REVIEW / SYNTHÈSE

Evidence-based risk assessment and recommendations for physical activity clearance: Consensus Document 2011[1]

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Abstract: The Physical Activity Readiness Questionnaire (PAR-Q) and the Physical Activity Readiness Medical Evaluation (PARmed-X) are internationally known preparticipation screening tools developed on the basis of expert opinion. The primary purposes of this consensus document were to seek evidence-based support for the PAR-Q and PARmed-X forms, to identify whether further revisions of these instruments are warranted, to determine how people responding positively to questions on the PAR-Q can be safely cleared without medical referral, and to develop exercise clearance procedures appropriate for various clinical conditions across the human lifespan. Seven systematic reviews were conducted, examining physical-activity-related risks and effective risk-stratification procedures for various prevalent chronic conditions. An additional systematic review assessed the risks associated with exercise testing and training of the general population. Two gap areas were identified and evaluated systematically: the role of the qualified exercise professional and the requisite core competencies required by those working with various chronic conditions; and the risks associated with physical activity during pregnancy. The risks associated with being physically inactive are markedly higher than transient risks during and following an acute bout of exercise in both asymptomatic and symptomatic populations across the lifespan. Further refinements of the PAR-Q and the PARmed-X (including online versions of the forms) are required to address the unique limitations imposed by various chronic health conditions, and to allow the inclusion of individuals across their entire lifespan. A probing decision-tree process is proposed to assist in risk stratification and to reduce barriers to physical activity. Qualified exercise professionals will play an essential role in this revised physical activity clearance process.

Key words: preparticipation screening, exercise, PAR-Q, PARmed-X, adverse events, complications.

Résumé : Le Questionnaire sur l'aptitude à l'activité physique (Q-AAP) et l'Évaluation médicale de l'aptitude à l'activité physique (X-AAP) sont des instruments de dépistage de réputation internationale préalable à la pratique de l'activité physique et conçus d'après l'opinion d'experts. Cette étude se propose principalement de 1) localiser des documents probants au sujet du Q-AAP et du X-AAP et de déterminer la nécessité de révision de ces instruments, 2) d'évaluer à quel degré des réponses affirmatives au Q-AAP peuvent être traitées sans consultation d'un médecin et 3) d'élaborer des modalités d'approbation de la pratique de l'activité physique convenant à diverses conditions cliniques tout au long de la vie. On effectue sept analyses documentaires systématiques dans lesquelles on analyse les risques associés à la pratique de l'activité physique et les méthodes efficaces de stratification du risque en ce qui concerne diverses conditions chroniques les plus prévalentes. Dans une autre analyse documentaire, on évalue les risques associés aux épreuves d'effort et à l'entraînement physique de la population en général. On identifie et évalue systématiquement deux zones grises; le rôle du professionnel de l'exercice

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certifié et les compétences de base requises chez les professionnels œuvrant auprès de diverses populations chroniques et des femmes enceintes pouvant présenter des risques associés à la pratique de l'activité physique. Les risques associés à l'inactivité physique sont nettement plus importants que les risques passagers associés à une brève séance d'exercice physique et à la récupération consécutive chez les personnes asymptomatiques et symptomatiques, et ce, tout au long de la vie. Il faut mettre à jour le Q-AAP et le X-AAP (incluant des versions en ligne de ces questionnaires) afin de composer avec les limites particulières associées aux diverses conditions chroniques et d'autoriser l'inclusion d'individus tout au long de leur vie. On présente un arbre décisionnel à des fins de stratification du risque et d'élimination des barrières à la pratique de l'activité physique. Les professionnels de l'exercice certifiés jouent un rôle essentiel dans ce processus révisé d'autorisation à la pratique de l'activité physique.

Mots-clés : dépistage préalable, exercice physique, Q-AAP, X-AAP, événements indésirables, complications.

[Traduit par la Rédaction]

Introduction

The incontrovertible health benefits of habitual physical activity (PA) (Warburton et al. 2006*a*, 2006*b*, 2007*e*, 2010) clearly outweigh the transient increase in risk associated with acute bouts of PA (Goodman et al. 2011). Therefore, reducing barriers to participation in PA is important to the health of Canadian society (Warburton et al. 2006*a*, 2006*b*, 2007*e*, 2010).

The Canadian Society for Exercise Physiology (CSEP) (specifically its Health & Fitness Program) has played a leading role in disseminating information on the health benefits of PA, both nationally and internationally (Bouchard et al. 1994; Paterson and Warburton 2010; Timmons et al. 2007; Tremblay et al. 2007; Warburton et al. 2007*e*, 2010). Contributions include the creation of the Canadian Physical Activity and Lifestyle Approach (CPAFLA), Canada's Physical Activity Guides for Children & Youth, Canada's Physical Activity Guide to Healthy Active Living, and Canada's Physical Activity Guide to Healthy Active Living for Older Adults. Seminal conferences — such as the first and second International Conference on Physical Activity, Fitness and Health (1988 and 1992, respectively), the Dose-Response Symposium (held in Hockey Hills, Ont. in 2000), the Communicating Physical Activity and Health Messages Science into Practice meeting (held in Whistler, B.C. in 2001), and the third International Congress on Physical Activity and Public Health (held in Toronto in 2010) — have further established the role of the CSEP Health & Fitness Program in the promotion of health-enhancing PA.

Perhaps the most widely recognized document emerging from the CSEP Health & Fitness Program has been the Physical Activity Readiness Questionnaire (PAR-Q) (Shephard 1988; Thomas et al. 1992). This simple screening tool is intended for completion by everyone who plans to undergo a fitness assessment or to become much more physically active. When a positive response is made to this instrument, the individual is directed to consult with his or her physician to seek clearance to engage in either unrestricted or restricted PA. The Physical Activity Readiness Medical Evaluation (PARmed-X) is a second form to assist their peers in addressing medical concerns identified by the PAR-Q.

The PAR-Q has been widely used, both nationally and internationally, for many years. More than 400 000 Canadians are required to complete the PAR-Q annually as a part of the CPAFLA (Canada's primary health and fitness battery) (Canadian Society for Exercise Physiology 2003). The PAR-Q is also used as the primary screening component in a variety of non-CPAFLA fitness tests and as a preliminary to participation in PA or exercise programs. Many Canadian community centres make completion of the PAR-Q a prerequisite to initiating a PA program. Moreover, the PAR-Q is the standard screening instrument in various occupational test protocols (Gledhill and Jamnik 1992). The PAR-Q is also used for screening in other environments (e.g., entrance to university and college courses that involve PA, high school fitness and athletic programs, summer camps). Thus, it is estimated that at least 2.5 million Canadians complete the PAR-Q form every year. Before the PAR-Q and PARmed-X were developed, Canadians who wanted to take a fitness test or become more active were screened by their family physicians (Shephard 1988, 1994). The development of the PAR-Q has reduced the number of physician clearances by some 90%.

The PAR-Q form is currently one of the most frequently downloaded resources on the national Web sites of the CSEP (www.csep.ca) and the Public Health Agency of Canada. Moreover, its use in clinical practice is endorsed by the College of Family Physicians of Canada. It has also seen widespread use by individuals and organizations throughout the United States, the United Kingdom, and many other nations. The systematic review process we undertook underlined the fact that the PAR-Q is now the international standard preparticipation screening instrument. A recent report from Israel recommended the use of the PAR-Q by primary health care physicians when screening healthy individuals for noncompetitive PA (Scheinowitz et al. 2008). Nevertheless, an estimated 100 000 Canadians each year respond positively to 1 or more PAR-Q questions, and are therefore referred to their physician with a copy of the PARmed-X. Moreover, the PARmed-X is widely utilized in clinical trials that involve exercise (Culos-Reed et al. 2006).

Recent feedback from various end-users (including clients, research investigators, exercise professionals, clinicians, and their respective professional organizations) has highlighted the need for further evaluation and refinement of both instruments. Research investigators must often make the difficult decision to exclude participants from a PA intervention, even if they suspect that their clients would benefit from greater PA. In one trial (Bull et al. 1999), the PAR-Q excluded 70% of 882 primary care patients, although the authors considered that many of these individuals would have benefited from the general health recommendation of undertaking 30 min of

moderate-intensity PA on most days of the week. Intuitively, their contention appeared valid, but empirical evidence was hard to interpret. Moreover, medico-legal concerns arise, now that the completion of the PAR-Q prior to initiation of a PA is considered to be best practice (Eickhoff-Shemek 2010; Herbert and Eickhoff-Shemek 2010). As an interim solution, the CSEP Health & Fitness Program developed a protocol in which highly trained personnel (CSEP Certified Exercise Physiologists) can deal with many clinical situations in which people answer yes to 1 or more questions on the PAR-Q, allowing such individuals to be cleared, where appropriate, for unrestricted PA without referral to a physician (Jamnik et al. 2007). Further information on this process is given by Jamnik et al. (2007).

The PARmed-X has met with some criticism, particularly from family physicians. Despite their vast breadth and depth of knowledge in other areas of medicine and health behaviours, family practitioners often have limited knowledge about the absolute and relative contraindications to exercise (Petrella et al. 2003, 2007). Moreover, many physicians acknowledge limited ability to offer effective counselling on lifestyle modifications, particularly concerning diet and PA (Bruce and Burnett 1991; Flocke et al. 2009). The PARmed-X was intended to simplify the medical clearance process and to assist physicians in providing sound exercise advice to their patients. However, recent feedback suggests that physicians have found the PARmed-X neither simple to use nor helpful to themselves or their patients. Indeed, the existing PAR-Q and PARmed-X forms sometimes become barriers to PA. Moreover, physician organizations, such as the College of Family Physicians of Canada, have yet to endorse the PARmed-X, because they consider the instrument too long, not user-friendly, and not evidence-based. Also, this PA clearance process does not reflect fully the advance in exercise science education and the field's evidence base that have occurred since the PAR-Q and PARmed-X forms were originally developed.

Accordingly, a decision was made to evaluate the evidence base supporting the PAR-Q and PARmed-X forms and to decide if revisions were warranted, with an emphasis on the needs of individuals with various chronic health problems. Advances in the training and certification of exercise professionals suggested a need to re-evaluate this aspect of clearance (Jamnik et al. 2007; Warburton and Bredin 2009; Warburton et al. 2007*c*). Specifically, could positive responses to the PAR-Q instrument be safely evaluated by appropriately qualified exercise professionals and other trained health care practitioners? Finally, there was a need to reconsider age restrictions on the use of the PAR-Q and PARmed-X forms (which is currently restricted to people 15 to 69 years of age).

On March 11 to 14, 2009, the CSEP and the Public Health Agency of Canada held a consensus conference to discuss current literature related to clinical (symptomatic) populations, with specific reference to the questions contained in the PAR-Q and PARmed-X forms. The Consensus Panel consisted of 6 members, all with expertise in clinical exercise physiology, PA, and health (D.W., N.G., V.J., D.M., J.S., R.S.); 3 were physicians (D.M., J.S., and R.S.), and 3 panel members (N.G., V.J., and R.S.) had played central roles in previous international consensus conferences on the health benefits of PA. Additionally, 1 panel member was an expert in the Appraisal of Guidelines for Research and Evaluation (AGREE) process, and had previously been involved in the development, evaluation, and harmonization of several clinical practice guidelines (J.S.). The Consensus Panel was supplemented by experts from various backgrounds, including an AGREE consultant (J.M.) (Jamnik et al. 2011). These invited experts presented their findings on evidence-based risk assessment and recommendations for PA clearance in clinical conditions, including cardiovascular disease (excluding stroke), stroke, cancer, arthritis, low back pain, osteoporosis, respiratory disease, cognitive and psychological conditions, metabolic disorders, and spinal cord injury (SCI) (Chilibeck et al. 2011; Eves and Davidson 2011; Jones 2011; Rhodes et al. 2011; Riddell and Burr 2011; Thomas et al. 2011; Zehr 2011). Additional research examined the risks associated with exercise testing and training in the general population (Goodman et al. 2011). The Consensus Panel reviewed the Levels and Grades of Evidence presented at the conference, using predefined and objective criteria, as established in Tables 1 and 2 (see the companion paper by Jamnik et al. (2011)). They also identified areas warranting future research, and they developed recommendations for improved data reporting in clinical trials involving exercise interventions.

The approach used to define the Levels and Grades of Evidence was consistent with that adopted during the creation of the "Canadian clinical practice guidelines on the management and prevention of obesity in adults and children" (Lau et al. 2007). The Level indicates the strength of evidence favouring PA or exercise in the treatment of a given chronic condition. The Grade of each article assesses the efficacy of PA in the secondary prevention of the condition evaluated (Table 2). Where applicable, the Grade also informs the reader about the potential risks of PA. In studies receiving the highest Grade, the benefits clearly outweigh the risks, and PA would receive a strong positive recommendation.

The purposes of this consensus document are to provide an independent evaluation of the 8 commissioned articles, and to create a list of recommendations on the basis of those evaluations. Specific details regarding the review and consensus processes are provided in a companion paper (Jamnik et al. 2011). As the process drew to a close, the Consensus Panel noted some significant gaps in the literature. In particular, there was a need to define the requisite training and qualification of exercise professionals; a supplemental systematic review by Warburton et al. (2011*b*) addresses this need. Moreover, information was required regarding the risks of exercise testing and training during pregnancy. This need became apparent during the validation and evaluation of decision trees through the Physical Activity Support Line (www.physicalactivityline.com; an important partner in the creation of the new PAR-Q+ and ePARmed-X+) (Warburton et al. 2011*c*, 2011*d*).

This Consensus Statement provides information and recommendations regarding the benefits and risks associated with exercise in various clinical conditions, including cardiovascular disease (excluding stroke), stroke, cancer, arthritis, low back pain, osteoporosis, respiratory disease, cognitive and psychological conditions, metabolic disorders, and SCI. We define the term "qualified exercise professional" in the context

Table 1. The Levels of Evidence scaling criteria applied to the articles.

Level of Evidence	Criteria
1	Randomized controlled trials without important limitations
2	Randomized controlled trials with important limitations
	Observational studies (nonrandomized clinical trials or cohort studies) with overwhelming evidence
3	Other observational studies (prospective cohort studies, case–control studies, case series)
4	Inadequate or no data in population of interest
	Anecdotal evidence or clinical experience

Table 2. The Grade of Evidence scaling criteria applied to the articles.

Grade of Evidence	Criteria
A	Strong recommendation (action can apply to most individuals in most circumstances)
	Benefits clearly outweigh risks (or vice versa)
	Evidence is at Level 1, 2, or 3
B	Weak recommendation (action may differ, depending on individual's characteristics or other circumstances)
	Unclear if benefits outweigh risks
	Evidence is at Level 1, 2, or 3
C	Consensus recommendation (alternative actions may be equally reasonable)
	Unclear if benefits outweigh risks
	Evidence is at Level 3 or 4

of safe and effective exercise prescription, providing guidelines regarding the minimal education and certification requirements for qualified exercise professionals working with clinical populations. We also discuss the risks associated with exercise testing and training in the general population and in pregnant women. The Consensus Panel has based its recommendations on the information provided from the systematic review, and on additional sources when further information was required. This Consensus Statement represents a compilation of information from various sources, including the 2007 and 2010 papers developed to evaluate Canada's PA guidelines (for children and youth, adults, and older adults) (Janssen 2007; Paterson et al. 2007; Paterson and Warburton 2010; Warburton et al. 2007*e*, 2010), the systematic reviews presented at the consensus conference (Chilibeck et al. 2011; Eves and Davidson 2011; Goodman et al. 2011; Jones 2011; Rhodes et al. 2011; Riddell and Burr 2011; Thomas et al. 2011; Zehr 2011), debate at the consensus conference, and additional information (when required). This Consensus Statement provides information and recommendations related to various clinical conditions, the risks associated with exercise stress testing, the risks associated with PA participation during pregnancy, the evidence to support or refute a screening process that accounts for age, and the need for advanced training in the exercise sciences. Consistent with previous consensus statements (including those recently created by CSEP (Kesäniemi et al. 2010)), we provide a short summary of the available evidence for each recommendation, with direct reference to primary-source articles. The Consensus Panel recommendations that are outlined often reflect an amalgamation and harmonization of information from specific recommendations found in the individual systematic reviews and other sources that inform these recommendations. The individual systematic reviews should be consulted for further information on their specific recommendations.

