ministry of Defence, at their Chemical Defence Experimental Establishment (CDEE) on Porton Down, Wiltshire. I had been charged with developing objective

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methods to measure the physical working capacity of volunteers, with the long-term goal of evaluating chemical agents that would reduce the working capacity of hostile groups and thus assist the army in riot control in Northern Ireland and elsewhere. As a first step in this process, I had built an electrically-braked bicycle ergometer, but I was having difficulties with an unstable work-load as the resistors in the braking system of the cycle increased in temperature.

The Toronto vacancy was posted on the bulletin board of the CDEE, and I decided to apply for the job, reasoning that I would be better employed in seeking to enhance fitness, rather than trying to reduce it. It was the first week of October 1964, and I was quickly flown to Canada to meet with the Search Committee at the University of Toronto [Drs. John Brown (Physiological Hygiene), Reginald Haist (Physiology) and Jack Sword (Physical Education)]. I also flew to Ottawa to meet with the Federal Minister of Health and Amateur Sport (Judy LaMarsh, 1924-1980 CE).

I quickly decided that leadership of the Toronto Fitness Research Unit would be a unique opportunity for me, and I acted with customary rapidity during my remaining 3 days in Toronto. I hired a secretary, ordered the necessary equipment for the unit, advertised for technicians, rented a house with an option to purchase in the (then) distant suburb of Willowdale, and arranged to ship my furniture from England on the last ship to sail the St. Lawrence before the Seaway froze for the winter. Before taking the plane back to England to complete several research projects at CDEE and sell my house in Salisbury, I managed to obtain a small and blotchy Multiple-Listing photo to show my long-

suffering spouse where she and our 2 children would be living in 4 weeks time!

Attitudes to exercise were already changing in Scandinavia, in part because the role of the clinical physiologist was well recognized in that part of the globe. With the agreement of Dr. Brown, I thus decided to spend the final 4 days before boarding the *RMS Queen Mary* on a lightning tour of Scandinavia. Among the notable exercise scientists of that era, I was able to visit the laboratories of Martti Karvonen in Helsinki, Erling Asmussen in Hellerup, Denmark, and Per-Olaf Åstrand and Torgny Sjöstrand in Stockholm. I also had opportunity to observe first-hand the direct measurement of maximal oxygen intake (Åstrand, 1952), its prediction from submaximal tests (Åstrand and Ryhming, 1954), the determination of the PWC₁₇₀ in patients with chronic disease (Sjöstrand, 1947; Sjöstrand, 1960), and the principles of exercise prescription and training based on an age-related maximal heart rate (Asmussen and Molbeck, 1959; Karvonen et al., 1957) as these various procedures were developing in Scandinavia.

Objectives of the Toronto Fitness Research Unit

The Toronto Fitness Research Unit was established within the Department of Physiological Hygiene in the University of Toronto's School of Hygiene, an institution then headed by Dr. Alex Rhodes. The laboratories were relatively old, and indeed had been used by Banting and Best in their classic research on insulin.

Being in a university environment, the Toronto Fitness Research Unit set itself both academic and applied objectives. On the academic front, it planned to establish an internationally-recognized graduate

and post-doctoral programme in the Exercise Sciences (the first doctoral graduate was Dr. Terry Anderson, with a thesis that looked at the changes in pulmonary diffusing capacity during maximal exercise), and the research group began to explore the integrated complex of physiological processes that contributed to the delivery of oxygen from the atmosphere to the working muscles during prolonged vigorous exercise (Shephard, 1969, 1970b). The Search Committee left me blissfully unaware of the "applied" objectives of the federal government, as stated or implicit in Table 1, but nevertheless I decided that we should address what I judged to be some immediate practical concerns of the Canadian government:

- Motivation of the medical profession to a greater interest in the promotion of health and fitness
- Assessment of current levels of population health and fitness, and
- Devising tactics to increase the level of physical activity in the general population.

Increasing interest of the medical profession in the promotion of physical activity

The first step towards increasing the interest of the medical profession in the promotion of physical activity was for the Toronto Fitness Research Unit to host a major international conference on physical activity and cardiovascular health. This event brought together a critical mass of experts who provided clear and unequivocal evidence of the value of greater physical activity both for the average inactive individual and for the person with chronic conditions such as cardiovascular disease. With the enthusiastic support of the Ontario Heart

Foundation, the Ontario Medical Association and the Canadian Medical Association, the 3-day symposium (entitled "*Physical activity and Cardiovascular Health*") was held at Toronto's "*Inn on the Park*," from the 11th to the 13th of October, 1966. There were over 600 cardiologists and exercise scientists in attendance. Moreover, some 5 months later a carefully edited version of the entire proceedings, including contributions to the discussion, was published as 2 special issues of the Canadian Medical Association Journal (Shephard, 1967) - a remarkable feat in the days of hand-written manuscripts.

We also recognized that because of the structure of the medical curriculum, most physicians were sadly lacking in knowledge of exercise science; thus, they needed a simple tool that would enable them to provide appropriate and effective advice to those patients who asked about increasing their personal physical fitness. After extended discussion, the PARmed-X screening tool was introduced to meet this requirement, under the guidance of the British Columbia Ministry of Health.

Preparations for national surveys of physical fitness

It was decided that from the viewpoint of cardiovascular health, the most important component of national fitness was the individual's ability to transport oxygen from the lungs to the working muscles. In the laboratory, this could be assessed by direct measurements of maximal oxygen intake. In the field, two measurement options were the PWC₁₇₀ test (Sjöstrand, 1947; Sjöstrand, 1960) or a sub-maximal prediction of maximal oxygen intake, based on the heart rate response to a

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standard step test (Åstrand and Ryhming, 1954).

With the support of the Edmonton Fitness Research Unit, the Canadian Association for Physical Education and Recreation (CAHPER) embarked upon an ambitious survey of a representative sample of Canadian students aged 10-17 years, carrying cycle ergometers to a substantial number of schools and performing PWC₁₇₀ tests on site (Howell and MacNab, 1968). However, we decided that a step test was preferable to a cycle ergometer when undertaking large-scale surveys of adults. The PWC₁₇₀ necessarily represented a larger fraction of an individual's maximal oxygen intake in older than in younger people, because of the decline in maximal heart rate with age (Asmussen and Molbech, 1959). Further, weakness of the quadriceps muscles tended to compromise ergometer results in older individuals (Shephard et al., 1968a; Shephard et al., 1968b). Finally, if

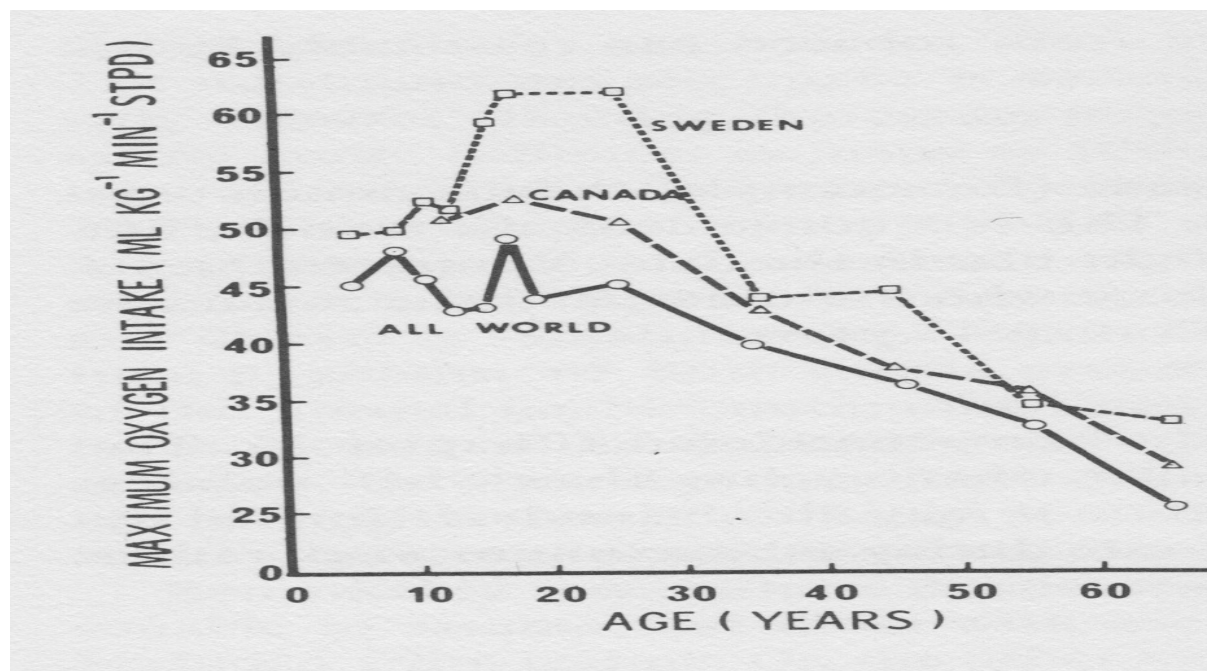
the intent of a survey was to assess a representative sample of the adult population, investigators would not find their subjects assembled in convenient clusters like the school-children- it would be necessary to visit individual homes, and a collapsible step would be more convenient than a heavy cycle ergometer when making such visits.