Consensus review: risks of PA, exercise training, and exercise testing

Goodman et al. (2011) identified more than 190 000 articles through electronic database searches. A total of 616 papers relating to PA and adverse events were systematically reviewed; 527 were obtained through the electronic search and another 89 identified by the authors. Of these papers, 51 reported directly on adverse events during PA or exercise testing. Goodman et al. (2011) systematically evaluated the risks associated with both exercise testing and training. The review highlights a risk paradox: despite overwhelming evidence associating habitual PA with a reduced risk of long-term morbidity and mortality, there is also evidence that an acute bout of exercise transiently increases the risk of nonfatal cardiovascular complications and sudden cardiac death.

Risks associated with maximal symptom-limited stress testing

Exercise stress testing facilitates effective exercise prescription by providing important information on functional capacity, the risk or presence of cardiovascular disease, and the risk of premature mortality. However, several reports on sudden cardiac death during and following PA have raised concerns regarding the extent to which activity increases the immediate risk of fatal and nonfatal cardiovascular events. Analysis of the literature shows that the risk of a cardiovascular event during maximal exercise testing is less than 0.8 per 10 000 tests, or 1 per 10, 000 h of testing. Unfortunately, this estimate is confounded by the fact that many published studies included patients with cardiovascular disease and (or) risk factors for cardiovascular disease. Goodman et al. (2011) note a lower risk of adverse events in apparently healthy individuals than in those at higher risk of cardiovascular disease. The risk of adverse cardiovascular events in healthy

asymptomatic individuals is very low, in the range of 0.3–0.8 and 1.4 per 10 000 tests for fatal and nonfatal incidents, respectively.

Risks associated with participating in PA and exercise

Goodman et al. (2011) note that data are limited. Most studies only reported deaths, and information on nonfatal adverse events was lacking. The risk of a fatality appears to be well below 0.01/10 000 participant-hours, although it is slightly greater if the activity is vigorous and when previously inactive individuals become more active. This small risk must be weighed against compelling evidence of the health benefits of habitual vigorous PA. The benefits clearly far outweigh the risks. There is consistent evidence demonstrating a 25%–50% reduction in adverse cardiovascular events in individuals who routinely participate in PA (Warburton et al. 2010). There is also increasing evidence that vigorous PA is more beneficial than lower intensities of effort (Paterson and Warburton 2010; Warburton et al. 2010).

Age restrictions for the PAR-Q

Goodman et al. (2011) found insufficient data to support the current restriction of the PAR-Q to people 15 to 69 years of age. They acknowledge that the development of cardiovascular disease is linked to aging, but found no compelling evidence of a linear relationship between age and the risk of cardiovascular or other adverse events during and immediately following PA or exercise.

The qualified exercise professional's ability to clear participants

Goodman et al. (2011) examine the issue of allowing qualified exercise professionals the discretion to clear individuals who respond yes to 1 or more questions on the original PAR-Q form. Their analysis recognizes that the risks of exercise testing and training are both quite low, even in patients with established cardiovascular disease, and they underline the fact that the PA of many individuals at intermediate risk (i.e., those with established risk factors for cardiovascular disease) is unnecessarily restricted by the use of the PAR-Q. They thus recommend that qualified exercise professionals (as defined below) should be permitted to advise clients who were initially screened out by the PAR-Q, allowing them to engage in unrestricted PA or guiding them to appropriately adapted PA prescription and (or) further investigation, as appropriate.

Recommendations: risks of PA, exercise training, and exercise testing

Based on the literature, systematic reviews, the data presented at the consensus conference, and other materials available to the Consensus Panel, the following recommendations are made with respect to PA, exercise training, and stress testing in healthy asymptomatic individuals. These (and many subsequent recommendations) underline the high benefit-to-risk ratio of PA or exercise.

Recommendation no 1: Maximal exercise stress testing is associated with a very low risk of fatal and nonfatal cardiac events in either healthy asymptomatic or clinical populations. In healthy asymptomatic individuals, the respective incidences of fatal and nonfatal events are approximately 0.3–0.8/10 000 tests and 1.4/10 000 tests (Level 3, Grade B).

Interpretation of evidence and justification

There is strong evidence that maximal exercise stress testing has an extremely low risk of precipitating fatal and nonfatal events in either asymptomatic individuals or people with established cardiovascular disease. The low level of risk in healthy individuals should be underlined, given the important information on maximal aerobic power, peak aerobic power, and (or) exercise capacity obtained from testing. The benefits of maximal stress testing far outweigh the associated risks at all ages, particularly in healthy individuals; concerns regarding the risks of stress testing as sometimes expressed by ethics review committees of academic institutions are no longer justified.

Recommendation no 2: Regular PA or exercise is recommended across the lifespan for individuals with and without cardiovascular disease. Such activity reduces the risks of fatal and nonfatal cardiovascular events by 25%–50%. The benefits of being physically active far outweigh the transiently increased risk of cardiovascular events seen during and immediately following acute bouts of PA or exercise (Level 2, Grade A).

Interpretation of evidence and justification

There is overwhelming evidence that routine PA or exercise is associated with lower premature mortality and morbidity. Seminal review articles, conferences, and Consensus Panel meetings have all shown the efficacy of habitual PA in the primary, secondary, and (or) tertiary prevention of more than 25 chronic medical conditions. Although the risk of cardiovascular events is transiently increased after a bout of PA (particularly if the intensity of effort exceeds 6 METs), the overall risk in the active individual is markedly lower than that which would have been observed if the person had chosen to remain physically inactive. It is also important to highlight the fact that the risk of adverse events in physically active or fit individuals during exercise remains lower than the baseline (at rest) risk seen in physically inactive pople.

Recommendation no. 3: The PAR-Q and PARmed-X should be used without age restriction (Level 3, Grade A).

Interpretation of evidence and justification

The risk of developing cardiovascular disease and many other chronic conditions increases with age, and an individual's age is therefore often included in risk-stratification schemes (see hypertension discussion, below). However, regular PA benefits people across the entire lifespan, from toddlers to the elderly (Paterson and Warburton 2010; Timmons et al. 2007), and the risk of an exercise-related event is extremely low at all ages; thus, the benefits far outweigh the risks of exercise-related cardiovascular-related events throughout life. Similar arguments apply to other chronic conditions; again, regular PA yields substantial net health benefits across the lifespan. There is, therefore, no compelling evidence to support restriction of the PAR-Q to people 15–69 years of age. Recommendation 3 (and its incorporation into the PAR-Q+ and ePARmed-X+) will remove an unnecessary barrier to becoming active for individuals who are likely to benefit greatly from an increase in their habitual PA.

Recommendation no. 4: That appropriately qualified exercise professionals be permitted to advise further clients who answer yes to 1 or more of the PAR-Q questions. The revised clearance process should include standardized probing questions and guidelines, allowing the exercise professional to stratify the client's risk status and provide appropriate PA and (or) exercise recommendations (Level 4, Grade A).

Interpretation of evidence and justification

Qualified exercise professionals play an important role in the testing and training of both asymptomatic and symptomatic populations (as discussed below). People who answer yes to 1 or more questions on the current PAR-Q are automatically referred to a physician for further assessment. However, this process is unnecessarily conservative, considering the training, knowledge, and expertise of qualified exercise professionals, the health benefits of being physically active, and the substantial risks associated with an inactive lifestyle. We accept the recommendations of Goodman et al. (2011) and Jamnik et al. (2007), which would allow appropriately qualified exercise professionals to advise further participants who are screened out by the PAR-Q, either recommending unrestricted PA or guiding them to an appropriate PA prescription and (or) further investigation. This recommendation reduces barriers to PA and helps to alleviate the strain currently placed on physicians by frequent medical referrals. However, we cannot endorse this provision for fitness personnel who have not met the minimal qualifications of an exercise professional, and who have not demonstrated the core competencies and defined knowledge base needed for these important decisions (see below).

Consensus review: arthritis, osteoporosis, and back problems

Arthritis (mainly rheumatoid and osteoarthritis), osteoporosis, and lower back pain affect a significant proportion of Canadian society, with respective prevalence rates of 15%, 6%, and 21% (Lim et al. 2006; Osteoporosis Canada 2010; Statistics Canada 2010). Each of these conditions imposes a significant financial burden on the health care system, and has a major impact on an individual's well-being and quality of life. There is increasing evidence that PA has a favourable influence on diseases of the musculoskeletal system. As reviewed by Chilibeck and colleagues (2011), improvements in health status have been shown in those living with osteoarthritis (Talbot et al. 2003; Taylor et al. 2007; Vuori 2001), osteoporosis (Vuori 2001), and chronic lower back pain (Taylor et al. 2007; Vuori 2001); regular PA is now accepted as playing an important role in the secondary and tertiary prevention of musculoskeletal conditions.

Chilibeck et al. (2011) evaluated 111 articles on adverse PA-related events in people with arthritis, osteoporosis, and lower back pain. Their systematic review indicates quite low risks of adverse PA-related events (approximately 3%–11%). Given the substantial benefits of regular PA in most of these conditions, there is now compelling support for the promotion of PA for such individuals. However, as established by Chilibeck et al. (2011) (and supported by the Consensus Panel), there are specific precautions that exercise and other allied health professionals should take when working with such people.

Recommendations: arthritis, osteoporosis, and back problems

Based on the literature, systematic reviews, the data presented at the consensus conference, and other materials, the Consensus Panel makes the following recommendations with respect to PA, exercise training, and stress testing in people living with arthritis, osteoporosis, and (or) lower back pain.

Recommendation nos. 5a and 5b: Arthritic patients with well-controlled disease and no evidence of progressive joint damage may engage in a wide range of both weight-bearing and nonweight-bearing physical activities. Patients with advanced disease (stage III or IV) or radiological evidence of severe joint damage should focus on nonweight-bearing activities and avoid heavy load-bearing (Level 2, Grade A). Individuals with recently diagnosed arthritis and those who are experiencing an acute flare-up of their condition should engage in activities that limit further worsening of their condition (Level 3, Grade B).

Interpretation of evidence and justification

Chilibeck and coauthors (2011) offer limited evidence of absolute contraindications to PA in arthritis; the health benefits of regular PA clearly outweigh the risks. Nevertheless, we support the recommendations of Chilibeck and colleagues (2011) — that relative contraindications to PA be considered carefully in people with arthritis. Limited research supports the need to restrict certain types and intensities of activity for some categories of arthritic individuals, and the new ePARmed-X+ takes these relative contraindications into account. Particular caution is required if the disease is advanced (stage III or IV) and (or) there is radiological evidence of severe joint damage. Such individuals should avoid heavy and high-intensity load-bearing activities. In contrast, individuals with stable or quiescent arthritis with no evidence of progressive joint damage are at lower risk and are free to engage in a wide range of PAs. Caution should be shown with recently diagnosed arthritis and when there is an acute flare-up of the condition.

Recommendation no. 6: Patients with osteoporosis should avoid trunk flexion (Level 2, Grade A) and powerful twisting movements of the trunk (Level 3, Grade C).

Interpretation of evidence and justification

Chilibeck and coauthors (2011) found limited information on the risks associated with PA in people living with osteoporosis. Adverse PA-related events were encountered in approximately 11% of such people; general musculoskeletal pain was the most frequently reported event, followed by fractures and other orthopaedic complications. Despite such risks, the benefits of PA far outweigh the risks for most patients with osteoporosis (Chilibeck et al. 2011). A variety of aerobic and muscle-strengthening activities can be performed safely; we support the recommendations of Chilibeck et al. (2011) for light to moderate PA, increasing progressively based on the individual's response. We recognize (as did Chilibeck and colleagues (2011)) that there is also evidence supporting the safety and efficacy of higher intensities of PA

in people with osteoporosis, provided that increases in intensity are gauged to the individual's tolerance. Limited data suggest that flexion and powerful twisting movements of the trunk should be avoided, owing to the potential for fractures (particularly vertebral compression fractures) (Sinaki and Mikkelsen 1984).

The work of Chilibeck and colleagues (2011) represents a major step forward in the process of risk stratification, allowing the development of effective exercise prescriptions for people with osteoporosis. We have incorporated some of these authors' findings into other recommendations in this consensus document (e.g., for SCI and pregnancy). These recommendations are now included in the PAR-Q+ and ePARmed-X+. Further research in this field is warranted to clarify the risks associated with specific types of PA.

Recommendation nos. 7a and 7b: People with SCI and osteoporosis of the lower limbs should avoid maximal-intensity PA (particularly maximal-strength testing with electrical stimulation) of the lower limbs (Level 3, Grade C). Individuals with SCI who do not have recent osteoporotic fractures can participate in progressive lower-limb resistance training, cycling, and ambulation with functional electrical stimulation and (or) body-weight-supported treadmill training (Level 2, Grade A).

Interpretation of evidence and justification

There is an increased risk of lower-limb osteoporosis in people with SCI (Fattal et al. 2011; Lazo et al. 2001; Scott et al. 2011; Shojaei et al. 2006). Chilibeck et al. (2011) note various case studies of PA-induced fractures in such individuals. The risk is greatest with interventions that involve high-intensity exercise induced by electrical stimulation; adverse events seem to be minimal for individuals who engage in submaximal exercise involving functional electrical stimulation and (or) body-weight-supported treadmill training. High-volume functional electrical stimulation may partially reverse bone loss (Frotzler et al. 2008). Therefore, the Consensus Panel supports the recommendations of Chilibeck et al. (2011) regarding the prevention of adverse PA-related events in people with SCI and osteoporosis.

Recommendation no. 8: People with nonspecific chronic low back pain but without serious underlying pathology (i.e., no history of back surgery, spondylolysis, spondylolisthesis, neurological symptoms, inflammatory or infectious conditions, or spinal fractures) can safely perform various progressive PAs. However, we recommend that initially such individuals avoid high-impact PA, heavy resistance training and (or) extreme trunk flexion, extension, or rotation in a direction that induces pain (Level 2, Grade B).

Interpretation of evidence and justification

There is compelling evidence to support the health benefits of regular PA in people living with chronic back pain who do not have a serious underlying pathology (i.e., a history of previous back surgery, spondylolysis, spondylolisthesis, or neurological symptoms) (Chilibeck et al. 2011). Exercise interventions have often reduced pain and (or) disability in individuals with chronic back pain (Dundar et al. 2009; Friedrich et al. 1998; Frost et al. 1998; Shirado et al. 2010; van der Velde and Mierau 2000). As reviewed by Chilibeck and colleagues (2011), the incidence of adverse PA-related events is approximately 7%, but the serious adverse event rate is only 0.06%. Common and mild adverse events are increased back or leg pain and back stiffness. The recommendation to avoid high-impact PA, heavy resistance training and (or) extreme trunk flexion, extension, or rotation that induces pain is based on a small, yet compelling, body of literature. The Consensus Panel accepts the recommendations of Chilibeck et al. (2011), and the new PAR-Q+ and ePARmed-X+ incorporate these recommendations.

Recommendation no. 9: Patients with acute low back pain (for more than 2 days and less than 4 weeks) can safely undertake preference-based PA (i.e., PA that does not induce pain), including low back extension and flexion (Level 2, Grade B).

Interpretation of evidence and justification

Evidence examining the effectiveness of routine PA or exercise interventions in individuals with acute low back pain (for more than 2 days and less than 4 weeks) is limited (Chilibeck et al. 2011). Current information suggests that patients can safely perform PAs that do not induce pain, including trunk flexion and (or) extension. A small body of literature suggests that pain may be relieved and functional ability enhanced when such activities are combined with heat-wrap therapy. Further research is warranted to confirm these recommendations, which do not extend to people with serious spinal pathologies (such individuals were excluded from existing trials).

Recommendation no 10: People with subacute low back pain (for 4–8 weeks) but without serious underlying pathology can safely perform PAs that include walking, cycling, stretching, trunk and limb strengthening, and progressive strength and postural training of the back and abdominal muscles (Level 2, Grade B).

Interpretation of evidence and justification

Limited studies suggest that PA is safe and effective in people with subacute (for 4–8 weeks) lower back pain but without serious underlying pathology. We support the recommendations of Chilibeck and colleagues (2011); a wide range of PAs can be performed by such individuals, and the benefits of PA outweigh the risks. However, further research is required to identify more clearly the optimal means of reducing pain and improving functional status in those with subacute back pain.

Recommendation nos. 11a and 11b: People with spondylolisthesis or spondylolysis can safely perform progressive strength and postural training of the back and abdominal muscles (Level 2, Grade A). However, athletes with these conditions should cease strenuous sport participation for at least 3 months (Level 3, Grade A).

Interpretation of evidence and justification

There is little literature on the health benefits of PA in people with spondylolisthesis or spondylolysis. Further research is needed to elucidate fully the risks of PA for such individuals. Preliminary evidence supports the health benefits of carefully controlled PA (such as postural training on the back and abdominal muscles), but it also suggests that strenuous sport participation should be avoided for at least 3 months. The Consensus Panel supports the recommendations of Chilibeck et al. (2011) regarding PA in people with spondylolisthesis or spondylolysis.

Recommendation no. 12: One year after surgery for disc herniation, people can safely perform isometric abdominal and back exercises, progressive aquatic programs (e.g., water aerobics), and dynamic back or hip extension and abdominal exercises (Level 2, Grade B).

Interpretation of evidence and justification

As with other back conditions, there is limited information on the safety and effectiveness of PA following surgery for disc herniation. However, 2 randomized controlled trials were conducted at least 1 year after lumbar disc surgery (Brox et al. 2006; Manniche et al. 1993). Other retrospective analyses have shown that such surgery does not limit sport or work-related activity, at least in young individuals (Dollinger et al. 2008; Ozgen et al. 2007). A variety of activities can be performed with a minimal risk of adverse PA-related events (Chilibeck et al. 2011). However, caution is needed because certain types of activity can cause a transient aggravation of pain in the lower back or legs. We support the recommendations of Chilibeck and colleagues (2011) for the initiation of PAs involving isometric abdominal and back exercise, with the progressive addition of other activities.

Recommendation no. 13: Pregnant women with low back pain can safely perform aquatic exercise (e.g., water aerobics), low-impact aerobics, and pelvic muscle exercises (Level 2, Grade A).

Interpretation of evidence and justification

The health benefits of PA during pregnancy are well established, and clearly outweigh the transient immediate risks (Charlesworth et al. 2011). However, special precautions are required during pregnancy (Charlesworth et al. 2011; Wolfe et al. 1989). Careful consideration must be given to minimizing the risk of worsening the lower back pain that is common during pregnancy, although studies involving pregnant women with low back pain have reported no adverse events (Chilibeck et al. 2011). Indeed, various forms of PA (e.g., aquatic exercise, low-impact aerobics, and pelvic muscle exercises) reduce pain, disability, and (or) the number of sick days in pregnant women.

Consensus review: cancer of any kind

Considerable evidence links physical inactivity to site-specific cancers, particularly of the breast and colon (Lee 2003; Monninkhof et al. 2007; Physical Activity Guidelines Advisory Committee 2008; Rockhill et al. 1999; Sesso et al. 1998; Shephard and Futcher 1997; Thune and Furberg 2001; Warburton et al. 2010). Physical inactivity has also been linked to an increased risk of other cancers, including endometrial cancer (Cust et al. 2007; Warburton et al. 2010). Habitually active individuals are thought to have a 20%–40% reduction in the risk for cancers of the breast and colon (Lee 2003; Physical Activity Guidelines Advisory Committee 2008; Warburton et al. 2010). A recent systematic review (Warburton et al. 2010) found strong evidence (Level 2, Grade A) from high-quality studies that the risks of breast and colon cancer were 20% and 30% lower, respectively, when the most active or fit group was compared with the least active or fit group. Most studies examining the association have found a dose-dependent relationship. Monninkhof et al. (2007) reported a 6% lower risk of breast cancer for each additional hour of PA performed per week. Collectively, these studies support the view that 150 min of moderate- to vigorous-intensity PA per week is effective in reducing the risk of cancer (Warburton et al. 2010).

A growing body of literature also supports the health benefits of regular PA or rehabilitation in people with established cancer (Brown et al. 2003; Jones 2011). Considerable research has evaluated the effectiveness of home-based and (or) supervised exercise training on both psychological and physiological well-being (Adamsen et al. 2003; McKenzie 1998; McKenzie and Kalda 2003; Segal et al. 2003; Warburton et al. 2006*a*). Studies have involved mainly breast cancer patients undertaking endurance or combined endurance and resistance training (with the patients adhering to guidelines for healthy adults) (Jones 2011). Primary outcomes have included aerobic fitness, musculoskeletal fitness, various biochemical markers, fatigue, and psychosocial factors (such as quality of life and depression). The most consistent findings have been positive changes in aerobic fitness, quality of life, and fatigue (Jones 2011). Recent investigations have demonstrated that increased PA is associated with a decreased recurrence rate and (or) risk of death from breast and colon cancers (Haydon et al. 2006; Holmes et al. 2005; Meyerhardt et al. 2006*a*, 2006*b*; Pierce et al. 2007). Self-reported habitual PA in women with metastatic breast cancer is an important predictor of survival (Cunningham et al. 1998).

Despite a paucity of high-quality studies, the risks associated with PA appear to be exceptionally low in patients living with cancer, including those currently undergoing treatment (Jones 2011).

Consensus recommendations: cancer

Recommendation no. 14: There are few absolute or relative contraindications to PA in cancer patients. However, absolute contradictions include extensive skeletal or visceral metastases and anaemia (Level 2, Grade C).

Interpretation of evidence and justification

There are few data to indicate an increased risk of adverse PA-related events in people living with cancer (Jones 2011), unless there are extensive skeletal or visceral metastases. Marked anaemia may also increase risk. Questions currently included in the PAR-Q should capture individuals at high risk. However, the current PARmed-X does not consider the contraindications associated with cancer. Accordingly, the oncology-specific clinical decision trees developed by Jones (2011) have been incorporated into the new PAR-Q+ and ePARmed-X+, assisting exercise and other health care professionals in the risk stratification of cancer patients (Jones 2011).

Recommendation no. 15: The type of cancer that has been diagnosed should be incorporated into the risk stratification of cancer patients. Patients at higher risk include those with pulmonary and bronchogenic carcinomas, multiple myeloma, and head and neck cancers; the risk of adverse PA-related events is increased in such patients (Level 4, Grade C).

Interpretation of evidence and justification

The systematic review of Jones (2011) demonstrates the

low overall incidence of adverse PA-related events in patients with cancer; however, it also shows an increase in this risk in certain types of cancer. In particular, greater caution should be taken in patients with pulmonary and bronchogenic carcinomas, multiple myeloma, and head and neck cancers. We accept the recommendations of Jones (2011) regarding the referral of high-risk cancer patients to physicians or appropriately trained health care professionals. As with other high-risk populations, PA programing will be recommended in a supervised environment involving medical oversight and qualified exercise professionals.

Recommendation no. 16: Effective risk stratification in cancer patients should take into account whether the patient is currently receiving treatment for their neoplasm. Individuals receiving such treatment are at higher risk and should be referred to a physician or other allied health professional for further evaluation. The patient may be cleared for supervised exercise training if such an evaluation is unremarkable (Level 3, Grade C).

Interpretation of evidence and justification

Cancer therapy can have wide-ranging effects on the cardiovascular system, thus increasing the risk of an adverse PA-related event (Jones et al. 2007). As reviewed by Jones (2011), the adverse myocardial effects of such chemotherapies as anthracyclines and newer targeted therapies (including trastuzumab and bevacizumab) have increasingly been demonstrated (Hamada et al. 2006; Ho et al. 2010; Simbre et al. 2005; van der Pal et al. 2010; Zuppinger and Suter 2010). A recent review by an expert panel of the International Society for Geriatric Oncology stated that the risk of cardiotoxicity with conventional anthracyclines is increased by such factors as older age; the history or current presence of heart failure or cardiac dysfunction; hypertension, diabetes, and coronary heart disease; previous treatment with anthracyclines; and short infusion duration and higher cumulative dosages (Aapro et al. 2011). The majority of patients with cancer are older, they have been heavily pretreated, and they often exhibit a range of comorbid conditions (Jones 2011). Moreover, many cytotoxic therapies induce marked anaemia, with a direct adverse impact on exercise tolerance. Therefore, patients currently undergoing cancer therapy require special consideration.

The Consensus Panel supports the various components of the cancer decision trees proposed by Jones (2011), particularly the higher-risk category assigned to individuals currently receiving cancer therapy. Individuals answering yes to related questions on the new PAR-Q+ will complete the ePARmed-X+. Through probing questions (based on the decision trees), these patients will be stratified (via the ePARmed-X+) to either intermediate- or high-risk categories. Intermediate-risk patients will be currently receiving cancer therapy, but will have visited their physician recently, discussed becoming more physically active, and have unremarkable test results; they will be advised to visit a qualified exercise professional for an individually tailored PA program. Individuals considered at high risk will receive recommendations regarding supervised clinical exercise rehabilitation in consultation with their physician and under the direction of an exercise or other appropriately trained allied health professional.

Recommendation no. 17: Effective risk stratification in cancer patients should take treatment into account. Individuals who have previously received chemotherapy, in particular anthracyclines, should be considered to be at moderate risk (Level 3, Grade C).

Interpretation of evidence and justification

Treatment with anthracyclines and high cumulative dosages are often associated with cardiovascular complications. As reviewed by Jones (2011) and others (Aapro et al. 2011; Scully and Lipshultz 2007), these complications may only become manifest years after the initial diagnosis and conclusion of drug treatment. In conjunction with the findings on the cardiovascular systems (as discussed by Thomas and colleagues (2011)) and the associated risk continuum, the Consensus Panel supports risk stratification for cancer patients. Those who have previously received chemotherapy are at low to intermediate risk of a PA-related adverse event. Questions regarding previous chemotherapy are therefore incorporated into the new ePARmed-X+. Patients who have not received previous chemotherapy are considered to be at low risk.

Recommendation no. 18: Evidence strongly supports the health benefits of PA in people with cancer. The benefit/risk ratio markedly favours a recommendation of regular PA for such individuals (Level 2, Grade B).

Interpretation of evidence and justification

There is compelling evidence that PA benefits all cancer patients (Jones 2011). Regular PA confers both physiological and psychosocial benefits, and observational trials have demonstrated a reduced risk of cancer recurrence and premature mortality in physically active patients. The incidence rates of adverse PA-related events are also low, so that benefits outweigh transient immediate risks. Caveats to this evidence are the fact that current information is based mainly on large clinical trials with advanced supervision (often involving qualified exercise professionals, physicians, and other allied health professionals), and existing investigations have had stringent entrance requirements. Further scientific inquiry is needed to assess the generalizability of these findings to patients who engage in PA outside of such trials.

Consensus review: cardiovascular disease

Thomas et al. (2011) identified 166 papers related to exercise testing and training in patients with cardiovascular disease, and they considered 154 articles for this review.

Symptom-limited exercise testing in patients with cardiovascular disease

Thomas et al. (2011) underline the importance of symptom-limited exercise testing in identifying clinical symptoms, the individual's response to exercise, and the development of an appropriate and effective exercise prescription. Compelling research shows the predictive value of peak or maximal aerobic power in the primary, secondary, and tertiary prevention of cardiovascular disease and premature mortality (Myers et al. 2000, 2002). Thomas et al. (2011) also note an ongoing debate regarding the need for exercise testing in patients with established cardiovascular disease. Their findings highlight the fact that information provided by symptom-limited exercise testing extends well beyond traditional clinical

outcomes (electrocardiography abnormalities, chest pain, shortness of breath). Indeed, an individual's exercise capacity is a more powerful predictor of mortality than traditional cardiovascular risk factors (Kavanagh et al. 2002; Myers et al. 2002). Other submaximal exercise tests also predict premature mortality in patients with established vascular disease (McDermott et al. 2008), supporting arguments for the value of making a direct assessment of physical capacity (Canadian Association of Cardiac Rehabilitation 2009).

Increased PA or exercise participation in patients with cardiovascular disease

Thomas et al. (2011) outline strong evidence of the health benefits associated with exercise rehabilitation and (or) increased PA in people with cardiovascular disease. They point out that the risks associated with becoming more physically active appear to be greatest in those who have not engaged in regular PA or exercise, and least for those who have already participated in supervised exercise programs (whether based in an exercise facility, a home, or the community). The risk associated with engaging in light- to moderate-intensity activity is very low for individuals with a peak aerobic power greater than 5 METs (or >17.5 $mL \cdot kg^{-1} \cdot min^{-1}$). The favourable balance of risks and benefits seems to be similar for men and women, with health benefits becoming apparent after individuals engage in both aerobic and resistance-type activities. The Level of Evidence supporting these claims is very strong (consistently Levels 1 and 2).

On the basis of their systematic review, a risk continuum was created for people with established cardiovascular disease, allowing further refinement of the PARmed-X questions. Factors influencing risk are medical stability; completion of a cardiac rehabilitation program without adverse exercise-related events, or current participation in PA (e.g., walking) for more than 20 min at least 3 times per week without eliciting such symptoms as angina, palpitations, or shortness of breath; a peak aerobic power >5 METs; and being younger than 75 year of age. Individuals at the lowest risk were deemed able to participate in low- to moderate-intensity PA with minimal supervision. Those at intermediate risk were able to participate in PA under the guidance and (or) advice of a qualified exercise professional; medically supervised exercise programs were recommended for higher-risk individuals.

Hypertension

Thomas et al. (2011) identified 50 papers related to hypertension, exercise testing, and exercise training. A summary of the various randomized controlled trials and meta-analyses supports the ability of both habitual PA and exercise training to reduce blood pressures in individuals with elevated resting pressures. The Level of Evidence is very strong (Levels 1 and 2). Exercise training in hypertensive individuals reduces average systolic blood pressure by 3 to 5 mm Hg and diastolic blood pressure by 3 mm Hg. Those at the highest risk appear to benefit most from regular PA. The benefits outweigh the risks for individuals with high normal pressures (prehypertensive) through Stages 1 and 2 hypertension (provided there are no cardiovascular comorbidities). However, limited evidence suggests that there is an increase in the risk of an adverse PA-related event in people with hypertension (Levels 3 and 4). Guidelines developed using expert opinion and clinical judgment recommend caution when resting pressures exceed 200 mm Hg systolic and 110 mm Hg diastolic. Expert opinion suggests classifying individuals with blood pressures >200/110 mm Hg as being at high risk, relative to individuals with normotension, although the risk of an adverse event remains quite low.

Chronic heart failure

Chronic heart failure (CHF) is a complex and often lethal disorder affecting a significant proportion of North Americans (Thom et al. 2006; Warburton et al. 2007*b*; Wilson 2001). It is a clinically significant burden in patients with hypertension and coronary artery disease (Rich 2005; Warburton et al. 2007*b*). Some 500 000 Canadians are currently affected by CHF, and another 50 000 cases are diagnosed each year (Ross et al. 2006). In the United States, approximately 5 million people have CHF, and more than 550 000 new cases are diagnosed each year (Canadian Cardiovascular Society 2001; Thom et al. 2006). The 5-year survival rate is low (approximately 45%–50% (Ross et al. 2006)), with an annual mortality rate between 5% and 50%, depending upon the severity of CHF (Canadian Cardiovascular Society 2001). The peak aerobic power of individuals with CHF is often less than 50% of healthy age-matched people; not uncommonly, peak aerobic power values drop to 12 to 15 $mL \cdot kg^{-1} \cdot min^{-1}$ (Haykowsky et al. 2005; Myers et al. 2000). Breathlessness, early muscular fatigue, and exercise intolerance are hallmark symptoms (McKelvie et al. 1995; Piña et al. 2003), resulting from abnormalities in cardiac, vascular, skeletal muscle, and autonomic function (Warburton et al. 2007*b*).

Thomas and colleagues (2011) identified 92 papers related to heart failure and PA. Exercise test guidelines (Piepoli et al. 2006*a*, 2006*b*, 2006*c*) demonstrated a poor prognosis for individuals with a peak aerobic power of less than 10 $mL \cdot kg^{-1} \cdot min^{-1}$; those with a peak aerobic power of 18 $mL \cdot kg^{-1} \cdot min^{-1}$ or greater had a better prognosis (Thomas et al. 2011). Further information is needed regarding prognosis if peak aerobic power lies between 10 and 18 $mL \cdot kg^{-1} \cdot min^{-1}$. Thomas and colleagues (2011) acknowledge a lack of information about the safety of exercise testing in patients with CHF.