Essential preludes to undertaking large-scale national testing included a literature survey looking for benchmark values of national fitness, clarification of the risks when vigorous exercise was undertaken without close medical supervision, and the development of appropriate clearance procedures and a standardized exercise testing protocol.

Existing levels of national fitness

A survey of the world literature (Shephard, 1966) revealed that by 1966, a surprisingly large number of surveys of directly measured or predicted maximal

Figure 2: Data on the directly measured or predicted maximal oxygen intake of 6633 non-athletic men from various nations. Values assembled and corrected for systematic errors in 1966. (For details, see Shephard, 1966).



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oxygen intake had already been undertaken around the developed world (Fig. 2). At all ages, these reports apparently showed a much higher level of aerobic fitness among the Swedes than in people from other countries, including Canada. However, such findings were difficult to interpret, since no previous observers had examined anything approaching a representative national population. Indeed, in some cases (particularly the Swedish subjects of Åstrand (1952) the sample had deliberately been biased towards inclusion of physically fit individuals.

Risks of vigorous exercise

Another major issue requiring clarification was the safety of undertaking vigorous exercise testing, particularly when the intent was to assess large populations that had not received a prior medical examination. The main concern of physicians was that investigators might provoke a fatal coronary attack or ventricular fibrillation in one or more individuals by asking them to undertake a vigorous exercise test. Some of the literature of the late 1960s suggested that this risk was quite high (Table 2). The largest data set in that era had been obtained by (McDonough and Bruce, 1969); they had suggested that a 1 in 15,000 risk of ventricular fibrillation was associated with sub-maximal testing. Plainly, this was many times the anticipated rate for a middle-aged adult who was not undertaking vigorous exercise, around 2 attacks per 1000 person-years. Physicians started from the soon to be discredited assumption that a medically supervised treadmill test could predict and thus avert the occasional exercise-induced cardiac arrest (Shephard, 1974; Siscovick et al., 1991),

argued that anyone over the age of 35 years who wished to increase their physical activity required a stress electrocardiogram (Cooper, 1970) However, others quickly ridiculed this suggestion. It would cost \$13 billion even to screen current athletes (Northcote and Ballantyne, 1984), it would be necessary to screen 10,000 potential exercisers to identify one person who might die, and even given this precaution, 4 others who had not been identified by the stress test would also die (Epstein and Maron, 1986) Finally, the laboratory stress test itself carried some mortality, and generated a heavy burden of anxiety among those who were given false-positive test results (Van Camp, 1988).

Table 2: Early estimates of the risk associated with exercise testing.

Author	Type of exercise	Risk
(McDonough and Bruce, 1969)	Maximal exercise test	Ventricular fibrillation 1 in 3000 tests
(McDonough and Bruce, 1969)	Submaximal exercise test	Ventricular fibrillation 1 in 15,000 tests
(Rochmis and Blackburn, 1971)	Mixture of maximal & sub-maximal tests	Fatalities 1 in 13,000
(Brock, 1967)		3 deaths in 17,000 tests
(Ellestad et al., 1969)	Symptom-limited maximal tests	No deaths in 4000 tests
(Kattus and Grollman, 1972)	Treadmill testing	2 attacks of ventricular fibrillation (1 fatal) in 500 tests
(Phibbs et al., 1968)	Submaximal step, cycle ergometer or treadmill exercise	3 major complications in 787 tests

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In any event, the level of risk shown in Table 2 is hardly relevant to exercise and PA participation screening of the general population. Most of these studies were carried out in cardiology laboratories where those who were being tested either had or were suspected of having serious cardiac disease, and were correspondingly anxious about the findings from their examinations. In order to obtain objective statistics on the risk in the general population, we hit upon the idea of taking a large sample of patients who had incurred a heart attack, asking each of them to select as a control a healthy colleague at their place of work. Both the patients and the controls then completed a questionnaire detailing any unusual physical activity that they had undertaken on the day of the attack or the corresponding control day. We recognized that this methodology would set an upper limit to risk, since the heart attack might have drawn the patient's attention to a recent bout of physical activity that would otherwise have been ignored. Episodes of vigorous PA were reported about 5 times more commonly in the patients than in the controls (Shephard, 1974). Subsequent studies from other laboratories confirmed that in ostensibly healthy adults the risk was of this order (Vuori, 1982; Northcote and Ball, 1984; Cobb et al, 1986). Our data suggested that there was commonly some special emotional connotation to a bout of PA that precipitated a heart attack, such as competing in the final of a competition, or shovelling snow out of a drive-way under severe time-pressure (Shephard, 1974).

Accepting the average risk of a coronary attack for a middle-aged adult as 2 incidents per 1000 people over the course of an entire year, a progressive

exercise test that required only 3 minutes at vigorous submaximal exercise could hardly be considered very dangerous for the ostensibly healthy adult. Even if there were to be a fivefold increase of cardiac risk during exercise testing, the danger would remain extremely low. Nevertheless, we also recognized that we could reduce this risk still further by asking subjects some simple questions about their cardiac health and other possible causes of an adverse exercise response.

Development of standardized exercise screening procedures

The development of simple standardized methods of exercise screening was not only an important prerequisite to the conduct of large-scale fitness surveys, but was also vital to the encouragement of greater physical activity in the general population. Misconceptions about the risks of exercise remained a substantial potential barrier to an increase of physical activity in older inactive people (Ostrow and Dzewaltowski, 1986), as did the logistics (and in the U.S., the financial cost) of visiting a physician for exercise clearance (Simpson, 1986).

Two surveys of population fitness provided our laboratory with an opportunity to evaluate potential standardized screening tools. We organized the first survey at the Canadian National Exhibition (CNE) in Toronto in August of 1966 (Shephard and Pelzer, 1966); on this occasion, participants performed sub-maximal exercise on a cycle ergometer. The results from this study seemed to confirm previous assertions that Canadians were less fit than Swedes, with test values for predicted maximal oxygen intake falling

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substantially below the norms that had been recently been proposed by Irma Åstrand (Åstrand, 1960) Table 3).

After we had developed a standardized step test (below), a much larger population of 1230 men and women aged 15-69 years was evaluated in Saskatoon during the summer of 1973. The second sample was mainly selected by calling random numbers from the Saskatoon telephone directory, but was supplemented by radio and TV announcements and recruitment through police, fire departments and schools.

Table 3: Predicted maximal oxygen intake (mean ± SD; mL·kg⁻¹·min⁻¹) of Toronto population tested on a cycle ergometer at the Canadian National Exhibition in Toronto in August 1966 (Shephard and Pelzer, 1966), relative to Swedish norms proposed by (Åstrand, 1960).

Age (yr)	Toronto sample	Swedish norm
20-29	42.5 ± 7.7	44-51
30-39	37.8 ± 8.6	40-47
40-49	31.7 ± 7.4	36-43
50-59	31.5 ± 6.6	32-39

In considering procedures for the screening of participants in these 2 surveys, a review of various reports on fatal and non-fatal incidents suggested a number of warning signs (Shephard, 1974, Table 4).

Table 4: Factors increasing the risk of an exercise-related catastrophe.

- A history of fainting or chest pain during exercise
- A family history of cardiac death at an early age
- Undertaking a greater intensity and duration of activity than recently experienced
- Competition, publicity or pride encouraging continuation of exercise in the face of warning symptoms

- Exercising under pressures of time, or when facing business or social problems
- Engaging in activity that required heavy lifting or prolonged isometric effort
- Adverse weather conditions (either heat or cold)
- A viral infection, a sense of chest discomfort, cardiac irregularity, or a feeling of being "unwell."

Based on these precepts, our participants were asked two simple questions at the initial telephone contact: (1) Have you ever had heart trouble? and (2) Have you ever had or do you now have persistent chest pains? If the answer to either of these questions was "yes," the contact was excluded from the study. A registered nurse administered a further simple six-item medical questionnaire to volunteers attending the test centre. Our aim was to exclude anyone with responses suggestive of hypertension, heart disease or chest disease, as well as individuals taking specific medication on a regular basis and anyone who had been hospitalized in the six months preceding the study. Because the value of these screening questions had yet to be established, all subjects were also monitored by EKG (both before and during exercise) and a physician (Dr. John Merriman) was present throughout testing.

In terms of physical fitness levels, the maximal oxygen intake of the Saskatoon sample was slightly lower than that observed at the Canadian National Exhibition (Shephard and Pelzer, 1966), and again average values were well below the proposed Swedish norms (Åstrand, 1960). However, the data also showed a substantial gradient with the individual's self-rating of the frequency of physical activity during the preceding 3 months, suggesting the potential to correct low fitness scores by an appropriate physical

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activity programme.

Both Health & Fitness Canada and the newly formed ParticipACTION closely monitored the findings from these early trials, and largely through their interest further observations on the format of screening tests were undertaken by the Ministry of Health in British Columbia. Working with Dr. David Chisholm and his colleagues, a trial was organized at another large Agricultural Fair, the Pacific National Exhibition (PNE) in Vancouver, BC. Responses were obtained to a list of 19 self-response questions along the lines that we had used in Saskatoon in a sample of 1253 people attending the PNE. The results were compared with the findings from a clinical examination that included the measurement of blood pressure and the recording of resting and exercise electrocardiograms. Seven of the 19 questions (Table 5) were retained as providing the clearest indication of individuals who required medical evaluation prior to an increase in their PA participation level (Chisholm et al., 1975). Thus was born the PAR-Q test, along with the PARmed-X test (a 4-page form intended to help physicians in the evaluation of individuals failing the PAR-Q test).

Unlike the simple exercise and PA participation screening procedure suggested by the American College of Sports Medicine (American College of Sports, 2013), the PAR-Q outcome was

not influenced by age or cigarette smoking. Both of these factors certainly increase a person's risk of sudden cardiac death, but when designing the PAR-Q, it was argued that neither age nor smoking, considered in isolation, warranted discussion with a physician prior to beginning a moderate exercise programme; the benefits of greater physical activity far outweighed the risks posed by moderate physical activity (Blair et al., 1992; Warburton et al., 2006). Moreover, possible issues associated with aging and smoking were already addressed by the standard 7 questions of the PAR-Q.

The PAR-Q was quickly endorsed by various national (Canadian Society of Exercise Physiology, 1994) and international organizations (American College of Sports Medicine, 1995). In 1991, the American College of Sports Medicine officially endorsed its use for the clearance of healthy adults (men <40 years, women <59 years). However, it is important to highlight that the PAR-Q was endorsed or adopted for use but not created by these organizations, a point that is often left out of the discussion regarding the history of the PAR-Q and its subsequent alterations.

Evaluation of the original PAR-Q

Chisholm estimated that the 7 questions of the PAR-Q test would give a sensitivity of 60-70%, and a specificity of

Table 5.:The seven questions originally selected for the PAR-Q questionnaire (Chisholm et al., 1975; Shephard et al., 1991; Thomas et al., 1992).

1. **Has your doctor ever said that you have heart trouble?**
2. **Do you frequently have pains in your heart or chest?**
3. **Do you often feel faint or have spells of severe dizziness?**
4. **Has a doctor ever said you blood pressure was too high?**
5. **Has your doctor ever told you that you have a bone or joint problem such as arthritis that has been aggravated by exercise, or might be made worse by exercise?**
6. **Is there a good physical reason not mentioned here why you should not follow an activity program even if you wanted to?**
7. **Are you over 65 and not accustomed to vigorous exercise?**

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over 80% relative to a clinical examination (Chisholm et al., 1975). They looked specifically at (a) a clinical examination plus blood pressure determination (specificity 78.5%, sensitivity 92.5%), (b) adding a resting EKG to procedure (a) (72.9, 91.6%), and supplementing procedure (b) by an exercise stress test (41.8, 41.8%). Unfortunately, these estimates refer to their entire list of 19 questions, rather than to the 7 items that were finally selected for the PAR-Q. The official report on the Pacific National Exhibition study suggested a sensitivity of 36.7% and a specificity of 95.5% for the 7 question list (British Columbia Ministry of Health, 1978).

We checked the PAR-Q assessment against the findings from a medical examination in a group of University of Toronto retirees; our data in this study showed a sensitivity of 55.0% and a specificity of 83.3% (Shephard et al., 1984). However, these studies necessarily accepted the medical examination as the gold standard of risk. In other studies, we found that medical exclusion rates for exercise testing of the general adult population ranged from 0.7 to 15.6%. Moreover, the rigour of exclusions apparently had no influence upon the incidence of EKG abnormalities or other test complications (Shephard, 1980). The physicians involved in the retiree study tended to err on the side of caution, and this necessarily led to a low estimate of test sensitivity. A third evaluation, in the offices of a life assurance company, identified all individuals that the company physician thought should not exercise or be physically active, but it also yielded 19% false positive responses (a specificity of 81%, (Shephard et al., 1981). The findings from this last study agreed

well with our practical experience in use of the PAR-Q test as a screening procedure for 2 decades; we had formed the conclusion that the test had a sensitivity of close to 100% (since there had been no reported cardiac catastrophes in those cleared by the PAR-Q), but the test specificity was around 80%, since a fifth of subjects gave false positive results (Shephard, 1994). Often, false positives were due to an erroneous belief that blood pressure was high (Shephard et al., 1981), possibly reflecting a "white coat hypertension" that had developed in the doctor's office (Celis and Fagard, 2004).

Objective assessments of the validity of the PAR-Q test as a screening tool have been quite few. A 7-year follow up of participants in the Canada Health Survey of 1978-1979 (Arraiz et al., 1992) found that the proportion of deaths in those cleared by the PAR-Q test was 29/1359 (2.1%), whereas there were 67/922 deaths (7.3%) among those who were given only a conditional pass or a test failure. Thus, the PAR-Q test was apparently successful in screening out many individuals who were at increased risk of death. In particular, the relative risk of cardiovascular death in those pinpointed by the PAR-Q test was 9.1, or 7.8 after adjustment of the data for age, sex, body mass index and smoking habits. Interestingly, the relative risk identified by the PAR-Q test was greater than that obtained either from poor performance on the Canadian Aerobic Fitness Test or from the results of an exercise stress test (Siscovick et al., 1991).

A study of office workers further examined outcomes of a progressive step test relative to PAR-Q data (Shephard et al., 1981). Positive responses to the PAR-Q test identified only 7 of 23 subjects who

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developed premature ventricular contractions (PVCs), and only 16 of 53 subjects who developed an ST segmental depression > 2 mm (although it should be noted that the medical examiner also failed to identify these individuals). To the extent that PVCs and ST depression are harbingers of the rare event of cardiac arrest, neither medical examination nor use of the PAR-Q were very effective screening procedures. On the other hand, despite many false positive results, the PAR-Q test correctly identified 32/46 individuals with hypertension, defined as a diastolic pressure >90 mm Hg (sensitivity 69.6%, specificity 93.7%). Finally, it was successful in identifying 4 of 5 individuals who were unable to complete the first 3 minutes of testing, and 50 of 71 subjects who had an excessive heart rate response to exercise (>85% of the age-related maximal heart rate).

In this same study, we compared the diagnostic success of the PAR-Q with a much more complex screening tool that was popular in the U.S. during the middle of the past century, the Cornell Medical Index (CMI) (Brodman et al., 1949). Comparing results to a standard medical examination, the CMI was less effective than the PAR-Q; if the CMI form was incomplete, or there were at least 2 positive responses to section C (cardiovascular complaints), the sensitivity of this instrument was 66.7%, and the specificity was 86.1%.

Developing measures of population fitness

During the 1960s, there were a wide range of treadmill, cycle ergometer and step test protocols, and the Toronto Fitness Research Unit recognized that in order to make regional or national

comparisons of aerobic fitness it was vital to develop internationally accepted and agreed exercise test protocols. With the support of the International Biological Programme, IBP, (Weiner and Lourie, 1969) and the World Health Organisation (Shephard, 1968), the world's leading exercise scientists of the period thus met to undertake a bench-level research project in Toronto, from June to August 1966.

A precise and detailed laboratory protocol was agreed for the direct treadmill measurement of maximal oxygen intake (Shephard et al., 1968a). In terms of sub-maximal testing, a variety of treadmill, cycle ergometer and stepping protocols were considered. Much to the surprise of some of those attending the working group, very good results were yielded by a simple test requiring the ascent and descent of a double nine-inch (0.457 m) step. During maximal effort, the oxygen consumption came to within 4% of the treadmill figure, and during submaximal testing, data also compared favourably with those obtained from submaximal treadmill and cycle ergometer tests (Shephard et al., 1968b).