As reviewed by Thomas et al. (2011) and others (Braith and Beck 2008; Meyer et al. 2004; Warburton et al. 2007*b*), exercise training may reduce morbidity and premature mortality in CHF. Most investigations have studied patients with a New York Heart Association classification of I, II, or III; a risk reduction of at least 30% is seen with regular PA, with the greatest advantage being seen in older and more impaired individuals (Goebbels et al. 1998; Thomas et al. 2011). Exercise training also improves health-related quality of life (Davies et al. 2010; Tyni-Lenné et al. 1998). Patients who fail to improve their exercise capacity with training have a poor prognosis (Tabet et al. 2009).

The review of Thomas and colleagues (2011) (based on 81 articles) suggests that exercise training is safe and effective in CHF, with a very low incidence of adverse PA-related events. Both moderate-intensity aerobic and resistance training programs lead to health benefits; vigorous-intensity interval training is also safe and effective in rehabilitation (Safiyari et al. 2005; Wisløff et al. 2007). Existing studies were predominantly conducted in well-supervised medical settings, with

appropriately trained health care professionals (often including qualified exercise professionals) in attendance. There is some evidence that home-based exercise interventions are safe and effective (Safiyari et al. 2005), although the magnitude of benefit seems less under these conditions (Haykowsky et al. 2005; McKelvie et al. 2002). As with directly supervised programs, a medical team (including qualified exercise professionals) generally monitors carefully the progress of home-based interventions.

Arrhythmias

Thomas and colleagues (2011) note the debate regarding the prognostic value of exercise-induced ventricular arrhythmias during stress testing and exercise training. Early work suggested that malignant ventricular arrhythmias were not predictive of the risk of complications during maximal stress testing (Young et al. 1984). In fact, Young et al. (1984) found that none of a series of clinical variables commonly considered to be associated with an increased risk during exercise (decreased left ventricular function, high-grade ventricular arrhythmias before or during exercise, exertional hypotension, and ST depression) predicted PA-related complications (Young et al. 1984). Apparently healthy endurance-trained athletes also have a substantial prevalence of electrocardiographic abnormalities (Maron and Pelliccia 2006); however, the risks of adverse exercise-related events in endurance-trained athletes remain unclear. Exercise training studies are inconclusive regarding the risks associated with exercise-induced arrhythmias. Thomas et al. (2011) reviewed a series of studies (largely Level 3 Evidence) demonstrating that patients with arrhythmias that are generally regarded as nonlethal (such as unifocal premature ventricular contractions and nonsustained atrial fibrillation) can exercise without increased risk.

Recommendations: cardiovascular disease

Based on the literature, systematic reviews, the data presented at the consensus conference, and other materials, the Consensus Panel makes the following recommendations with respect to PA, exercise training, and stress testing in individuals with cardiovascular disease (including high blood pressure, arrhythmias, and (or) CHF).

Recommendation no. 19: Symptom-limited exercise testing provides important information in the development of effective exercise prescriptions for patients with cardiovascular disease (Level 3, Grade B).

Interpretation of evidence and justification

Symptom-limited exercise testing provides an ideal setting for creating individualized exercise prescriptions for people with cardiovascular disease. Determinations of peak aerobic power and time to exhaustion provide independent assessments of the risks of premature cardiovascular-related morbidity and mortality. Assessment of exercise capacity during a symptom-limited exercise test is, thus, highly recommended for patients with cardiovascular disease.

Recommendation no. 20: Symptom-limited exercise testing as a means of identifying the risk of adverse events while participating in PA is a matter of judgment (Level 3, Grade C).

Interpretation of evidence and justification

The symptom-limited exercise test provides valuable information on the risks of a cardiovascular-related event and premature mortality, and therefore is important when stratifying patients with cardiovascular disease. A person with a low maximal (or peak) aerobic power is at increased risk. However, the literature is unclear as to how much additional insight the test results provide into a participant's risk of an adverse PA-related event. One could argue intuitively that the stress test assists in the definition of this risk, but data supporting this contention are currently limited.

Recommendation no. 21: A risk continuum may be established, based on criteria that include the medical stability of the patient, a demonstrated ability to engage in regular PA (60 min or more per week at moderate intensity) or to participate in supervised exercise rehabilitation, the level of maximal or peak aerobic power, and age younger than 75 years (Level 2, Grade B).

Interpretation of evidence and justification

Effective risk stratification of patients with established cardiovascular disease is important to both patients and clinicians. Barriers to PA created by the PAR-Q and PARmed-X instruments are not warranted for many lower-risk individuals with cardiovascular disease. Nonetheless, these individuals should complete the PAR-Q before commencing an exercise program; by default, this has meant that currently a physician must clear them for unrestricted PA (irrespective of whether they were previously physically active or had been engaged in formal cardiac rehabilitation). The recommendations provided by Thomas and colleagues (2011) represent a major step forward in the secondary prevention of cardiovascular disease, demonstrating criteria that can be used to stratify risk. Based on their decision tree, consideration must be given to medical stability, completion of a cardiac rehabilitation program without adverse exercise-related events or current participation in moderate-intensity PA for at least 60 min per week without adverse symptoms, and a maximal (or peak) aerobic power exceeding 5 METs (>17.5 $mL \cdot kg^{-1} \cdot min^{-1}$).

The Consensus Panel accepts the recommendations of Thomas and colleagues (2011) for the risk stratification of patients with cardiovascular disease, and has adopted this stratification in the new PAR-Q+ and ePARmed-X+. Individuals who are not medically stable, not currently physically active, and who have an aerobic power of less than 5 METs are considered to be at the highest risk; such individuals will be referred to a physician for further assessment before becoming much more physically active, and even after receiving medical clearance, they will be advised to exercise under the direct supervision of a qualified exercise or other allied health care professional. These individuals would be considered to be at a higher risk for PA-related adverse events, requiring further evaluation before becoming more physically active. Individuals at intermediate risk will be cleared for low- to moderate-intensity PA under the supervision and guidance of a qualified exercise professional, without direct referral to a physician. Individuals at low risk will be cleared for unrestricted PA, with the recommendation to consult a qualified exercise professional periodically. It is anticipated

that this change in practice will greatly reduce barriers to PA in people with cardiovascular disease.

Recommendation no. 22: Individuals with high normal pressures (prehypertension) through Stage 1 or 2 hypertension who are free of cardiovascular comorbidities should be encouraged to exercise. Further evaluation and caution is advisable for those with very high resting systolic (200 mm Hg) and (or) diastolic (100 mm Hg) blood pressures, and (or) for those with other cardiovascular disease risk factors or comorbidities (Level 1, Grade A).

Interpretation of evidence and justification

There is very strong evidence (Levels 1 and 2) that the health benefits of routine PA far outweigh the transient risks associated with PA in people living with systemic hypertension; however, certain hypertensive individuals require further probing and clinical judgement. Those with very high resting blood pressures, other cardiovascular disease risk factors, and (or) comorbidities may be at an increased risk of an adverse event, and they need special attention. Pending further evidence, they will be classified as being at higher risk.

Recommendation no. 23: A risk continuum may be established for people with systemic hypertension, based on the medical stability of the patient, resting blood pressures, medication usage, the presence of additional cardiovascular disease risk factors, comorbidities, and age older than 75 years (Level 4, Grade C).

Interpretation of evidence and justification

Risk stratification is important in hypertension. For most patients, the health benefits of PA far outweigh the transient risks associated with PA. People with hypertension may not have been previously captured by the PAR-Q, but if identified when undergoing fitness assessment (as in the CPAFLA), they would have been referred back to a physician for medical clearance. Creation of a risk-stratification strategy will reduce such referrals, diminishing barriers to PA for those with hypertension.

The systematic review of Thomas et al. (2011) and other research indicates an effective strategy for assigning patients to lower-, intermediate-, and higher-risk categories. The decision tree provided by Thomas et al. (2011) is based on the medical stability of the patient, resting blood pressures, medication usage, the presence of additional cardiovascular disease risk factors and (or) comorbidities, and age older than 75 years. This method of risk stratification is adopted in the new PAR-Q+ and the ePARmed-X+. Those at high risk will require medical clearance prior to exercise, and their activity will be performed under the direct supervision of an appropriately trained exercise or other allied health care professional. Those at intermediate risk will be cleared for low- to moderate-intensity PA under the guidance and (or) advice of a qualified exercise professional, without direct referral to a physician. Individuals at low risk will be cleared for unrestricted PA, with a recommendation to consult a qualified exercise professional periodically. The risk stratification for higher-risk individuals is currently based on limited evidence, and clinical judgement remains the best practice for such individuals, until further information becomes available. We assign, collectively, a Level 4, Grade C recommendation for the risk-stratification process because information related to higher-risk individuals is limited. However, this does not negate overwhelming research demonstrating the low risks and major benefits of PA in people with hypertension.

Recommendation no. 24: A risk continuum may be established for people living with CHF, based on their clinical status. People with CHF are at intermediate risk if they are medically stable with a New York Heart Association classification of I or II, they are currently physically active (e.g., walking) for more than 20 min at least 3 times per week without symptoms, and their maximal (or peak) aerobic power is >5 METs. Individuals not meeting these criteria are at higher risk (Level 2, Grade B).

Interpretation of evidence and justification

Individuals with CHF benefit greatly from regular PA or supervised cardiac rehabilitation. These benefits clearly outweigh the transient risks of an adverse PA-related event. The Consensus Panel accepts the recommendations of Thomas and colleagues (2011) for risk stratification in CHF, and this strategy is adopted in the new PAR-Q+ and ePARmed-X+. Individuals with a history of CHF or significant ventricular dysfunction who are medically stable, physically active, and who have a maximal (or peak) aerobic power >5 METs are considered to be at intermediate risk. Such patients can be cleared for low- to moderate-intensity PA under the guidance and (or) advice of a qualified exercise professional, without direct referral to a physician. Individuals in the highest-risk category will be referred to a physician (ideally a cardiologist or an internal medicine specialist) for discussion about becoming much more physically active. Once they receive medical clearance for unrestricted PA, they should exercise under the direct supervision of an appropriately qualified exercise or other allied health care professional. It is anticipated that this change in practice will greatly reduce barriers to PA in people with CHF.

Recommendation no. 25: A risk continuum may be established for patients with cardiac arrhythmias, based on their type. Nonlethal arrhythmias, such as unifocal premature ventricular contractions and nonsustained atrial fibrillation, indicate an intermediate risk of an adverse PA-related event, provided that the patient is medically stable and is currently engaging in PA for more than 20 min at least 3 times per week. Individuals who are not medically stable or who have other types of arrhythmias are at higher risk (Level 3, Grade C).

Interpretation of evidence and justification

There is limited evidence on the risks of adverse PA-related events in people with cardiac arrhythmias. Available literature (largely Level 3) indicates that patients with nonlethal arrhythmias can engage in PA without increased risk. Given the core knowledge required when working with such patients (particularly an understanding of the potential complications associated with cardiac arrhythmias), best practice recommends that exercise and other health care professionals who work with such individuals have a detailed understanding of arrhythmias. If the patient is medically stable, has a nonlethal arrhythmia, and is currently active for more than 20 min at least 3 times per week, he or she is considered to be at intermediate risk. Individuals who are medically unstable and (or) have life-threatening arrhythmias are considered to be at high risk, at least until further research has been con-

ducted on such individuals. High-risk patients will be referred to a physician (ideally a cardiologist) for evaluation before becoming much more physically active.

Consensus review: metabolic disorders

Metabolic disorders have an enormous impact on health and well-being (Riddell and Burr 2011). They may arise from either congenital or acquired defects of organs critical to effective metabolism, particularly the liver and pancreas (Riddell and Burr 2011). This discussion focuses on conditions with the largest population-attributable risks: diabetes mellitus, prediabetes, and the metabolic syndrome. The Canadian Diabetes Association estimates that more than 9 million Canadians are living with diabetes or prediabetes (Canadian Diabetes Association 2011). More than 3 million have diabetes (10% type 1 and 90% type 2), and 6 million have prediabetes, identified by above-normal blood glucose levels (Canadian Diabetes Association 2011). Diabetes is associated, in turn, with an increased incidence of cardiovascular disease, kidney disease, blindness, amputations, and premature mortality (Canadian Diabetes Association 2007). It accounts for more than 8% of all deaths in the United States and Canada (Roglic et al. 2005). People of Asian, South Asian, and Aboriginal descent appear to be at increased risk of type 2 diabetes, compared with Caucasians (Canadian Diabetes Association 2007); this reflects a complex interaction between environmental factors and genetic predisposition (Abate and Chandalia 2007). Risk is increased 3- to 5-fold in those of Aboriginal descent (Canadian Diabetes Association 2007). The prevalence of type 2 diabetes in North America seems likely to increase markedly over the next few years because of increasing obesity rates, an aging population, and immigration of vulnerable ethnic groups (Riddell and Burr 2011); a 7% increase of diagnosed diabetes is likely by 2016 (Ohinmaa et al. 2004).

Regular PA can play a significant role in the primary, secondary, and tertiary treatment of type 2 diabetes (Warburton et al. 2006*a*, 2007*e*, 2010). Such activity also benefits individuals with the metabolic syndrome, prediabetes, and type 1 diabetes, facilitating weight loss and improving body composition (Kriska et al. 2003; Warburton et al. 2001*a*, 2001*b*). It can significantly improve glucose tolerance and insulin sensitivity, independent of changes in body mass and body composition (Ivy et al. 1999; Kriska 2003), and it can also enhance psychological well-being (Warburton et al. 2007*e*). PA interventions are particularly effective in reducing the risk of developing diabetes in high-risk individuals (e.g., those who are overweight and (or) exhibit impaired glucose tolerance) (Tuomilehto et al. 2001; Williamson et al. 2004). Nevertheless, as discussed by Riddell and Burr (2011), people with metabolic disorders are at increased risk of cardiovascular disease and related comorbidities. Thus, special consideration is needed when prescribing PA for such individuals (Warburton et al. 2007*a*, 2007*c*).

The electronic database searches of Riddell and Burr (2011) identified more than 4 100 articles on metabolic disorders. Of these articles, 355 were eligible for further review, 47 met inclusion criteria, and 35 were specifically related to adverse PA-related events in metabolic disease. Randomized controlled designs were adopted in some 45% of these studies. Collectively, more than 6 500 individuals were studied, and the health benefits of PA overwhelmingly outweighed the risks (Riddell and Burr 2011).

Recommendations: metabolic disorders

Recommendation Nos. 26a and 26b: People with common metabolic disorders (prediabetes, diabetes mellitus) should be specifically identified on the PAR-Q+ and ePARmed-X+, given the well-established associated risks of cardiovascular disease and related comorbidities (Level 2, Grade A). A qualified exercise professional may assist with this process of risk stratification (Level 4, Grade C).

Interpretation of evidence and justification

The risk of an adverse PA-related event is very low in people with metabolic disorders such as prediabetes and diabetes. However, there is strong evidence that such individuals are at an increased risk of cardiovascular disease and related comorbidities. Therefore, caution is needed when screening them prior to their becoming much more physically active and (or) engaging in a fitness appraisal. Given the high prevalence of metabolic disorders in Canadian society, the population-attributable risk (Katzmarzyk et al. 2000), and unique associated complications (particularly in diabetes), we support the recommendations of Riddell and Burr (2011) to include questions specific to these conditions in the PAR-Q+ and ePARmed-X+. We also support recommendations regarding the role of qualified exercise professionals in risk stratification and (or) exercise prescription for individuals with metabolic disorders. As outlined by Riddell and Burr (2011) and others (Warburton et al. 2007*a*, 2007*c*, 2010), exercise professionals require a thorough understanding of the unique complications associated with PA in the face of various metabolic disorders.