We thus decided to adopt the double-step test as the basis of what was originally termed the Canadian Home Fitness Test, and what later became known (through its use in field assessments) as the Canadian Aerobic Fitness Test. The protocol was extremely simple. The test subject climbed and descended the double step at an age and sex-specific rhythm designed to demand (in three successive 3 min bouts of exercise) 50-55%, 60-65% and 70-75% of the individual's maximal oxygen intake. The maximal oxygen intake was then estimated from the final rate of stepping, an assumed net mechanical efficiency for

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ascent and descent of the double step, and the pulse rate recorded during the final minute of exercise or in the immediate recovery period. Calculations were based on a simple nomogram (Åstrand and Ryhming, 1954) or its computer solution (Shephard, 1970 -a). The procedure had its first large-scale trial in Saskatoon in 1974, when a large segment of that city's population was tested, 16 people at a time, as they climbed elongated benches (Fig. 3).

Figure 3: A mass trial of the Canadian Aerobic Fitness test (CAFT) was conducted in Saskatoon in 1974. A large segment of the city's population was assessed, 16 people at a time, using elongated stepping benches.



One of the objectives of the IBP Human Adaptability Project was to study various aspects of health and fitness in isolated populations that were still living as hunter-gatherers. In this context, the Toronto Fitness Research Unit was invited to evaluate the PA and fitness of Inuit living in Igloolik, a small island off the Melville Peninsula, near the northern tip of Baffin Island (Shephard and Rode, 1996). This study provided us with a unique opportunity to evaluate the effectiveness of the CAFT under arduous field conditions. At the time of the IBP survey, most of the inhabitants in Igloolik spoke only Inuktituk, and few had any experience in climbing stairs. In order to

instruct and encourage our subjects, we thus chanted the required age and sex specific stepping rhythm in Inuktituk, using the words 1-2-3 (*Atausiq, Marruuk, Pingasut*) on an ascending scale as subjects climbed the stairs, and the same chant on a descending scale as they made their backwards descent.

I was impressed with the effectiveness of this musical pacing, and in discussion with Fitness Canada and ParticipACTION, an LP recording was thus created with bands of music that set the required age and sex specific stepping tempos for the CAFT. Fitness Canada created an attractive "Fit-Kit" that included the LP, the PAR-Q, the Active Living Guide, and other fitness-related information (Fig. 4).

Figure 4: The Canadian Home Fitness Kit as developed by Fitness Canada in 1974-75 CE. The package included a LP record for conducting the CAFT, the original PAR-Q questionnaire, the Active Living Guide, and other fitness-related information.



Early criticism of the CAFT

One early user of the CAFT complained that as the needle approached the centre of the LP, the speed of the record slowed, so that the tempo set for the exerciser

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was substantially less than the intended pace (Cumming and Glenn, 1977). This was possibly a problem if a cheap record-player was used, but the difficulty was soon overcome, as the LP recording was replaced firstly by a tape recording, and subsequently by a CD.

A second difficulty, less readily overcome, was the limited accuracy of heart rate determinations, as estimated by wrist or neck palpation (Jetté et al., 1976; Shephard et al., 1979). One survey found that 10 second post-exercise pulse counts under-estimated the true EKG heart rate by an average of 1 ± 2 bpm (Shephard et al., 1979). This remains an issue in domestic use of the CAFT, although many surveys now have access to devices such as the Polar pulse-counter.

A third source of uncertainty was the net mechanical efficiency of stepping. In fit young men, the ascent and descent of the double step was performed fairly consistently, with an efficiency of close to 16% at the slowest pace, dropping to about 15.4% at a speed of 25 ascents/min (Shephard et al., 1979). Other investigators, testing subjects within Faculties of Physical Education, have observed similar levels of mechanical efficiency. For example, Jetté et al. reported values of 15.4% at 25 ascents/min (Jetté et al., 1976). However, substantially lower values (14.5-15.0%) have been seen even in some samples of laboratory subjects (Jetté, 1983; Shephard et al., 1979), and in groups with little experience of rhythmic stepping efficiency dropped to around 14% (Shephard and Bouchard, 1993). Estimation of the energy cost of working from the rate of climbing was further compromised if the subject failed to

maintain the intended rate of stepping, or did not stand erect on the top step.

Because of these various limitations, we initially viewed the CAFT mainly as a motivational device, offering a three-level evaluation of an individual's level of fitness. Rather than reporting specific numbers, we chose to describe a person as "at the recommended age and sex specific fitness level," "at the minimum age and sex-specific level," or "much poorer than desirable" (Shephard, 1980).

Table 6: Reasons why subjects were not allowed to undertake the CAFT in the 1981 Canada Fitness Survey (Cora Craig- personal communication, 1987).

- Heart trouble 3.6%
- Frequent chest pain 3.4%
- Dizziness 3.3%
- High blood pressure/medication 3.8%
- Joint problem 2.8%
- Over 65 years and unaccustomed to exercise or regular physical activity 0.9%
- Other reasons 4.6%
- Fever 0%
- Pregnancy 1.2% of women
- Cough 0.1%
- Poor muscular coordination 0.2%
- Impairment due to alcohol 0%
- Other observations 0.2%
- Resting heart rate >100 bpm 0.5%
- Resting systolic pressure > 150 mm Hg 3.0%
- Resting diastolic pressure >100 mm Hg 1.5%

Evolution of the PAR-Q

Since its introduction in 1975, the PAR-Q test has undergone a continuous process of evolution. The original questionnaire was purposely conservative. It has since seen enormous use worldwide (currently, it is downloaded 2.5 million times per year in Canada alone). It seems a very safe approach, and there have been no published reports suggesting that it has

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contributed to adverse outcomes during either exercise testing or prescribed PA programmes. However, there were "false positive" responses in some 20% of adults completing the original PAR-Q test (Warburton et al., 2011b; Warburton et al., 2011f), and the large number of medical referrals created substantial logistic problems for health services. Although a second tool, the PARmed-X, had been devised to help physicians in the evaluation of those patients who failed the PAR-Q test, doctors generally regarded this form as too long, complicated and difficult to use. Moreover, the more sophisticated clinicians objected that it was not "evidence-based." Thus, the PARmed-X was never widely adopted (Warburton et al., 2010b).

Several changes to the PAR-Q were introduced for the 1981 Canada Fitness Survey (Canada Fitness Survey, 1983). Observation of the client, and measurement of the resting heart rate and blood pressure were included in the initial screening. Additional reasons for exclusion included acute infection, pregnancy, difficulty in breathing at rest, persistent cough, swelling of the ankles, current use of medications, and failure to follow pre-test instructions (recent consumption of a meal or alcohol). Testing was refused if the heart rate after 5 minutes of sitting exceeded 100 beats/min (in part because such tachycardia would invalidate the exercise heart rate). Likewise, those with repeated right-arm blood pressure readings >150 mm Hg systolic, and/or diastolic (4th sound) > 100 mm Hg were excluded. The percentage of exclusions rose from 5.3% of males and 8.9% of females at ages 15-19 years to 52.3% of males and 58.2% of

females at ages 60-69 years. The reasons for exclusion are summarized in Table 6.

Our research team also considered possible changes to the wording of the PAR-Q test that might increase its specificity. The question regarding high blood pressure might be expanded to ask whether a doctor had reported that the problem was sufficiently serious to preclude sub-maximal exercise. The question about joint trouble could advantageously ask whether the problem was current and sufficiently serious as to interfere with the exercise or PA participation that was contemplated. A clearer definition of "heart trouble" would also be helpful, and there was a need for a comprehensive list of drugs that would imply a requirement for caution when exercising. With these issues in mind, we made some cautious recommendations and modifications of the PAR-Q wording in the early 1990s (Table 7, (Shephard et al., 1991; Thomas et al., 1992). The revised form was evaluated on 399 people attending 40 of 55 accredited exercise testing centres across Canada. Of 47 individuals making a positive response to the original PAR-Q, 27 were now cleared; the main reason for these changes being altered responses to the questions about high blood pressure and heart trouble (Shephard, 1994). However, since medical opinion differs widely on the appropriate criteria for exercise or PA participation clearance (Shephard, 1980), we felt unable to make any accurate empirical assessment of sensitivity and specificity for the revised test; the only realistic measure of validity would be long-term experience in its use. There still seemed to be an undesirable, and apparently unnecessary proportion of medical referrals (Thomas et al., 1992). Other items requiring further

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consideration were the need for special clearance forms for children and the elderly, and the level of formal qualification to be required of fitness professionals who interpreted responses to questions 5 and 6 on the new form.

In order to address these remaining questions, an Expert Committee was established by Dr. Norman Gledhill (York University) with the support of what had become the Fitness and Active Living Unit of Health Canada (Adams, 1999).

Table 7: Revisions of the PAR-Q questionnaire, as introduced in 1992. (Thomas et al., 1992).

1. Has a doctor ever said that you have a heart condition and recommended only medically supervised physical activity?
2. Do you have chest pain brought on by physical activity?
3. Have you developed chest pain in the past month?
4. Do you tend to lose consciousness or fall over as a result of dizziness?
5. Do you have a bone or joint problem that could be aggravated by the proposed physical activity?
6. Has a doctor ever recommended medication for your blood pressure or a heart condition?
7. Are you aware through your own experience, or a doctor's advice, of any other physical reason against your exercising without medical supervision?

Note: If you have a temporary illness such as a common cold or are not feeling well at the time-*postpone*.

CLARIFICATION QUESTIONS IN REVISED PAR-Q.
(to be used by the person administering the questionnaire in all cases if the response to questions 1, 5 or 6 is yes).

1. Have you had heart surgery or a heart attack? If yes, see M.D.
5. Do you have any difficulty walking up or down stairs? If yes, do not perform step test.
6. (a). Are you taking medication for a heart condition? If yes, see M.D.
(b). Have you ever taken medication for blood pressure? If yes, see M.D. If no, continue pre-

screening (including blood pressure measurement).

Note: If a woman to be tested is pregnant, recommend that she seek the advice of a physician, or postpone the appraisal.

Much of the discussion centred around the upper age limit for the PAR-Q test, and the possible need to develop a PAR-Q test specific to seniors. I argued that the elderly suffered from a multitude of chronic complaints, and it would be almost impossible to devise a simple clearance procedure in the face of such a plethora of issues. Moreover, I reasoned that most older people who contemplated exercise or PA participation would be thinking only in terms of walking at a moderate speed. The best advice might thus be for them to take a short daily walk, and if this caused no adverse response over the following 2-3 weeks, then they should extend the distance progressively until the desired level of PA had been attained. However, one American author explored responses of the elderly to the 1992 version of the PAR-Q test, evaluating an initially sedentary sample of 91 women and 90 men with an average age of 71.2 yr (Cardinal, 1997). Exclusion rates were similar for those aged 60-69, 70-79, and 80-89 yr, at around 55%, with question 6 (regarding high blood pressure) being the commonest reason for rejecting test candidates. Minor modifications to other PAR-Q items resulted from the work of Gledhill's committee, and the wording reached by the Year 2002 is shown in Fig. 5.

Safety concerns of physicians about the probing and interpretation of PAR-Q responses by qualified exercise and fitness professionals have been alleviated by a rapid increase in the knowledge base

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Figure 5: The 2002 Revision of the PAR-Q form created by Gledhill and colleagues.

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	
<input type="checkbox"/>	<input type="checkbox"/>	1. Has your doctor ever said that you have a heart condition <u>and</u> that you should only do physical activity recommended by a doctor?
<input type="checkbox"/>	<input type="checkbox"/>	2. Do you feel pain in your chest when you do physical activity?
<input type="checkbox"/>	<input type="checkbox"/>	2. In the past month, have you had chest pain when you were not doing physical activity?
<input type="checkbox"/>	<input type="checkbox"/>	4. Do you lose your balance because of dizziness or do you ever lose consciousness?
<input type="checkbox"/>	<input type="checkbox"/>	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?
<input type="checkbox"/>	<input type="checkbox"/>	6. Is your doctor currently prescribing drugs (for example, water pills) for your blood pressure or heart condition?
<input type="checkbox"/>	<input type="checkbox"/>	7. Do you know of <u>any other reason</u> 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.



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of those administering fitness and wellness programmes over the past two decades (Warburton et al., 2013; Warburton et al., 2011c). Educational advances have been spurred by the introduction of various specialist qualifications for exercise professionals,

such as the American College of Sports Medicine's *Clinical Exercise Physiologist*. Health professionals with such qualifications now combine a broad understanding of the indications and contraindications for exercise testing and prescription in health and disease.

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These exercise professionals hold a 4-yr honours degree in Kinesiology, Human Kinetics, or Health Exercise or Physical Activity Sciences, and often they have a greater understanding of the nuances of exercise and PA participation than physicians, most of whom still lack specialist certification in sports medicine (Jamnik et al., 2007; Shephard, 1991; Squires et al., 1999). Qualified exercise and fitness professionals are currently well-placed to discuss apparently positive PAR-Q responses with potential exercisers, and they have been very helpful to Dr. Gledhill and his colleagues in developing a series of supplementary questions that probe the need for a possible limitation on exercise and PA participation (Jamnik et al., 2007); this accumulated practical knowledge has been incorporated into the latest evidence-based test format (i.e., the new Physical Activity Readiness Questionnaire for Everyone (PAR-Q+, updated 2014 PAR-Q+)), see below.

Drs. Darren Warburton, Veronica Jamnik, and Norm Gledhill next recognized that if the PAR-Q approach was to be extended successfully to provide adequate guidance to patients with the full range of chronic conditions where exercise had therapeutic value, there was need for a major extension of the current evidence-base on the risks and benefits of regular PA participation. With the support of the Public Health Agency of Canada and funding from their own research programs,, they convened a broadly-based international panel of acknowledged experts to provide detailed, objective and standardized assessment of the risks and benefits of exercise in each of a range of clearly specified disorders. Their approach to the development of the new PAR-Q+ was

strongly evidence-based. The expert panel undertook systematic evaluation of the literature covering over 540,000 articles, with detailed review of more than 1000 papers. This information was presented to plenary sessions, allowing consensus formulation of more than 60 recommendations (Warburton et al., 2011a). The systematic study of the risks and benefits of increased PA participation at various stages in many chronic disease reached consensus opinions using the Appraisal of Guidelines for Research and Evaluation (AGREE) protocol (AGREE Collaboration, 2003; Jamnik et al., 2011). The end-result of these extended deliberations was the new evidence-based PAR-Q+ and electronic Physical Activity Readiness Medical Examination (ePARmed-X+).

Despite an increase in length, the new PAR-Q+ (Figs. 6-8) remains a straightforward clearance process. It is freely accessible at <http://www.eparmedx.com> and in the Health & Fitness Journal of Canada (Warburton et al., 2011e). The PAR-Q+ provides valid advice both in health and disease. Responses can be completed by an exercise professional or the potential exerciser in 5 min or less, either on paper or on-line. Page 1 asks 7 evidence-based questions that have been modified from the original PAR-Q. If the client answers "no" to all of the questions on page 1, then the immediate recommendation is to follow international PA guidelines. However, if there is a positive response to any of the first group of questions, the two-page stratified list of supplementary questions shown in Figs. 7-8 is presented (again, either on paper, or by a computer linkage). These supplementary questions probe issues relating to the chronic medical conditions concerned.

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Figure 6: Page 1 of the new Physical Activity Readiness Questionnaire for Everyone (PAR-Q+).

2014 PAR-Q+

The Physical Activity Readiness Questionnaire for Everyone

The health benefits of regular physical activity are clear; more people should engage in physical activity every day of the week. Participating in physical activity is very safe for MOST people. This questionnaire will tell you whether it is necessary for you to seek further advice from your doctor OR a qualified exercise professional before becoming more physically active.

GENERAL HEALTH QUESTIONS

Please read the 7 questions below carefully and answer each one honestly: check YES or NO.	YES	NO
1) Has your doctor ever said that you have a heart condition <input type="checkbox"/> OR high blood pressure <input type="checkbox"/> ?	<input type="checkbox"/>	<input type="checkbox"/>
2) Do you feel pain in your chest at rest, during your daily activities of living, OR when you do physical activity?	<input type="checkbox"/>	<input type="checkbox"/>
3) Do you lose balance because of dizziness OR have you lost consciousness in the last 12 months? Please answer NO if your dizziness was associated with over-breathing (including during vigorous exercise).	<input type="checkbox"/>	<input type="checkbox"/>
4) Have you ever been diagnosed with another chronic medical condition (other than heart disease or high blood pressure)? PLEASE LIST CONDITION(S) HERE: _____	<input type="checkbox"/>	<input type="checkbox"/>
5) Are you currently taking prescribed medications for a chronic medical condition? PLEASE LIST CONDITION(S) AND MEDICATIONS HERE: _____	<input type="checkbox"/>	<input type="checkbox"/>
6) Do you currently have (or have had within the past 12 months) a bone, joint, or soft tissue (muscle, ligament, or tendon) problem that could be made worse by becoming more physically active? Please answer NO if you had a problem in the past, but it <i>does not limit your current ability</i> to be physically active. PLEASE LIST CONDITION(S) HERE: _____	<input type="checkbox"/>	<input type="checkbox"/>
7) Has your doctor ever said that you should only do medically supervised physical activity?	<input type="checkbox"/>	<input type="checkbox"/>

If you answered NO to all of the questions above, you are cleared for physical activity. Go to Page 4 to sign the PARTICIPANT DECLARATION. You do not need to complete Pages 2 and 3.

- Start becoming much more physically active – start slowly and build up gradually.
- Follow International Physical Activity Guidelines for your age (www.who.int/dietphysicalactivity/en/).
- You may take part in a health and fitness appraisal.
- If you are over the age of 45 yr and **NOT** accustomed to regular vigorous to maximal effort exercise, consult a qualified exercise professional before engaging in this intensity of exercise.
- If you have any further questions, contact a qualified exercise professional.