Recommendation nos. 27a to 27d: Individuals with prediabetes should be screened for both traditional and atypical signs and symptoms of cardiovascular disease before initiating a new PA program because of their increased risk of cardiovascular disease (Level 1, Grade A). If there are no signs or symptoms of cardiovascular disease, individuals with prediabetes or the metabolic syndrome require no additional screening before initiating a low- to moderate-intensity PA program; the risk of adverse events associated with low- to moderate-intensity PA is low in asymptomatic prediabetic individuals (Level 2, Grade A). If there are typical or atypical symptoms of cardiovascular disease, then physician screening for coronary artery disease is required before undertaking any activity more vigorous than brisk walking (Level 2, Grade A). Higher-intensity PA should be avoided, at least initially, by previously inactive middle-aged and older individuals with prediabetes or the metabolic syndrome, as such activity may place them at an elevated risk of acute myocardial infarction and sudden death (Level 4, Grade C).

Interpretation of evidence and justification

As reviewed by Riddell and Burr (2011), the risk of an adverse PA-related event is remarkably low in people with common metabolic disorders such as prediabetes and diabetes. However, such individuals are at an increased risk of cardiovascular disease and related comorbidities. Therefore, caution

is needed when screening them before they become much more physically active and (or) engage in a fitness appraisal. This is particularly salient given the widespread media promotion of "quick fix" boot-camp-style programs that involve high-intensity training of overweight and obese individuals without the necessary supervision by a physician, allied health professional, and (or) qualified exercise professional.

There is limited evidence on the safety and effectiveness of high-intensity training among people with prediabetes. Interval training has recently been advocated as an effective means of improving health status in prediabetes (Earnest 2008). A randomized controlled study that used university-trained and qualified exercise professionals revealed that prediabetic individuals without established heart disease had no increased risk of adverse PA-related events during interval training, relative to volume-matched moderate-intensity exercise (Warburton et al. 2004). This recommendation may be tempered in the future, as more information becomes available on the safety and effectiveness of high-intensity training in prediabetics.

Recommendation nos. 28a and 28b: Youth with prediabetes or the metabolic syndrome should be considered to be at low risk of an adverse event if they become more physically active (Level 3, Grade B). These individuals need no additional screening for cardiovascular disease before initiating low-, moderate-, or vigorous-intensity PA (Level 4, Grade C).

Interpretation of evidence and justification

The risk of an adverse event is very low in children and youth, even if they have prediabetes and (or) the metabolic syndrome (Riddell and Burr 2011). Moreover, there is very strong evidence of the health benefits of regular PA in such individuals. The benefits of PA clearly outweigh the risks, and barriers to PA should be minimized. Accordingly, the Consensus Panel supports the recommendations of Riddell and Burr (2011).

Recommendation nos. 29a to 29c: Middle-aged and older people with type 2 diabetes mellitus should be considered to be at higher risk of cardiovascular disease events and sudden cardiac death (Level 1, Grade A). Because of this risk, more advanced screening should be conducted before beginning new physical activities that are more vigorous than brisk walking (Level 3, Grade A). All people with type 2 diabetes who have signs or symptoms suggestive of cardiovascular disease should seek medical approval before initiating new activities more vigorous than brisk walking (Level 4, Grade C).

Interpretation of evidence and justification

The recommendations of Riddell and Burr (2011) highlight the increased risk of cardiovascular disease and sudden cardiac death in individuals with diabetes, a risk that increases with age and in males. However, this does not negate the importance of regular PA in reducing morbidity and premature mortality in type 2 diabetics. The current recommendation of more rigorous screening for those interested in participating in vigorous PA is warranted until more information is available. As with CHF (Wisløff et al. 2007) and coronary artery disease (Warburton et al. 2005), it is likely that future research will evaluate more closely the health benefits and risks of higher-intensity activity, possibly reducing this conservative approach. Riddell and Burr (2011) also underline the fact that despite referring some patients to physicians, barriers to PA should be reduced in many diabetics who (under international guidelines) would previously have been sent automatically for medical clearance.

Recommendation nos. 30a and 30b: In individuals with type 2 diabetes who have been diagnosed with or who have signs or symptoms of cardiac or peripheral vascular disease, or who have signs and (or) symptoms of microvascular complications (retinopathy, nephropathy, peripheral or autonomic neuropathy), vigorous aerobic exercise should be performed only after an initial medical assessment that includes an exercise stress test and electrocardiography evaluation (or alternative imaging) (Level 4, Grade C). In those with inducible coronary ischemia, following medical clearance, PA should ideally be performed under appropriate supervision (e.g., a cardiac rehabilitation program that has qualified exercise professionals on staff) to reduce the risk of mortality and morbidity from cardiovascular disease (Level 4, Grade C).

Interpretation of evidence and justification

Based on a critical evaluation of the risks of comorbidities in individuals with type 2 diabetes, the Consensus Panel supports the recommendations of Riddell and Burr (2011). Further research is needed to evaluate the risks associated with PA in diabetics with established (or symptoms of) cardiac and peripheral vascular disease, and (or) microvascular complications. Until such evidence is available, our risk-stratification strategy will follow the recommendations of Riddell and Burr (2011), which considers people with diabetes and comorbidities to be at higher risk and refers them to a physician for medical clearance and exercise under appropriate supervision by a qualified exercise professional.

Recommendation nos. 31a to 31c: No exercise restrictions should be placed on previously physically inactive people with type 1 diabetes if they are younger than 30 years (or older than 30 years with a diabetes duration of less than 10 years) and are free of the symptoms of cardiovascular disease and diabetes-related complications; in such individuals, the risk of clinically significant adverse events, with the exception of hypoglycemia, is low (Level 3, Grade C). Individuals with signs and symptoms of cardiovascular disease should be sent to a physician for cardiovascular screening before beginning activity more vigorous than brisk walking. (Level 3, Grade C). For all individuals with type 1 diabetes, vigilance is required to avoid PA-associated hypoglycemia, as the risk of this is high (Level 2, Grade A).

Recommendation no. 32: For previously inactive people with type 1 diabetes older than 30 years with a diabetes duration of 10 years or more, or with any micro- or macrovascular complications, activities more vigorous than brisk walking should be suspended, pending medical follow-up that includes exercise stress testing for cardiovascular disease (Level 4, Grade C).

Interpretation of evidence and justification

The Consensus Panel supports the recommendations of Riddell and Burr (2011). Evidence to date does not support the need for barriers to PA for previously inactive people with type 1 diabetes who are free of cardiovascular disease

and other comorbidities. However, type 1 diabetics with signs of cardiovascular disease and (or) comorbidities are considered to be at higher risk, and should be referred to a physician, with any recommended PA performed under appropriate supervision of a qualified exercise professional.

Recommendation no. 33: Vigorous-intensity PA (but not low to moderate PA) should be suspended in individuals with either type 1 or type 2 diabetes mellitus who have autonomic dysfunction or polyneuropathy until they have been evaluated medically (Level 4, Grade C).

Interpretation of evidence and justification

Riddell and Burr (2011) offer preliminary evidence and expert opinion supporting a conservative approach to PA in diabetics with autonomic dysfunction or polyneuropathy, at least until more information is available. Preliminaries should include medical referral and an exercise stress test, where feasible. As with other recommendations on metabolic disorders, there remains an urgent need for further investigation, with detailed reporting of any PA-related adverse events.

Recommendation nos. 34a to 34e: For patients with diabetes, it is advisable to have their retinal status assessed by an ophthalmologist or experienced optometrist before starting a new PA program (Level 4, Grade C). In most individuals with nonproliferative retinopathy, no additional PA restrictions are required (Level 3, Grade B). Those with severe nonproliferative or proliferative retinopathy should have a clinical evaluation, which may include a graded exercise test with electrocardiography and blood pressure monitoring, before beginning any activity more vigorous than brisk walking or cycling (Level 4, Grade C). After appropriate screening, people with severe diabetic nonproliferative retinopathy or proliferative diabetic retinopathy should avoid strenuous aerobic or resistance activity that raises the systolic pressure above 170 mm Hg, particularly when vitreous haemorrhage and (or) fibrous retinal traction is present (Level 3, Grade B). Activity should be suspended, pending screening by an ophthalmologist, if there is worsening preproliferative or proliferative retinopathy, because of the elevated risk of retinal detachment and (or) vitreous haemorrhage (Level 4, Grade C).

Interpretation of evidence and justification

As reviewed by Riddell and Burr (2011), retinopathy is a common microvascular complication of diabetes that may result in blindness. It is not clear whether PA can worsen retinopathy, but there is concern that related increases in systolic pressure and (or) physical movement may exacerbate the condition (Aiello et al. 2001). In particular, there is concern about the aggravation of vitreous (retinal) haemorrhage in patients with advanced retinopathy (Aiello et al. 2001). Therefore, careful medical monitoring of PA is needed in individuals with diabetic retinopathy.

Recommendation nos. 35a to 35c: People with diabetes mellitus (either type 1 or type 2) who have end-stage renal failure should undergo medical screening prior to initiating PA (Level 4, Grade C). After clinical evaluation, light to moderate activity can be undertaken by those with early nephropathy, but vigorous PA should be avoided (Level 4, Grade C). In those with advanced nephropathy who are undergoing dialysis, exercise testing should be performed before initiating activity more vigorous than brisk walking, but low-intensity exercise under appropriate supervision is not contraindicated (Level 4, Grade C).

Interpretation of evidence and justification

Consistent with the risk stratification developed during the PAR-Q+ project, diabetics with end-stage kidney failure must be considered to be at higher risk for cardiovascular events; they require medical evaluation prior to becoming more physically active (Riddell and Burr 2011). This recommendation is currently based largely on expert opinion (Level 4, Grade C), including that of the Consensus Panel. The findings by Riddell and Burr (2011) support the effectiveness of low- to moderate-intensity PA, if performed in a controlled setting with appropriate supervision (including that of a qualified exercise professional). Until more information is available, best practice guidelines (including the new ePARmed-X+) will recommend low- to moderate-intensity PA for this population.

Recommendation no. 36: People with diabetes mellitus (either type 1 or type 2) who have severe peripheral neuropathy should engage in PA under appropriate supervision, using appropriate footwear to lower their risk of injury from falls and the development of foot ulcers (Level 4, Grade C).

Interpretation of evidence and justification

People with diabetes are at an increased risk of peripheral neuropathy. Fortunately, regular PA appears to decrease, markedly, the risk of developing this condition (Balducci et al. 2006; Kriska et al. 1991), and Riddell and Burr (2011) found no conclusive evidence that PA worsens the condition. Regular PA decreases the risk of foot ulceration in diabetics (Armstrong et al. 2004; Lemaster et al. 2003), although there are some concerns that a sudden increase in the intensity of effort may transiently increase this risk (Kanade et al. 2006). The recommendations of Riddell and Burr (2011) are therefore prudent; PA must be adequately supervised, with an understanding of appropriate precautions (e.g., proper footwear) (Kanade et al. 2006).

Recommendation nos. 37a and 37b: No PA restrictions should be placed on individuals recently diagnosed with diabetes (either type 1 or type 2) as long as blood glucose management strategies have been initiated by their physician (Level 4, Grade C). Individuals with excessive hyperglycemia (fasting blood glucose >15 $mmol \cdot L^{-1}$) and (or) ketonuria should refrain from initiating vigorous exercise until glycemic control is re-established (Level 4, Grade C).

Interpretation of evidence and justification

There is overwhelming evidence supporting the health benefits of regular PA in the secondary prevention of diabetes (Warburton et al. 2010). Riddell and Burr (2011) note that there is limited evidence to support restricting PA in those recently diagnosed with diabetes until glucose control is effective. The vast majority of recently diagnosed persons with diabetics are advised by their physicians to initiate more PA. Therefore, such individuals would be considered to be at low to intermediate, rather than high risk, warranting the involvement of a qualified exercise professional who understands the unique exercise-related complications and can provide adequate advice and (or) supervision (Warburton et al. 2011*b*).

Recommendation no. 38: Qualified exercise professionals should have advanced training modules on exercise and diabetes mellitus, based on currently available position stands, clinical practice guidelines, and technical reviews published by various professional organizations (CSEP, American College of Sports Medicine (ACSM), American Diabetes Association, Canadian Diabetes Association, and American Heart Association) (Level 4, Grade C).

Interpretation of evidence and justification

Strong evidence supporting the health benefits of PA in people with metabolic disorders comes from many randomized controlled trials; these demonstrate the overwhelming safety and effectiveness of regular PA and structured exercise programing (Riddell and Burr 2011). However, available evidence is based largely on carefully controlled trials employing highly trained health care workers (including qualified exercise professionals). An evaluation of the core competencies required for working with diabetics strongly suggests the need for advanced training in effective exercise prescription and monitoring for people with metabolic disorders (Riddell and Burr 2011; Warburton et al. 2011*b*).

Consensus review: psychological disorders

Both epidemiological and longitudinal investigations indicate a positive association between habitual PA and psychological well-being — including enhanced mood state; increased social engagement; reduced perceived anger, depression, and anxiety; increased self-efficacy; and improvements in various indicators of cognitive function (Dunn et al. 2001; Katzmarzyk and Janssen 2004; Paterson and Warburton 2010; Warburton et al. 2001*a*, 2001*b*). However, very little research has examined the risks of PA for those with psychological disorders. As part of the PAR-Q and PARmed-X evaluation and revision, Rhodes et al. (2011) evaluated the literature on the risk of PA-related adverse events in people with cognitive or psychological disorders. They identified 50 unique research trials related to dementia ($n = 5$), depression ($n = 10$), anxiety disorders ($n = 12$), eating disorders ($n = 4$), psychotic disorders ($n = 4$), and intellectual disability ($n = 15$). A remarkably low risk of PA-related adverse events was seen, with the exception of Down syndrome patients with atlanto-axial instability. Collectively, this research supports the conclusion that the health benefits of PA greatly outweigh the associated risks, and most individuals with psychological disorders should be classified as low risk, particularly since in many of these studies evidence of naturally occurring incidental adverse events was included.

Recommendations: psychological disorders

Recommendation nos. 39a and 39b: No specific changes to the PAR-Q are necessary for individuals with dementia and other psychological disorders (including anxiety states, psychoses, and intellectual disability). People with dementia or such psychological disorders should be considered to be at low risk of an adverse PA-related event (Level 3, Grade A). Consent from a care provider or guardian is recommended for people with such conditions (Level 4, Grade C).

Interpretation of evidence and justification

A series of studies involving dementia (largely Alzheimer patients) and psychological disorders (including anxiety states, psychoses, and intellectual disability) has shown that the risks of PA are remarkably low in such individuals (Rhodes et al. 2011), even though very few studies have employed pre-exercise screening procedures. Many of the risks reported were naturally occurring adverse events, not necessarily related to PA. Therefore, as a Consensus Panel, we support the recommendations of Rhodes et al. (2011) that no further changes to the PAR-Q are required to accommodate those with psychological disorders, and that people with dementia and psychological disorders (including anxiety states, psychoses, and intellectual disability) be considered to be at low risk.

A wide range of PAs appears to offer health benefit, including resistance activities, brisk walking, cycling, functional exercises, dance, yoga, martial arts, and jogging. It remains difficult to quantify the dose–response relationships between PA and psychological well-being and cognitive function (Dunn et al. 2001; Paterson and Warburton 2010). Careful examination of the literature suggests that current rehabilitation guidelines (as employed in cardiac settings) are appropriate; this finding informs the recommendations provided to patients with low-risk psychological conditions who complete the ePARmed-X+. Both the PAR-Q+ and ePARmed-X+ include provisions for a designate to complete the risk-screening process on behalf of someone with a psychological disorder.

Recommendation no. 40: The PAR-Q and (or) PARmed-X for populations with Down syndrome require addition of an item to screen for atlanto-axial instability (Level 4, Grade C).

Interpretation of evidence and justification

Individuals with Down syndrome generally have markedly reduced aerobic and musculoskeletal fitness, affecting their ability to undertake the activities of daily living (Mendonca et al. 2010). Various factors explain their reduced exercise capacity, including chronotropic incompetence and reduced exercise economy (Mendonca et al. 2010). There is strong support for a need to increase PA in people with Down syndrome, and there is compelling evidence of the physiological and psychosocial benefits of PA, exercise, and sport for such individuals (Birrer 2004; Mendonca et al. 2010). However, special precautions are needed in Down syndrome, since 10%–40% are affected by atlanto-axial instability, with a risk of subluxation, instability, or dislocation of the first and second vertebrae (Cremers et al. 1993; Rhodes et al. 2011). Symptomatic atlanto-axial instability occurs in at least 10% of these individuals, leading to difficulty in walking, an impaired gait, neck pain, spasticity, head tilt, sensory deficits, and hypereflexia (Alvarez and Rubin 1986).