If you answered YES to one or more of the questions above, COMPLETE PAGES 2 AND 3.

Delay becoming more active if:

- You have a temporary illness such as a cold or fever; it is best to wait until you feel better.
- You are pregnant - talk to your health care practitioner, your physician, a qualified exercise professional, and/or complete the ePARmed-X+ at www.eparmedx.com before becoming more physically active.
- Your health changes - answer the questions on Pages 2 and 3 of this document and/or talk to your doctor or a qualified exercise professional before continuing with any physical activity program.



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Figure 7: Page 2 of the new Physical Activity Readiness Questionnaire for Everyone (PAR-Q+).

2014 PAR-Q+

FOLLOW-UP QUESTIONS ABOUT YOUR MEDICAL CONDITION(S)

1. **Do you have Arthritis, Osteoporosis, or Back Problems?**
If the above condition(s) is/are present, answer questions 1a-1c If **NO** go to question 2

1a. Do you have difficulty controlling your condition with medications or other physician-prescribed therapies? (Answer **NO** if you are not currently taking medications or other treatments) YES NO

1b. Do you have joint problems causing pain, a recent fracture or fracture caused by osteoporosis or cancer, displaced vertebra (e.g., spondylolisthesis), and/or spondylolysis/pars defect (a crack in the bony ring on the back of the spinal column)? YES NO

1c. Have you had steroid injections or taken steroid tablets regularly for more than 3 months? YES NO

2. **Do you have Cancer of any kind?**
If the above condition(s) is/are present, answer questions 2a-2b If **NO** go to question 3

2a. Does your cancer diagnosis include any of the following types: lung/bronchogenic, multiple myeloma (cancer of plasma cells), head, and neck? YES NO

2b. Are you currently receiving cancer therapy (such as chemotherapy or radiotherapy)? YES NO

3. **Do you have a Heart or Cardiovascular Condition? This includes Coronary Artery Disease, Heart Failure, Diagnosed Abnormality of Heart Rhythm**
If the above condition(s) is/are present, answer questions 3a-3d If **NO** go to question 4

3a. Do you have difficulty controlling your condition with medications or other physician-prescribed therapies? (Answer **NO** if you are not currently taking medications or other treatments) YES NO

3b. Do you have an irregular heart beat that requires medical management? (e.g., atrial fibrillation, premature ventricular contraction) YES NO

3c. Do you have chronic heart failure? YES NO

3d. Do you have diagnosed coronary artery (cardiovascular) disease and have not participated in regular physical activity in the last 2 months? YES NO

4. **Do you have High Blood Pressure?**
If the above condition(s) is/are present, answer questions 4a-4b If **NO** go to question 5

4a. Do you have difficulty controlling your condition with medications or other physician-prescribed therapies? (Answer **NO** if you are not currently taking medications or other treatments) YES NO

4b. Do you have a resting blood pressure equal to or greater than 160/90 mmHg with or without medication? (Answer **YES** if you do not know your resting blood pressure) YES NO

5. **Do you have any Metabolic Conditions? This includes Type 1 Diabetes, Type 2 Diabetes, Pre-Diabetes**
If the above condition(s) is/are present, answer questions 5a-5e If **NO** go to question 6

5a. Do you often have difficulty controlling your blood sugar levels with foods, medications, or other physician-prescribed therapies? YES NO

5b. Do you often suffer from signs and symptoms of low blood sugar (hypoglycemia) following exercise and/or during activities of daily living? Signs of hypoglycemia may include shakiness, nervousness, unusual irritability, abnormal sweating, dizziness or light-headedness, mental confusion, difficulty speaking, weakness, or sleepiness. YES NO

5c. Do you have any signs or symptoms of diabetes complications such as heart or vascular disease and/or complications affecting your eyes, kidneys, **OR** the sensation in your toes and feet? YES NO

5d. Do you have other metabolic conditions (such as current pregnancy-related diabetes, chronic kidney disease, or liver problems)? YES NO

5e. Are you planning to engage in what for you is unusually high (or vigorous) intensity exercise in the near future? YES NO



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Figure 8: Page 3 of the new Physical Activity Readiness Questionnaire for Everyone (PAR-Q+).

2014 PAR-Q+

6. **Do you have any Mental Health Problems or Learning Difficulties?** *This includes Alzheimer's, Dementia, Depression, Anxiety Disorder, Eating Disorder, Psychotic Disorder, Intellectual Disability, Down Syndrome*
If the above condition(s) is/are present, answer questions 6a-6b If **NO** go to question 7
- 6a. Do you have difficulty controlling your condition with medications or other physician-prescribed therapies? (Answer **NO** if you are not currently taking medications or other treatments) YES NO
- 6b. Do you **ALSO** have back problems affecting nerves or muscles? YES NO
-
7. **Do you have a Respiratory Disease?** *This includes Chronic Obstructive Pulmonary Disease, Asthma, Pulmonary High Blood Pressure*
If the above condition(s) is/are present, answer questions 7a-7d If **NO** go to question 8
- 7a. Do you have difficulty controlling your condition with medications or other physician-prescribed therapies? (Answer **NO** if you are not currently taking medications or other treatments) YES NO
- 7b. Has your doctor ever said your blood oxygen level is low at rest or during exercise and/or that you require supplemental oxygen therapy? YES NO
- 7c. If asthmatic, do you currently have symptoms of chest tightness, wheezing, laboured breathing, consistent cough (more than 2 days/week), or have you used your rescue medication more than twice in the last week? YES NO
- 7d. Has your doctor ever said you have high blood pressure in the blood vessels of your lungs? YES NO
-
8. **Do you have a Spinal Cord Injury?** *This includes Tetraplegia and Paraplegia*
If the above condition(s) is/are present, answer questions 8a-8c If **NO** go to question 9
- 8a. Do you have difficulty controlling your condition with medications or other physician-prescribed therapies? (Answer **NO** if you are not currently taking medications or other treatments) YES NO
- 8b. Do you commonly exhibit low resting blood pressure significant enough to cause dizziness, light-headedness, and/or fainting? YES NO
- 8c. Has your physician indicated that you exhibit sudden bouts of high blood pressure (known as Autonomic Dysreflexia)? YES NO
-
9. **Have you had a Stroke?** *This includes Transient Ischemic Attack (TIA) or Cerebrovascular Event*
If the above condition(s) is/are present, answer questions 9a-9c If **NO** go to question 10
- 9a. Do you have difficulty controlling your condition with medications or other physician-prescribed therapies? (Answer **NO** if you are not currently taking medications or other treatments) YES NO
- 9b. Do you have any impairment in walking or mobility? YES NO
- 9c. Have you experienced a stroke or impairment in nerves or muscles in the past 6 months? YES NO
-
10. **Do you have any other medical condition not listed above or do you have two or more medical conditions?**
If you have other medical conditions, answer questions 10a-10c If **NO** read the Page 4 recommendations
- 10a. Have you experienced a blackout, fainted, or lost consciousness as a result of a head injury within the last 12 months **OR** have you had a diagnosed concussion within the last 12 months? YES NO
- 10b. Do you have a medical condition that is not listed (such as epilepsy, neurological conditions, kidney problems)? YES NO
- 10c. Do you currently live with two or more medical conditions? YES NO
- PLEASE LIST YOUR MEDICAL CONDITION(S) AND ANY RELATED MEDICATIONS HERE: _____

GO to Page 4 for recommendations about your current medical condition(s) and sign the PARTICIPANT DECLARATION.



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08-01-2014

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If the client answers "no" to all of the supplementary questions, clearance is given for a level of PA participation that is appropriate to the individual's current medical condition, in consultation with the advice of a qualified exercise and fitness professional.

However, if there is a positive response to one or more of the supplementary questions on pages 2 and 3 of the PAR-Q+ (Figures 7 and 8), further probing is conducted, using a hierarchy of questions available in a second instrument, the on-line Physical Activity Readiness Medical Examination (ePARmed-X+), again freely available in electronic form at <http://eparmedx.com>. The ePARmed-X+ can be completed by the client with minimal objective guidance from an exercise professional (Warburton et al., 2011f). Ideally, the qualified exercise and fitness professional will work as part of a multi-disciplinary health team, thus avoiding possible conflicts with the supposed medical prerogative of prescribing exercise for patients with clinical conditions. The consensus panel defined exercise recommendations for each of a wide range of medical conditions. Importantly, these exercise recommendations are often quite distinct from general PA guidelines. Specific algorithms were developed to yield appropriate exercise recommendations for each of many common chronic ailments, including type I and type 2 diabetes mellitus (Burr et al., 2012 -b; Burr et al., 2012d)(Fig. 9), cardiovascular disease (Goodman et al., 2013), chronic respiratory disease (Burr et al., 2012a), arthritis and osteoporosis (Burr et al., 2012 -a), stroke and spinal cord injury (Burr et al., 2012c) and cancer (Burr et al., 2012b). At each juncture point in the algorithm, the client is cleared for a

specified exercise program, directed to a further probing question, or is referred to a qualified exercise professional or Sports Medicine Specialist for personal evaluation. In principle, computerized decision-making of this type can save much time in a busy practice, and moreover it is simple to update recommendations as new information becomes available. The ePARmed-X+ and PAR-Q+ have been used by thousands of individuals in various trials within Canada and the United Kingdom with success (personal communication Dr. Darren Warburton). A British trial of another potential computerized clinical decision support system concluded that it was not of great practical benefit, but this seems to have been because the physicians participating in that study often opted to over-ride the objective advice provided by the computer (Roshanov et al., 2013). In order to avoid such issues, the qualified exercise and fitness professional is strongly discouraged from computer over-riding when using the ePARmed-X+. The extent of the advance provided by the ePARmed-X+ relative to earlier screening procedures can be judged from the fact that less than 1% of all exercise or PA candidates now require medical referral (Warburton et al., 2011d).

Based upon evidence-based levels of risk as assessed from ePARmed-X+ responses, a continuum of exercise programmes and supervision is recommended to the exercise and fitness practitioner. The client may be cleared for unrestricted or restricted PA, they may be led to a specifically tailored exercise prescription, or they may be referred to a physician for further evaluation. Those at low risk can exercise to moderate intensities with minimal supervision.

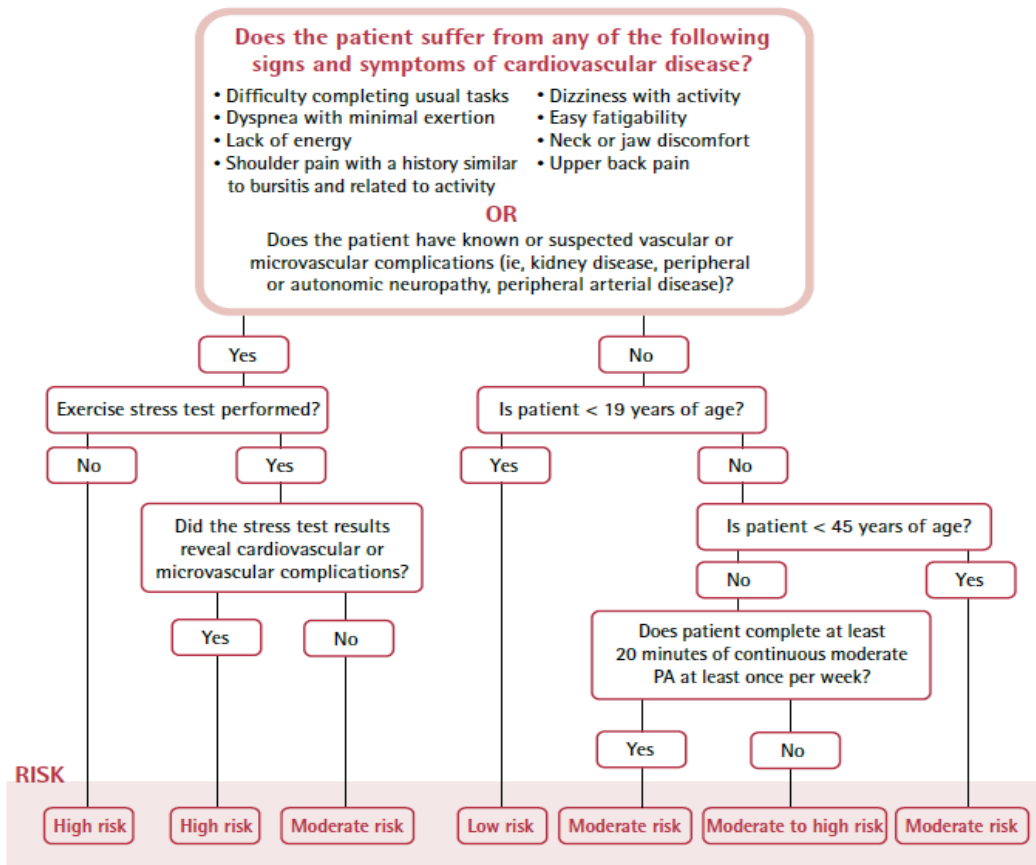
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Those at intermediate risk can exercise under the general guidance of appropriately qualified exercise and fitness professionals, and those at the highest risk can exercise only in medically supervised settings under the immediate supervision of a qualified exercise professional with advanced specialized training. To allow for possible fluctuations in health status, it has been decided that the PAR-Q+ evaluation is valid for a maximum of 12 months, and the ePARmed-X+ for a period of 6 months.

Evolution of the Canadian Aerobic Fitness Test

Given the simplicity of the CAFT, many investigators were eager to use this tool to predict an individual's maximal oxygen intake in such settings as fitness clubs, population surveys (Canadian Fitness & Lifestyle Research, 1983), and evaluations of occupational fitness (Bell and Allen, 1983; Canadian Public Health, 1979). In some of these surveys, pulse rate monitors were available, providing a

Figure 9: Clinical decision tree used to assess the risk of adverse events during physical activity in patients with pre-diabetes. Decision trees of this type have been developed for many chronic diseases, and they can be used either in electronic format or manually to categorize clients as high, intermediate, or low risk. They provide information informing both the requirements of physical activity prescription and the type of supervision required when participating in exercise programmes (reproduced from Burr, J.F., Shephard, R.J. and Riddell, M.C., 2012, Prediabetes and type 2 diabetes mellitus: Assessing risks for physical activity clearance and prescription. Canadian Family Physician, 58, 280-284).



PA—physical activity.

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more accurate estimate of end-exercise heart rates than could be obtained by palpation, and various multiple regression equations were proposed for the prediction of maximal oxygen intake (Table 8).

Many of these equations assumed the energy cost (E) of stepping in $L \cdot \text{min}^{-1}$ and thus the predicted $\dot{V}O_{2\text{max}}$ was expressed in these same units. Jetté (1983) claimed that his equation gave a more accurate prediction of maximal oxygen intake than an application of the Åstrand/Ryhming formulae to the same data set (Jetté, 1979). Nevertheless, independent evaluations showed the Jetté equation as yielding systematically lower $\dot{V}O_{2\text{max}}$ values than those measured directly by a treadmill test (Shephard, 1980; Shephard et al., 1979), and coefficients of correlation with the treadmill data were quite weak (in the range 0.55 to 0.57). Moreover, the Jetté equation categorized subjects more accurately if they were unfit than if they had a high level of aerobic fitness (Weller et al., 1992), possibly reflecting the limited number of CAFT test stages and thus a "ceiling effect" for fit individuals (Léger, 1984). The original CAFT format had a conservative peak intensity (70-75% of maximal heart rate). Given the demonstrated safety of testing to this level, Weller et al. (1992, 1993) proposed allowing subjects to undertake an additional test stage that would bring them to 80-85% of their age-predicted maximal heart rate; such a test modification would reduce the risk of ceiling effects (Weller et al., 1993; Weller et al., 1992). The equation based on this new protocol had a sensitivity (when seeking to place a person correctly in a 5-level gradation of fitness) of 81% for the fittest subjects, increasing to 100% for

the least fit subjects, with a specificity varying from 44 to 72%.

Luc Léger noted that there was no significant sex difference in the oxygen cost of stepping if this was expressed in units of $\text{mL} \cdot \text{kg}^{-1} \cdot \text{min}^{-1}$, and he thus recommended assigning a common oxygen cost to both sexes at any given rate of stepping. For the first time, the equation that he developed expressed the energy cost in the more logical units of mL oxygen consumed per kg of body mass. The correlation with directly measured maximal oxygen intake showed little change from alternative estimates, at $r = 0.88$, but it was claimed that the new formula substantially reduced the mean square error, and that the systematic error of predictions was abolished (Weller et al., 1993; Weller et al., 1992).

Current scoring of the modified CAFT (mCAFT) is based on this last equation. $\dot{V}O_{2\text{max}}$ predictions are multiplied by a factor of 10 to yield an "aerobic fitness score" (AFS). This score is used to classify clients on a five category age and sex specific scale. Dr. Gledhill introduced this simple data transformation in order to avoid giving the impression that the mCAFT provided an accurate measure of maximal aerobic power (personal communication, N. Gledhill, 2013). By way of example, the AFS for males aged 15-19 years ranges from >574 (excellent) to < 436 (needs improvement), and the corresponding values for young females range from >490 to <368.