There has been considerable debate regarding appropriate pre-exercise screening controls in Down syndrome (Birrer 2004), particularly the issue of participation in the Special Olympics in activities that may increase stress or trauma to the head or neck (American Academy of Pediatrics 1984, 1995; Birrer 2004; Cremers and Beijer 1993; Cremers et al. 1993). Various authors and organizations have advocated radiographic examination of the cervical spine for athletes who

wish to participate in higher-risk recreational and (or) sporting activities (Birrer 2004). We support the recommendation of Rhodes and colleagues (2011) to include specific questions probing atlanto-axial instability for people with Down syndrome. The follow-up questions on both the PAR-Q+ (p. 2) and the ePARmed-X+ now contain specific questions about interest in activities that impose stress on the head and neck (including bending of the neck forward and backward). Example activities include contact or collision sports (such as football, rugby, hockey, wrestling), diving, pentathlon, butterfly stroke in swimming, high jump, soccer, and gymnastics.

Consensus review: respiratory conditions

Respiratory conditions affect a large proportion of Canadian society. The Public Health Agency of Canada (2007) estimates that pulmonary disease (not including lung cancer) accounts for some 6.5% of total health care costs, amounting to $5.7 billion in direct costs and an additional $6.72 billion in indirect costs. The 2 most prevalent conditions are chronic obstructive pulmonary disease (COPD) and asthma. Regular PA and structured exercise training lead to significant physiological and psychological benefits in COPD and asthma. Key changes include improved exercise tolerance and overall quality of life (Eves and Davidson 2011). Becoming more physically active is, thus, widely considered to be best practice in the treatment of COPD and asthma (Eves and Davidson 2011). However, there is very little information regarding the risks associated with becoming more physically active in such patients.

Eves and Davidson (2011) reviewed 102 randomized controlled trials involving people with COPD (n = 6 938), and 30 studies (of mixed methodologies) involving people with asthma (n = 1 278). Very few studies were directly designed to assess the risks of becoming more active, and many failed to report adverse events. Despite these limitations, the available evidence suggests that the risks of an adverse PA-related event are quite low in both COPD and asthma, particularly if adequate screening, qualified exercise personnel, and optimal medical therapy are in place. Of the adverse events observed, the majority were musculoskeletal or cardiovascular in nature.

Recommendations: respiratory conditions

Recommendation no. 41: To help identify people with respiratory disease (who may not be aware of their condition), questions asking if an individual has a diagnosis of respiratory disease or if respiratory symptoms are experienced during or following exertion (i.e., shortness of breath, chest tightness, wheeze, or cough) should be added to the PAR-Q+ (Level 4, Grade C).

Interpretation of evidence and justification

Eves and Davidson (2011) outline the low risks of PA-related events in COPD and asthma. However, they acknowledge possible unique complications that warrant consideration prior to becoming more physically active. The current PAR-Q lacks questions related to respiratory disease, and people with a respiratory condition could receive clearance without visiting their physicians. We realize that this is unlikely in clinical practice, but it is a potential limitation of the current PAR-Q. This is of particular importance for individuals at higher risk of adverse PA-related events (such as those with cardiovascular or microvascular complications, including arrhythmias, angina, pulmonary hypertension, and high blood pressure; those currently receiving supplemental oxygen therapy; and those with uncontrolled asthma). We support the recommendation of Eves and Davidson (2011) to include a respiratory-specific question on the new PAR-Q+, together with probing questions in the ePARmed-X+, to stratify risk in respiratory disease.

Recommendation nos. 42a and 42b: Individuals with respiratory disease may be considered to be at higher risk if they have significant arterial hypoxaemia ($SaO_2 \leq 85\%$) at rest and (or) during exertion, uncontrolled asthma, cardiovascular or microvascular complications, or pulmonary hypertension (Level 4 Grade C). It is recommended that such individuals seek medical screening prior to becoming more physically active; once cleared, they should exercise under the supervision of an appropriately qualified exercise or healthcare professional (Level 4, Grade C).

Interpretation of evidence and justification

Eves and Davidson (2011) outline the low risk of PA-related events in COPD and asthma. However, they acknowledged that special precautions are likely warranted when these respiratory disorders are associated with other risk indicators. To date, this conclusion is based largely on expert opinion (Level 4 Grade C), since few studies have reported adverse events. Until more evidence is available, we recommend a conservative medical clearance if there is evidence of significant arterial hypoxaemia ($SaO_2 \leq 85\%$) at rest and (or) exertion, uncontrolled asthma, cardiovascular or microvascular complications, and (or) pulmonary hypertension.

Recommendation no. 43: Ideally, people with known COPD who want to become more physically active should be evaluated with a properly supervised incremental cardiopulmonary exercise test (with electrocardiography monitoring and pulse oximetry) (Level 4, Grade C).

Interpretation of evidence and justification

Eves and Davidson (2011) note that despite the low risk of PA-related events in COPD, there is an increased risk of comorbidities (particularly cardiovascular disease) and of exertional hypoxaemia. The secondary complications of prolonged cigarette use or exposure may increase the risk of adverse events. Therefore, best practice demands exercise stress testing and medical clearance prior to becoming more physically active (Eves and Davidson 2011) or entering a rehabilitation program (Nici et al. 2006). This recommendation has not been tested systematically to date, but it is current expert opinion. Nevertheless, individuals with COPD stand to gain large benefits from regular PA; as more evidence becomes available, this recommendation may be tempered to reduce barriers to PA in COPD.

Recommendation no. 44: People with asthma should be medically stable before they become more physically active. Individuals with controlled asthma are at low risk if they become more physically active (Level 4, Grade C).

Interpretation of evidence and justification

Eves and Davidson (2011) outlined the low risk of PA-related events in well-controlled asthma. Objective indicators of good control include symptoms less than 2 days a week,

nighttime symptoms less than once per week, mild and infrequent asthma flare-ups, no missed work due to asthma, no asthma-related limitations of PA, and the use of less than 2 doses of fast-acting β2 agonists per week (Lemière et al. 2004). It is likely that the risk of an adverse PA-related event increases in individuals when asthma is not well controlled; best practice guidelines call for a conservative approach, with further medical evaluation of such individuals. However, those with controlled asthma are at a low risk, similar to that of healthy asymptomatic individuals.

Consensus review: SCI and stroke

Problems associated with physical inactivity appear to be particularly prevalent in people living with chronic conditions that limit mobility, such as SCI (Myers et al. 2007) and stroke (Gordon et al. 2004). Reduced functional capacity, increased dependence, and the inability to undertake activities of daily living are of great concern to the health and well-being of people with SCI or stroke. Patients are often deconditioned and live a physically inactive lifestyle that increases the risk for recurrence (in stroke) and the development of cardiovascular disease (in both SCI and stroke) (Gordon et al. 2004; Myers et al. 2007; Warburton et al. 2007*d*). Both SCI and stroke patients commonly have an early onset of cardiovascular disease and various secondary complications, a poor quality of life, reduced social engagement, and an increased risk of cardiovascular mortality (Gordon et al. 2004; Myers et al. 2007; Pang et al. 2007; van de Port et al. 2006; Warburton et al. 2007*d*). The prevalence of all cardiovascular risk factors is higher in both SCI and stroke patients than in normally ambulatory individuals (Gordon et al. 2004; Myers et al. 2007).

Fortunately, PA can play a significant role in the secondary prevention of SCI and stroke (Gordon et al. 2004; Myers et al. 2007; Warburton et al. 2006*a*, 2006*c*, 2007*d*, 2010). In fact, health behaviours interventions are now the cornerstone in the secondary prevention of cardiovascular disease in patients with stroke (Gordon et al. 2004) or SCI (Myers et al. 2007; Warburton et al. 2007*d*). Exercise rehabilitation yields marked improvements in the health status of people with SCI or stroke; benefits include enhanced psychological function, reduced pain, improved sensorimotor function, greater aerobic and musculoskeletal fitness, glucose homeostasis, improved lipid profiles, and improved functional status and quality of life (Gordon et al. 2004; Myers et al. 2007; Warburton et al. 2007*d*; Ivey et al. 2008; Michael et al. 2005; Pang et al. 2006), and it is now recommended for most cases of stroke or SCI (Ivey et al. 2008; Warburton et al. 2007*d*). The Consensus Panel recognizes that PA levels are low in people with stroke or SCI (Ginis et al. 2010; Lindahl et al. 2008; Michael et al. 2005); in our experience and that of others (Ginis et al. 2010), this is particularly evident in individuals who have been out of acute care for a prolonged time. People with stroke or SCI experience significant practical barriers to PA participation, and reducing these barriers is important to improving their health. However, clearance and PA recommendations must be made in a manner that maintains a high benefit-to-risk ratio.

There is very little information on the risks incurred if people with SCI or stroke becoming more physically active. Zehr (2011) evaluated these risks, limiting analysis to adequately designed trials. This yielded a total of 32 studies related to stroke (n = 730) and 4 randomized controlled trials related to SCI (n = 143). All of these investigations were conducted in a supervised environment that included trained exercise personnel (e.g., exercise professionals, physiotherapists, or occupational therapists). This review demonstrated a low overall risk of adverse PA-related events, and it also established instances in which there is a need for further medical screening and supervision of training by a qualified exercise professional.

Recommendations: stroke and SCI

Recommendation nos. 45a and 45b: People who have suffered a stroke or SCI in the previous 6 months should receive medical clearance before becoming more physically active (Level 2, Grade B). Once such clearance has been provided, they should exercise under the direct supervision of a qualified exercise professional (Level 3, Grade A).

Interpretation of evidence and justification

Current literature supports the health benefits of PA in stroke and SCI. However, there is limited evidence on the safety of becoming more active in the first 6 months after injury; the vast majority of research trials (Warburton et al. 2006*c*, 2007*d*) deal with individuals who are more than 6 months postinjury. We support the recommendations of Zehr (2011), who highlights the need for medical clearance if the lesion is recent and the requirement to exercise in a supervised environment with trained exercise personnel.

Recommendation nos. 46a and 46b: People living with stroke who are unaccustomed to vigorous exercise should only perform vigorous PA under the supervision of appropriately trained individuals (such as a qualified exercise professional) (Level 2, Grade B). The same applies to people living with SCI (Level 3, Grade A).

Interpretation of evidence and justification

Zehr (2011) and others (Gordon et al. 2004; Myers et al. 2007; Warburton et al. 2007*d*) have shown a high risk of cardiovascular morbidity in both stroke and SCI. Current evidence supports the need for supervision by specially trained personnel when initiating vigorous-intensity exercise. This conservative recommendation will continue until contrary evidence becomes available. However, it should not be interpreted as placing restrictions on people with chronic SCI who engage in such sports as wheelchair rugby, wheelchair basketball, and sledge hockey. For these individuals, medical clearance should be given prior to entering the sport, with subsequent advice provided by a qualified exercise professional.

Recommendation no. 47: Medical screening is required for stroke patients with cardiovascular comorbidities, and for individuals with SCI who have established autonomic dysreflexia or low blood pressure at rest and (or) during exercise (Level 4, Grade C).

Interpretation of evidence and justification

Owing to the risks associated with cardiovascular disease (Thomas et al. 2011), stroke survivors who exhibit cardiovascular comorbidities are considered to be at higher risk. Current

best practice calls for a further medical screening prior to their initiation of much greater PA.

Many individuals with SCI (in particular, those with tetraplegia) are at risk of both autonomic dysreflexia, and resting and (or) exertional hypotension when they engage in PA (Krassioukov et al. 2007, 2009*a*, 2009*b*). As reviewed by Krassioukov and colleagues (2007, 2009*a*, 2009*b*), both of these responses are potentially life threatening, and they require careful monitoring and evaluation. The Consensus Panel has built on the recommendations of Zehr (2011), including a risk stratification of SCI based on evidence of autonomic dysreflexia and hypotension. In such patients, medical clearance is recommended, with follow-up rehabilitation involving qualified exercise professionals (in accordance with the new clinical exercise guidelines for SCI) (Martin Ginis et al. 2011).

Recommendation no. 48: Individuals with SCI who have experienced a recurrent or recent (within the previous 6 months) musculoskeletal injury that is worsened by PA should receive medical clearance prior to becoming much more physically active, and they should exercise under the supervision of a qualified exercise professional once medical clearance has been granted (Level 4, Grade C).

Interpretation of evidence and justification

Patients with SCI report various barriers to becoming physically active (Bickel et al. 2004; Myers et al. 2007), including increased risks of musculoskeletal injury (Bickel et al. 2004) and pain. Many wheelchair-confined individuals experience chronic pain and overuse injuries, which are exacerbated by traditional physical activities involving the arms. Imbalances in muscle strength and function are common in SCI (particularly tetraplegia). If arm propulsion is not balanced, the spine and upper limbs are subject to marked strain, which may worsen pain and lead to scoliosis; this, in turn, negatively affects the ability to undertake the activities of daily living and reduces quality of life. Therefore, careful consideration must be given to providing adequate PA while minimizing the risk of musculoskeletal injury. This is reflected in new guidelines that acknowledge the need to modify PA patterns in SCI to reduce the risk of such injuries (Martin Ginis et al. 2011). Based on this evidence, the Consensus Panel recommends that the ePARmed-X+ include probing questions on musculoskeletal pain in people with SCI. This guideline (Level 4, Grade C) mandates further medical evaluation of those who are prone to musculoskeletal pain, with referral to a qualified exercise professional once medical clearance for PA has been granted. It is hoped that these provisions will allow better medical management and an optimization of the health benefits of PA for these individuals.

Consensus review (gap area): pregnancy

The original evaluation and revisions of the PAR-Q and PARmed-X focused on reducing barriers to PA in the general population and in those with common chronic disorders. However, in the process of testing the new PAR-Q+ and ePARmed-X+ during various research initiatives and validation studies conducted across Canada, and in collaboration with the Physical Activity Line (www.physicalactivity.com), it became apparent that issues of pregnancy needed to be incorporated into the risk-stratification strategy and the ePARmed-X+. The Consensus Panel thus commissioned a systematic review of the risks and benefits for pregnant women (Charlesworth et al. 2011). This review built directly on the pioneering work of the late Dr. Larry Wolfe, Dr. Michelle Mottola, and colleagues, in collaboration with the CSEP and Dr. Norman Gledhill.

Traditionally, women were often advised not to undertake PA while pregnant, on the basis that PA might cause adverse events for either the mother or the fetus. However, evidence is consistently emerging that participation in appropriate PA during pregnancy enhances health and wellness for both the mother and fetus. Wolfe and Mottola (1993) recognized the importance of PA for the mother and child, both during and after pregnancy. Pregnant women are now increasingly encouraged to maintain regular schedules of PA or, if previously inactive, to begin PA during gestation.

An important legacy of early Canadian research is the development of the PARmed-X for PREGNANCY; this instrument was designed to screen pregnant women prior to beginning PA programs. As outlined by Charlesworth and colleagues (2011), it marked a key transition in the field, providing support for the health benefits of PA during and after pregnancy (for both mother and child), a checklist of absolute and relative contradictions, and advice on appropriate exercise programs. A refined PARmed-X for PREGNANCY was published in 1996; it was revised in 2002, based on expert advice from an Expert Advisory Committee of the CSEP, chaired by Dr. Norman Gledhill.

To date, the risks associated with PA during pregnancy have not been analysed systematically, particularly in relation to the level of activity undertaken prior to a women's pregnancy. Accordingly, Charlesworth et al. (2011) completed a systematic review of adverse PA-related maternal and fetal events in women without other contraindications, relating these risks to the health benefits of PA. They identified 84 research trials that included 3 281 pregnant women. Of the 84 studies, 39% reported the presence or absence of adverse events, including pre-eclampsia, gestational hypertension, back pain, preterm labour, musculoskeletal injury, leg cramps, fatigue, nausea, and fatigue. Based on this evidence, the authors concluded that the health benefits of PA during pregnancy greatly outweighed the risk of inactivity. Women with uncomplicated pregnancies should be classified as being at low risk. Charlesworth et al. (2011) highlighted the fact that one factor contributing to the safety of PA is supervision by a qualified exercise professional. A substantial proportion of the investigations evaluated in pregnancy research to date utilized trained research personnel to implement and supervise exercise programs and (or) conduct the exercise testing (Charlesworth et al. 2011).