Given that the original CAFT was completed by what was intended as a nationally representative sample of 6,810 males and 6,448 females during the Canada Fitness Survey (Canadian Fitness & Lifestyle Research, 1983), we suggested that a further option would be to interpret the results for individual clients

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relative to this data base (Shephard and Bouchard, 1993). Data from the national sample were thus converted into estimates of peak MET values (ratios to resting metabolism) for each age and sex category, assuming a net mechanical efficiency of 14%, and using immediate recovery heart rates and a computer solution of the Åstrand nomogram. We emphasized that results should not be interpreted in an absolute sense, but rather should be used to place individuals in one of five age and sex-specific fitness categories (Shephard et al., 1987). These categories corresponded to peak MET values > +1 SD above, > +0.5 SD above, at or near the norm, < 0.5 SD below, and < 1SD below population norms. One important difference from the alternative prediction equations was that greater emphasis was given to the individual's exercise heart rate, which seems appropriate in a test of cardiovascular fitness. Thus, if a young man trained very hard, increasing his maximal oxygen intake by 33%, the equation of Jetté et al. would predict a gain in $\dot{V}O_{2max}$ of only 4.6%, whereas the population-based interpretation would indicate a 33.8% gain (Shephard et al., 1987). The main limitation to this approach was that a substantial proportion of older subjects had either excluded themselves from the Canada Fitness Survey, or had been advised against taking the CAFT by those involved in making the measurements because of adverse PAR-Q responses. Perhaps in part also because norms were expressed in units of METs rather than in $\text{mL}\cdot\text{kg}^{-1}\cdot\text{min}^{-1}$, the population approach never became very popular in interpreting CAFT test results.

Table 8: Equations proposed for the prediction of maximal oxygen intake from CAFT data. Note: E = gross oxygen cost ($\text{L}\cdot\text{min}^{-1}$) except in the Léger equation (where E is expressed in $\text{mL}\cdot\text{kg}^{-1}\cdot\text{min}^{-1}$, M = body mass (kg), f_H = end-exercise pulse rate (bpm), and A = age (years).

Author	Equation	Comment
(Jetté, 1983)	$\dot{V}O_{2max} = 42.5 + 16.6 (E) - 0.12 (M) - 0.12 (f_H) - 0.24 (A)$	$r^2 = 0.81$
(Bell and Allen, 1983)	$\dot{V}O_{2max} = 76.4 + 7.2 (E) - 0.2 (M) - 0.17 (f_H) - 0.24 (A)$	Best equation for Canadian Forces
(Weller et al., 1993; Weller et al., 1992).	$\dot{V}O_{2max} = 32.0 + 16.0 (E) - 0.17 (M) - 0.24 (A)$	All subjects. $r^2 = 0.77$
(Weller et al., 1993; Weller et al., 1992).	$\dot{V}O_{2max} = 32.5 + 16.3 (E) - 0.21 (M) - 0.20 (A)$	Omitting fittest subjects, $r^2 = 0.83$
Léger (cited by Weller)	$\dot{V}O_{2max} = 17.2 + 1.29 (E) - 0.09 (M) - 0.18 (A)$	$r^2 = 0.88$ E expressed in $\text{ml}/[\text{kg}\cdot\text{min}]$

We may conclude that without the direct measurements of oxygen consumption and EKG heart rate data, whatever method of prediction is used, variations in the net mechanical efficiency of climbing, departures from the intended rate of stepping and errors of pulse counting inevitably mean that the CAFT and mCAFT provide a relatively crude estimate of an individual's aerobic power, and except when obtaining average data for large groups, a qualitative classification of clients is preferable to the presentation of numerical data.

Motivational value of the CAFT and mCAFT

One potential application of the CAFT and mCAFT is in demonstrating changes of aerobic fitness to clients. How useful is it in this context, and how far does an increase of fitness score encourage clients

to persevere in their adoption of a more active lifestyle?

The change in CAFT score following a period of treadmill training was compared to the "gold standard" of a laboratory treadmill assessment, and Jetté concluded that his prediction equation gave a somewhat better estimate of gains in aerobic fitness than did application of the Åstrand nomogram to the same data set (Jetté et al., 1982).

In terms of client motivation, I gained the impression while working at a smoking cessation clinic in Toronto during the 1960s that many heavy smokers were quite concerned by the dyspnea that they developed when performing a double step test, and the symptoms and EKG abnormalities that they encountered during the test process were important factors in encouraging them to stop smoking. In an apparently unpublished study, W.J. Rutherford (1990) also noted that sedentary individuals reported a greater intensity and frequency of habitual activity one month after taking the CAFT (although apparently no objective measurements of daily PA were made). In contrast, Godin and associates used the Fishbein model of reasoned action to demonstrate that (at least in a group of individuals who were already attending an Athletic Centre), performance of a single CAFT in the exercise laboratory of that facility did little to strengthen psychological intentions to exercise, in either a short or a longer term perspective (Godin et al., 1983; Godin et al., 1987). A day of work-site counseling that included carrying out a modified CAFT and other fitness measurements also did little to change either PA or other health behaviors over the following 3 months (Monks, 1996).

Future Directions

One might conclude from the foregoing account that both exercise and PA participation screening by the PAR-Q and client assessment using the CAFT have now reached their apogee. A combination of the PAR-Q+ (recent version 2014 PAR-Q+) and the e-PARmed-X+ provide safe, effective and evidence-based screening for clients who wish to begin exercising or becoming more physically active, whether they are ostensibly healthy, or are affected by chronic disease. Likewise, the mCAFT provides a simple and approximate field measure of an individual's aerobic fitness status that can be used both as a guide to exercise prescription and as an initial motivational tool. Further, the mCAFT continues to find widespread application in large-scale nationally representative fitness surveys such as the Canadian Health Measures Survey of 2009-2011 (Canada, 2012).

In terms of client screening, there remains a need for the up-dating of the algorithms used in the e-PARmed-X+ as new information on risks and benefits becomes available. There is also scope to revise the PARmed-X for pregnancy, basing a new format on evidence-based recommendations garnered from an international consensus panel. There also remain some chronic medical conditions for which evidence-based recommendations have yet to be formulated.

It seems doubtful if the accuracy of the mCAFT can be enhanced further by any simple modification of test structure. However, there is growing interest in complementing such assessments of aerobic fitness by accurate measurements of habitual PA; in fact, the current level of habitual PA as assessed by inexpensive

and reasonably accurate pedometer/accelerometers may be more important to health than the client's current level of aerobic fitness (which has substantial anthropometric and genetic components). Use of pedometer/accelerometers suggests that an adequate level of PA is much less prevalent than has inferred from responses to traditional PA questionnaires (Colley et al., 2011; Iannotti et al., 2009). Such simple instrumentation may help to quantitate habitual inactivity as well as monitoring bouts of PA that fall below the intensity needed to enhance aerobic fitness, but are yet important to an individual's metabolic health.

However, the major challenge for future generations of qualified exercise professionals will be to find an effective way of translating an effective and appropriate exercise prescription into a sustained change of behaviour in a high proportion of their clients.

Conclusions

Although the original opinion-based PAR-Q instrument provided a simple, and safe basis of exercise and PA participation clearance, small changes in the wording of questions failed to eliminate the problem of a low test specificity. As many as 20% of false positive responses created client anxiety and led to many unnecessary medical referrals. However, introduction of the evidence-based PAR-Q+ in conjunction with the detailed ePARmed-X+ (<http://www.eparmedx.com>) has now largely eliminated this difficulty, with only about 1% of clients needing medical referral. The current tools offer qualified exercise and fitness practitioners and sports physicians a unique evidence-based decision-tree that can quickly provide an appropriately graded exercise

and PA participation recommendation not only for the typical sedentary adult, but also for clients affected by a wide variety of chronic conditions. Attempts to derive a precise measure of an individual's maximal oxygen intake from field use of the Canadian Aerobic Fitness Test are thwarted by inter-individual differences in the net mechanical efficiency of stepping, and findings from such tests should not be over-interpreted in the absence of direct measurements of oxygen consumption and EKG heart rate determinations. Nevertheless, the latest format of the CAFT enables exercise and fitness professionals to make a useful 5-category classification of an individual's aerobic fitness, thus allowing them to suggest an appropriate starting intensity for a conditioning programme, and giving some initial impetus to the client to improve his or her physical fitness. Future years will see application of the evidence-based system of exercise clearance to the PARmedX for pregnancy, and to other chronic conditions where appropriately graded PA participation recommendations are as yet lacking. The existing algorithms will also require updating as new knowledge on the risks and benefits of exercise becomes available. However, the largest challenge for future generations of exercise and fitness practitioners will be to find methods of translating an appropriate, evidence-based exercise prescription into a pattern of sustained client behaviour.

Author's Qualifications

The author's qualifications are: Roy J. Shephard, M.B.B.S., M.D. [Lond.], Ph.D., D.P.E., LL.D., D.Sc., F.A.C.S.M., F.F.I.M.S.

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