Recommendations: pregnancy

Recommendation no. 49: There is no evidence that previously inactive or active women (without contraindications) are at risk for adverse fetal events if they participate in routine PA throughout pregnancy. Pregnant women without contraindications should be encouraged to partake in PA throughout gestation, including a variety of moderate-intensity physical activities (e.g., walking, cycling, swimming, aerobics) (Level 3, Grade B).

Interpretation of evidence and justification

Systematic review shows that PA during gestation is associated with a low risk to the fetus in women who were previously active or inactive. With respect to physically active women, this recommendation is based on 35 studies that reported no adverse events (involving >700 000 min of exercise and >23 000 exercise sessions). With reference to previously inactive women, this recommendation is based on more than 860 000 exercise min in >18 500 exercise sessions from studies stating that no adverse events occurred, and >900 000 exercise min in >21 500 exercise sessions in all studies that investigated fetal events in women inactive prior to pregnancy. Therefore, we support the recommendation of Charlesworth and colleagues (2011), and would classify previously active or inactive pregnant women as being at low risk for adverse fetal events. Moderate to vigorous activity for 15–60 min per session (ranging from 1 to 6 sessions per week) appears to carry low risks for such individuals.

Recommendation no. 50: Pregnant women without contraindications (who were active or inactive prior to pregnancy) are at low risk for adverse maternal events if they participate in routine moderate-intensity physical activities (e.g., walking, cycling, swimming, aerobics). Pregnant women should be encouraged to partake in routine PA throughout gestation (Level 2, Grade B).

Interpretation of evidence and justification

As with fetal health, there is no evidence that PA during pregnancy increases maternal risk for women who were active or inactive prior to their pregnancy. Women without contraindications (as previously defined by Wolfe and Davies 2003) will be considered to be at low risk, based on strong evidence, including Level 2 and 3 evidence. In previously active women, this recommendation is based on evidence (Level 2, Grade A) from more than 1.7 million exercise min and close to 39 000 exercise sessions that reported the presence or absence of adverse events, and >1.9 million exercise min in >45 900 exercise sessions, including studies examining maternal events in active women. Although 10 of 45 studies reported some form of adverse event (e.g., preterm labour, back pain, musculoskeletal injury), 90% of the studies could not determine whether these events were related to PA or were naturally occurring. With respect to previously inactive women, this recommendation is based on strong evidence (Level 2, Grade B), and is supported by 34 studies. Of these, 23 reported adverse events; however, it is unclear whether these were simply naturally occurring events (preeclampsia, gestational hypertension, back pain). The above recommendation is based on more than 1.2 million exercise min, involving more than 29 000 exercise sessions. Therefore, we support the recommendation of Charlesworth and colleagues (2011), which classified pregnant women who were previously active or inactive as being at low risk for adverse PA-related events. Moderate to vigorous activity for 15–60 min per session (ranging from 1 to 6 sessions per week) appears to carry a low risk for women who were active or physically inactive prior to their pregnancy.

Recommendation no. 51: Healthy women with uncomplicated pregnancies can be risk stratified to low risk, irrespective of activity level prior to gestation (Level 3a). Further systematic evaluation is required to determine the risk of adverse exercise-related events for pregnant women with contraindications to exercise (Level 3, Grade A).

Interpretation of evidence and justification

The systematic review of Charlesworth et al. (2011) and the research of Wolfe and Mottala (1993) support the health benefits of PA in healthy women with uncomplicated pregnancies. Pregnant women will be risk stratified as being at low risk in the new ePARmed-X+, and cleared for becoming more physically active. We also endorse the recommendations of the PARmed-X for PREGNANCY, which call for a further risk stratification in individuals who carry additional risks. The Consensus Panel recommends that further research systematically address and update information concerning risks in pregnant women with relative or absolute contraindications to becoming more physically active, as identified by the PARmed-X for PREGNANCY.

Consensus review (gap area): qualified exercise professionals

As discussed in the companion systematic reviews (Chilibeck et al. 2011; Eves and Davidson 2011; Goodman et al. 2011; Jones 2011; Rhodes et al. 2011; Riddell and Burr 2011; Thomas et al. 2011; Zehr 2011), the risks associated with well-designed and appropriately supervised exercise interventions are relatively low, both for healthy individuals and for those with established chronic disease (Pavy et al. 2006). Moreover, the risk of being physically inactive far outweighs the risk of becoming more physically active and (or) participating in a well-designed and appropriately supervised training program (Warburton et al. 2010). Therefore, the reduction of barriers to PA is warranted for most individuals, and is based on a sound body of evidence. However, such a reduction of barriers must be tempered by the need to ensure safe and effective opportunities for PA.

The various reviews highlight a need for specialized training and evaluation of exercise professionals to provide appropriate programing (Franklin et al. 2009). However, the health and fitness field remains relatively unregulated, and a variety of pseudo-certifications and registrations are available, many of which do not require formal education or evaluation in clinical physiology. Information on the minimal requirements for both education and evaluation when working with various chronic disorders (particularly in Canada) is currently limited. Accordingly, this project addressed this knowledge gap, seeking evidence-based recommendations on the best practice in clinical exercise physiology. It noted the core competencies, educational attainments, and practical experience needed to serve such individuals safely and effectively, and it provided insight into the medico-legal requirements of being considered a qualified exercise professional.

A total of 52 articles were included in the systematic review. Much of the information consisted of expert opinion from various influential groups and organizations. Overall, current literature supports the need for qualified exercise professionals to possess advanced certification and education in the exercise sciences, particularly when dealing with at-risk populations. Current literature also substantiates the safety and effectiveness of exercise-physiologist-supervised stress testing and training in clinical populations. The low risk of

exercise routinely demonstrated in clinical trials seems to be the result of appropriate supervision and exercise prescription by qualified exercise professionals working as an integral member of the allied health team.

Recommendations: qualified exercise professionals

Recommendation no. 52: Clinical exercise stress testing can be conducted by qualified exercise physiologists (i.e., university-trained exercise physiologists with advanced training and certification), provided that a physician and emergency response equipment are readily available (Level 2, Grade A).

Interpretation of evidence and justification

Clinical exercise stress testing was once thought to be safe and effective only when conducted directly by a specially trained physician. However, considerable evidence (Levels 2 to 3) has shown no significant difference in outcomes between direct physician- and nonphysician-administered clinical exercise stress testing. Paramedical staffing (including qualified exercise professionals) does not appear to increase the risk of clinical stress testing, provided that appropriate training, resources, and emergency procedures are available (Shephard 1991). The qualified exercise professional possesses appropriate advanced training and certification to serve clinical populations, working in close collaboration with a physician and often other allied health professionals.

Recommendation no. 53: Qualified exercise professionals should be trained to deliver patient-centred care, work in an interdisciplinary team, utilize evidence-based practice, employ quality improvement and control processes, and make use of information technology to improve patient care (Level 4, Grade C).

Interpretation of evidence and justification

Despite challenges in regulating the field of clinical exercise physiology, qualified exercise physiologists are increasingly recognized as integral and often essential members of an interdisciplinary health care team (Brehm et al. 1999; Rutledge et al. 1999; Tong et al. 2001), and they are now required to meet the standards and level of qualifications found in other allied health professions. The above recommendation is consistent with the views advanced by the Institute of Medicine (Greiner and Knebel 2003) in their critical evaluation of the core competencies required by health care professionals. These core competencies (reflected in the recommendation above) appear relevant for all health care professionals (regardless of their basic discipline) (Level 4, Grade C).

Recommendation no. 54: Qualified exercise professionals should possess a series of discipline-specific core competencies before working with higher-risk conditions, such as pregnancy and various chronic diseases (Level 4, Grade C). These core competencies include

1. an in-depth knowledge of the acute and chronic responses and adaptations to PA in both healthy and clinical populations
2. a clear understanding of the influence of commonly used medications on response to PA
3. an understanding of the effects of various comorbidities on the response to PA
4. a comprehensive knowledge regarding the design and implementation of safe and effective exercise prescriptions for patients with chronic disease, functional limitations, and (or) disabilities
5. a critical, in-depth understanding of diagnostic stress testing protocols and procedures
6. an ability to interpret both resting and exercise 12-lead electrocardiograms and rhythm strips
7. a knowledge of effective risk-factor stratification and modification
8. an ability to provide haemodynamic and electrocardiographic monitoring by telemetry
9. effective skills in health-behaviour modification, education, and counselling
10. the ability to measure resting and exercise blood pressure accurately by auscultation
11. a thorough knowledge of the indications and contraindications to PA
12. an ability to determine when to terminate exercise testing or training
13. an ability to respond to emergency situations (including the provision of effective cardiopulmonary resuscitation and automated external defibrillation, as appropriate)
14. an ability to create and (or) respond to a written emergency plan appropriate to the testing and training facility
15. an understanding of the behavioural change model and strategies that need to be considered and appropriately applied when working with patients.

Interpretation of evidence and justification

Various position statements (based largely on expert opinion) have been created and refined as evidence has increased. A careful review of available literature has revealed a series of core competencies that are needed when working with various common clinical conditions. No adequately designed studies have conclusively determined the complete requirements. However, based on the systematic review and consistent expert statements, we maintain that the above recommendations provide a prudent basis for the training of appropriately qualified exercise professionals. Explicit in this recommendation is the need for advanced training and clinical evaluation to ensure the safety of higher-risk individuals who are seeking to become more physically active.

Recommendation no. 55: Graduates of exercise science programs destined for clinical employment should complete a clinical internship (Level 4, Grade C).

Interpretation of evidence and justification

Although not yet adopted by all advanced certifying bodies, various experts (Franklin et al. 2009) and professional organizations (such as ACSM and CSEP) have advocated the inclusion of clinical internships in the preparation of exercise professionals. This recommendation matches the standards expected of other allied health professions, where intensive clinical case studies and supervised clinical practice must continue over a prolonged time (Selig 2008). Nevertheless, this recommendation is based largely on expert opinion, since no study to date has compared the aptitude of exercise

professionals who have completed clinical internships with that of those who have not.

Recommendation no. 56: Practical skills in clinical exercise testing and prescription should be tested directly (Level 4, Grade C).

Interpretation of evidence and justification

Allied health professions have increasingly highlighted the need for advanced practical examinations. However, many certifying bodies in the exercise sciences have opted not to test "hands on" knowledge. Currently, no research has systematically compared the skills and competencies of individuals required to complete practical examinations prior to certification with those who did not have to meet this standard. Until such a comparison is made, it remains prudent to recommend the direct assessment of practical skills.

Recommendation no. 57: Physicians interested in health promotion and health behaviour modification should work in close collaboration with allied health professionals who have specialized training in these fields (including qualified exercise professionals) to optimize patient-centred care (Level 4, Grade C).

Interpretation of evidence and justification

Physicians (particularly primary care physicians) play a central role in maintaining the health of their patients (Petrella et al. 2007; Wallace and Haines 1984). Approximately 80% of the general population meets with a primary care physician at least once per year (Petrella et al. 2007), offering a major opportunity to promote healthy behaviours (Petrella et al. 2007). Unfortunately, physicians encounter a wide range of barriers that limit their ability to provide effective health behaviour counselling (Bruce and Burnett 1991; Flocke et al. 2009), including a lack of staff support and resources, limited access to educational materials, an excessive workload (limiting the time for effective health promotion counselling), and limited specialized training and knowledge regarding techniques to optimize lifestyle behaviours, such as diet and PA (McAvoy et al. 1999; Orleans et al. 1985; Petrella et al. 2003, 2007; Ross et al. 2009; Williams et al. 2004). Moreover, current fee schedules may serve as a disincentive to such initiatives. Thus, allied health professionals are increasingly taking a greater role in PA promotion and design. It is envisioned that this approach will enhance patient-centred care and reduce the current burden of PA counselling and clearance placed on physicians.

Recommendation no. 58: Qualified exercise professionals should pass rigorous, independent, ideally national-level written and practical examinations to establish their competency to work with at-risk populations (Level 4, Grade C).

Interpretation of evidence and justification

Recent advances in undergraduate training and, in particular, the development of advanced certifications for work with clinical populations (such as those provided by CSEP, ACSM, the Australian Association for Exercise and Sports Science, and the British Association of Sport and Exercise Science) have expanded the role of qualified exercise professionals in the primary prevention of chronic disease and the management of various chronic conditions. The qualified exercise professional is now an important and integral member of the allied health profession team. The present consensus process has underlined the need to train exercise professionals at a standard consistent with that of other allied health professionals who work in clinical settings. Several factors support this expert opinion, including the risks associated with serving clinical populations (see companion papers) and other conditions, such as overweight, obesity, and pregnancy (Charlesworth et al. 2011)), the necessary core competencies, and the medico-legal implications of the involvement of inadequately prepared individuals in clinical exercise physiology.

Consensus review: risk stratification and continuum recommendation

As discussed in detail by Jamnik et al. (2011) at the outset of the evaluation and revision of the PAR-Q and PARmed-X, our research collaboration sought to create a risk-stratification strategy that would allow more effective risk assessment and clearance. The authors of the systematic reviews discussed their findings in the context of a risk continuum, ranging from low to intermediate to higher risk (Fig. 1). The literature provides compelling support for such a stratification to improve patient management and ensure appropriate and safe PA or exercise prescription. Such stratification should greatly reduce barriers to PA (a principle supported by early experience with the PAR-Q+ and ePARmed-X+).

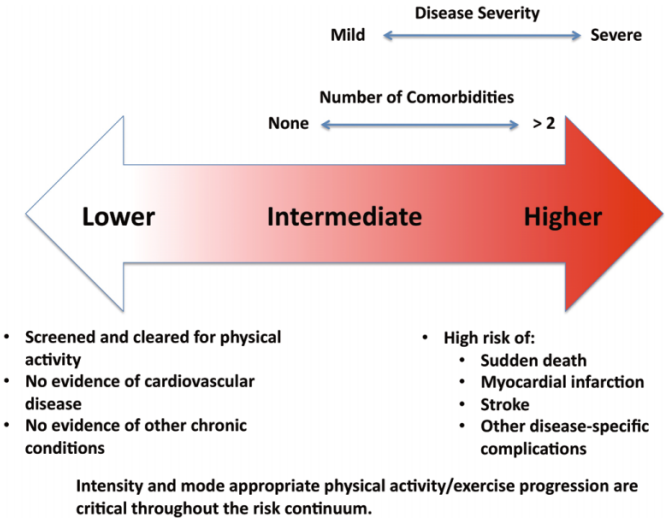
The importance of simplifying and harmonizing the information contained in the PAR-Q+ and ePARmed-X+ became apparent through feedback received from end-users. We maintain that the risk-stratification strategy and (or) continuum remains true to the recommendations of the individual authors and the literature search upon which their recommendations are based.

Recommendation no. 59: Patients considered to be at low risk may exercise at moderate intensities with minimum supervision. Those at intermediate risk should exercise after receiving guidance and (or) advice from a qualified exercise professional. Patients at high risk should receive medical clearance, and any permitted exercise should be performed in a medically supervised setting that includes a qualified exercise professional (Level 2, Grade A).

Interpretation of evidence and justification

The consensus process made apparent the fact that the previous PAR-Q and PARmed-X PA clearance process was unduly conservative, restricting many individuals who would have benefited greatly from PA. This finding was not unexpected, as the initial intent of these forms was to be purposely conservative. The new risk continuum and stratification strategy allows a greater proportion of people with chronic conditions to be reconsidered for PA without having to undergo further medical clearance (Warburton et al. 2011*a*). The first 7 questions of the PAR-Q+ ask about other chronic medical conditions; a positive response to these items can be followed up by condition-specific questions on pages 2 and 3 of the PAR-Q+ or with the ePARmed-X+ (www.eparmedx.com). The new strategy avoids medical referral of the vast majority of participants who complete the PAR-Q+ and (or) the ePARmed-X+, on the basis that the risk of adverse PA-related events, is exceptionally low in most conditions. A reduction in barriers to PA in these popu-

Fig. 1. Sample risk continuum from the consensus process.



lations, as far as is feasible, is best practice, and is supported by an overwhelmingly strong body of literature.

Areas requiring further investigation

Throughout this process, individual authors, the Consensus Panel, and various knowledge users of the PAR-Q and PARmed-X who were consulted have identified areas that need further research. Each review also discusses limitations in that field of research. Below, we have summarized some of the main areas that warrant further investigation.

Quantifying the risks associated with PA participation

More information is needed on the risks associated with exercise testing and training in both asymptomatic and symptomatic populations. Future prospective trials should report adverse events and document the specific risks associated with exercise testing and (or) training. To address this need, a national registry should be established, which will record in detail all fatal and nonfatal adverse PA-related events in asymptomatic populations and in various clinical conditions. As discussed by Goodman et al. (2011), such a registry will provide an important database to facilitate our understanding of factors that may decrease the risks associated with PA. This registry could operate in co-operation with other national registries (such as that instituted by the Canadian Association of Cardiac Rehabilitation).

Quantifying the risks associated with PA participation in children with chronic disease or disability

The consensus process recognized that there was no need to restrict the PAR-Q+ or ePARmed-X+ to people 15 to 69 years of age. The new risk-stratification strategy should allow young children with and without chronic conditions to be cleared for greater PA. However, evidence is currently limited, and for some conditions, expert opinion (based on adult data) formed the basis for this recommendation. As a Consensus Panel, we recognize the limitations inherent in this approach, and we recommend strongly that more well-controlled trials be conducted with children who have various chronic conditions to determine their risk of adverse PA-related events. This evidence will allow the individualization of the risk-stratification strategy and the tailoring of exercise prescription guidelines to the needs of the individual child.

The development of clinical practice guidelines and exercise prescriptions

There is an ever-increasing need to develop best practice guidelines in the primary and secondary prevention of chronic disease; such guidelines have become an important means of translating scientific evidence, identifying gaps in the literature, disseminating new information, and improving patient care (Tobe et al. 2011). Canada has played a leading role in the development of such guidelines, although there remains an acknowledged gap between the evidence derived from research investigations and the application of this evidence in the clinical setting (Tobe et al. 2011).

Evidence-based PA guidelines now exist for apparently healthy Canadians (Tremblay et al. 2011), but there are, as yet, no comprehensive, evidence-based guidelines for Canadians living with chronic medical conditions. End-user feedback on the new PAR-Q+ and ePARmed-X+ indicates that generic PA guidelines do not address the needs of many Canadians living with chronic conditions. With an aging population and an increasing prevalence of inactivity-related disorders, there is a clear need to develop safe and effective guidelines for various chronic conditions. Currently, most guidelines for chronic disease are based on either healthy asymptomatic guidelines or on expert opinion. Moreover, generic PA guidelines have been criticized by end-users (including individuals with chronic conditions and practitioners working with such individuals). New clinical exercise guidelines must provide more disease-specific prescriptions for use by physicians, allied health and qualified exercise professionals, and patients alike.

A follow-up initiative to the revision of the PAR-Q and PARmed-X has already been launched to meet this need. The proposed documents will go beyond traditional clinical practice guidelines, and will offer specific exercise prescriptions for various conditions, based on systematic reviews. Once these evidence-based prescriptive guidelines are available, the additional information will be incorporated into the new ePARmed-X+. Patients and their health care providers will be able to receive exercise prescriptions tailored to their unique needs. There is a plan to test these prescriptive guidelines systematically in randomized controlled trials that also monitor, directly, their impact on adverse events, short-term health indicators, and long-term morbidity and mortality rates.

Need for the international harmonization of messaging and effective knowledge translation

The knowledge gap between evidence and its clinical application is widened by a lack of international harmonization of messages. It is not uncommon for various national and international organizations to provide different messages about clinical practice recommendations and (or) guidelines (Tobe

et al. 2011), even though messaging is based largely on the same evidence (Warburton et al. 2010). There is also a lack of effective knowledge translation and implementation tools for end users. Many allied health professionals and physicians complain of inadequate continuing education and (or) resources to deal with the primary and secondary prevention of chronic disease. A rapidly changing evidence base demands resources that are dynamic in nature and that can keep pace with recent advances in the field. The PAR-Q+ and ePARmed-X+ have been developed with this in mind, and are living, dynamic documents that will be changed as the evidence base changes. Moreover, international collaboration has already been initiated to expand the utility of the PAR-Q+ and ePARmed-X+ worldwide (Warburton et al. 2011*d*).

There is now a desire to standardize the delivery of information related to the prevention and treatment of chronic disease. In Canada, there is a movement to harmonize and integrate cardiovascular disease prevention and treatment guidelines, known as the C-CHANGE (Canadian Cardiovascular HArmonization of National Guidelines Endeavour) initiative, a joint venture of the Canadian Institutes of Health Research and the Public Health Agency of Canada (Tobe et al. 2011) (spearheaded by Dr. James Stone and Dr. Peter Liu). The C-CHANGE initiative has highlighted the need to harmonize messaging across other chronic conditions, laying the foundation for the development of both clinical practice guidelines and exercise prescriptions (as discussed above).

Various organizations have attempted to address this knowledge gap by creating specific resources for practitioners and patients. The Canadian Association of Cardiac Rehabilitation has developed the Canadian Guidelines for Cardiac Rehabilitation and Cardiovascular Disease Prevention. The overall objective of this evidence-informed guideline is to "improve the clinical practice of Cardiac Rehabilitation through knowledge translation, knowledge transfer, and the professional development of health care professionals working in the field of cardiac rehabilitation, cardiology and chronic disease." The Canadian Association of Cardiac Rehabilitation has also created a serial publication, entitled "Current Issues in Cardiac Rehabilitation and Prevention". The purpose of this publication is to allow practitioners to keep abreast of advances in cardiac rehabilitation, and to learn how this evidence can be used to improve clinical practice. More recently, the CSEP Health & Fitness Program has created advanced training modules for cardiac rehabilitation professionals to ensure a consistent standard of care (in collaboration with the Canadian Association of Cardiac Rehabilitation). The CSEP Health & Fitness Program is developing similar modules for other chronic conditions, in collaboration with other disease-specific organizations (based on the evidence base developed during the current process). The popularity and acceptance of these resources underline the need for effective, harmonized messaging, and encourage ongoing initiatives related to this consensus process.

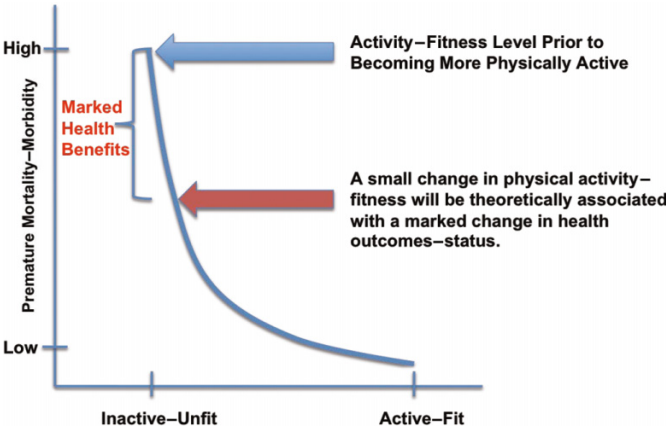
Dose–response relationships for various clinical conditions

The CSEP Health & Fitness Program (Paterson and Warburton 2010; Warburton et al. 2010) and other authors (Kohl 2001; Oja 2001) have attempted to quantify dose–response relationships between PA and health. A recent systematic review (Warburton et al. 2010) revealed clear dose–response relationships between PA and the primary prevention of premature mortality and several chronic conditions, including cardiovascular disease, stroke, hypertension, colon cancer, breast cancer, and type 2 diabetes. However, the dose–response relationships between becoming more physically active and premature mortality and morbidity in individuals with established chronic disease are less well defined. Although more PA brings marked health benefits in many chronic conditions, the dose that elicits optimal health benefits remains unclear. Randomized controlled trials using various volumes, intensities, and durations of PA are required. Gledhill and Jamnik have proposed that there are likely multiple dose–response relationships, which vary with the chronic condition and the objective outcomes that are examined (Canadian Society for Exercise Physiology 2003). We anticipate that the dose–response for most conditions (with the exception of psychological disorders) will follow a shape similar to that shown in Fig. 2. This suggests a marked change in health status with a small change in PA or fitness, indicating that the greatest risk reductions are seen at the lower end of the PA and fitness continuum (Warburton et al. 2010). As discussed above, it is not uncommon for individuals with chronic disease to have a maximal (or peak) aerobic power of only 15–20 $mL \cdot kg^{-1} \cdot min^{-1}$, less than 50% of the age-predicted value. Becoming more physically active will lead to marked health benefits for such individuals. This belief is reflected in the exercise prescriptions provided by the ePARmed-X+; these are quite distinct from guidelines for apparently healthy individuals (in particular, they start with a lower volume of exercise). More randomized controlled trials in various chronic conditions will help inform these recommendations more precisely. It should, however, be highlighted that we anticipate considerable interindividual variation in the response to training among patients.

Vigorous-intensity training in people living with chronic medical conditions

There is a transiently increased risk of cardiovascular-related events following PA, with the greatest risk seen with vigorous activities (>6 METs) (Goodman et al. 2011; Thomas et al. 2011). Moreover, expert opinion has raised concerns about the safety and effectiveness of higher-intensity training in a variety of clinical populations (such as patients with diabetes or cancer), although it remains to be determined whether these concerns are well founded. Interval training, once a largely experimental procedure conducted in highly supervised research laboratories, is now commonly employed in cardiac rehabilitation centres with specialized staff and emergency response procedures, providing another option for cardiologists, qualified exercise professionals, and patients alike (Stone et al. 2009; Warburton et al. 2005). Interval training can enhance aerobic and musculoskeletal fitness, functional status, and (or) overall quality of life (Meyer et al. 1990, 1997; Stone et al. 2009; Warburton et al. 2005; Wisløff et al. 2007). There is also strong evidence from randomized controlled trials in higher-risk populations, such as patients with CHF, that interval training may provide a

Fig. 2. Theoretical dose–response relationship between physical activity–fitness and health indicators in people living with chronic disease who become more physically active. For most people living with a chronic condition, their physical activity or health-related physical fitness (e.g., aerobic and musculoskeletal fitness) would be at the lower end of the activity–fitness continuum and at the higher end of the risk continuum. It is anticipated that there will be considerable interindividual variation in the response.



better training stimulus than traditional moderate-intensity rehabilitation (Wisløff et al. 2007). Despite this growing evidence, many physicians and researchers still hesitate to employ interval-type training in chronic conditions (as outlined in the companion papers to the present article). Riddell and Burr (2011) note that many questions need to be answered by well-designed randomized controlled studies before vigorous exercise will be accepted as an appropriate means of becoming more physically active in diabetes. Until this information becomes available, interval training will likely remain an option restricted to medically supervised rehabilitation programs that employ qualified exercise professionals with advanced training in unique diabetes-related complications.

The stance that physicians and researchers have taken against prescribing vigorous activity for people living with cancer is striking, given the literature to the contrary (Jones 2011). Current expert opinion on this topic is mixed, with many laboratories (such as those of our Consensus Panel members) employing interval training daily in various research trials. One such initiative is the world-renowned dragon boating program for breast cancer survivors, developed by Dr. Don McKenzie (entitled Abreast In A Boat), and hundreds of affiliate dragon boating programs around the world. However, other laboratories and researchers strongly oppose interval training in the rehabilitation of cancer survivors, even in medically supervised settings. What is often omitted from this discussion is the high relative intensity (Shephard 2001) of traditional programing for patients with cancer or other chronic conditions who have marked deconditioning. It is not uncommon for cancer patients to exhibit a peak aerobic power of only 15–20 $mL \cdot kg^{-1} \cdot min^{-1}$ (4.3 to 5.7 METs). Many trials have used brisk walking to improve health status in patients with cancer (Jones 2011). However, the metabolic requirement of slow to brisk walking ranges from 3 to 5, or even 6, METs (Ainsworth et al. 1993, 2000). Therefore, if brisk walking were prescribed for people with cancer, they might be exercising at a relative intensity that would be considered vigorous. Clearly, statements against vigorous training should be tempered when considering the relative intensities that have already been employed. Individuals with a maximal (or peak) aerobic power of 5.7 METs would seldom exercise at a level normally associated with increased risk for cardiovascular events (i.e., > 6 METs). The cardiac rehabilitation patient provides a good analogy; at the start of the program, he or she often cannot walk up a single flight of stairs, and brisk walking requires near maximal effort. Thus, by necessity, they are undertaking vigorous activity, often in an interval-type fasion (i.e., vigorous exercise with rest periods interspersed). Plainly, further research is warranted to establish the safety and effectiveness of vigorous-intensity training in various clinical conditions.

Need for easy-to-use risk assessment tools

Riddell and Burr (2011) outline the need for an easy-to-use risk assessment tool to assist in exercise prescription. The new risk-stratification strategy will reduce barriers to PA for many patients. However, practitioners and patients alike would benefit from a standardized risk assessment protocol that can be used in randomized controlled and clinical trials, where exercise and (or) PA is a treatment intervention (Riddell and Burr 2011). Riddell and Burr (2011) recommend this as a supplement to the current PAR-Q+ and ePARmed-X+, allowing for a clearer documentation of potentially serious adverse events (such as sudden cardiac death, marked hypoglycemia) and less serious events (such as musculoskeletal injury or soreness).

Need to revise and update the evidence base

From the start of this process, we understood the need to expand our risk-stratification strategy to include a variety of other medical conditions that affect Canadians. The Consensus Panel recognized that it could not review systematically all chronic conditions that may be affected positively by becoming more active (Warburton et al. 2011*d*). We therefore made an executive decision to focus on the most common conditions with significant population-attributable risks. Currently, the PAR-Q+ and ePARmed-X+ have a series of probing questions that allow for people with various chronic conditions and pregnant women to be risk stratified and provided with recommendations PA, markedly reducing their barriers to becoming more physically active. Through the PAR-Q+ and ePARmed-X+ risk-stratification and decision-tree processes, prospective participants are cleared for PA with minimal supervision (low risk) or with the guidance and (or) advice of a qualified exercise professional (intermediate (moderate) risk), or require medical clearance prior to PA (higher risk).

Those not included in the systematic decision-tree process are given a general recommendation to receive medical clearance prior to becoming more physically active (similar to the original PAR-Q and PARmed-X). The risk of PA for these individuals is likely low, but until these conditions have been evaluated systematically, this purposely conservative approach will be maintained. International initiatives are currently underway to address current gaps in the risk-stratification process; as these systematic reviews become

available, the PAR-Q+ and ePARmed-X+ will be revised accordingly (Warburton et al. 2011*d*).

We recognize the need to update the risk-stratification strategy repeatedly, based on current evidence. Therefore, the PAR-Q+ and ePARmed-X+ incorporate a plan to update the clearance process every 5 years after its initial release.

Conclusions

There is overwhelming evidence that regular PA decreases premature morbidity and mortality. Seminal review articles, conferences, and Consensus Panel meetings have shown that habitual PA is of benefit in the primary, secondary, and tertiary prevention of more than 25 chronic medical conditions. There is evidence of a transient increased risk of cardiovascular-related events after PA; the highest risk is associated with more vigorous activities (>6 METs). Although the risk of cardiovascular events increases transiently after acute bouts of PA, the overall risks are markedly lower than what would be observed had the participant chosen to remain inactive.

The recommendations generated throughout this process (and the resultant new PAR-Q+ and ePARmed-X+) promote the high benefit-to-risk ratio of becoming more physically active, reduce the barriers to PA participation, and acknowledge appropriately the role of qualified exercise professionals in fostering healthy living and healthy behaviours.

The systematic reviews have allowed the development of an effective risk-stratification strategy that serves to reduce the barriers to becoming more physically active for most categories of individual. Patients who were once automatically sent for medical clearance can now be cleared (and often self-cleared) for PA participation. It is anticipated that this process will have a marked impact on the number of individuals who can reap the health benefits of becoming more physically active.

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