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Pre-Diabetes Detection and Intervention for High Risk Communities

Jennifer L Kuk, Shahnaz Davachi, Andrea M. Kriska, Michael C. Riddell, and Edward W. Gregg

Kuk and Riddell are with the School of Kinesiology and Health Science, Physical Activity and Chronic Disease Unit, York University, Toronto, Canada. Davachi is with Diverse Populations, Primary Care & Chronic Disease Management, Alberta Health Services. Kriska is with the Dept of Epidemiology, University of Pittsburgh, and the Diabetes Prevention Support Center, Pittsburgh, PA. Gregg is with the Epidemiology and Statistics Branch, Division of Diabetes Translation, Centers for Disease Control and Prevention, Atlanta, GA.

This article briefly summarizes the "Pre-Diabetes Detection and Intervention Symposium" that described ongoing and past pre-diabetes interventions, and outlined some considerations when deciding to target specific populations with pre-diabetes. The success of type 2 diabetes (T2D) prevention clinical trials provides clear evidence that healthy lifestyle change can prevent the development of T2D in a cost effective manner in high risk individuals. However, who to target and what cut-points should be used to identify individuals who would qualify for these T2D prevention programs are not simple questions. More stringent cut-offs are more efficient in preventing T2D, but less equitable. Interventions will likely need to be adapted and made more economical for local communities and health care centers if they are to be adopted universally. Further, they may need to be adapted to meet the specific needs of certain high-risk populations such as ethnic minorities. The Chronic Disease Management & Prevention Program for Diverse Populations in Alberta and the Pre-diabetes Detection and Physical Activity Intervention Delivery project in Toronto represent 2 examples of specialized interventions that are targeted at certain high risk populations. To reverse the current T2D trends will require continued efforts to develop and refine T2D prevention interventions.

Keywords: screening, management, treatment, economics, public health

With the increasing prevalence of individuals with type 2 diabetes (T2D), there is an equally concerning rise in the number of individuals with pre-diabetes.[1] These individuals represent a high risk population that requires intervention to halt or delay the progression to overt T2D. This article will briefly summarize the "Pre-Diabetes Detection and Intervention Symposium" that described the lessons learned from ongoing and past pre-diabetes interventions, and outlined some considerations when deciding to target specific populations with pre-diabetes.

Over the past decade, we have witnessed several landmark clinical trials aimed at T2D prevention.[2] These clinical trials have incorporated diet, physical activity, and weight loss as part of their "lifestyle" intervention strategy for the common goal of preventing T2D in high risk individuals. The Diabetes Prevention Program (DPP) is one of the best known randomized clinical trials of diabetes prevention, and was conducted in a heterogeneous group of men and women of various ethnic backgrounds. The DPP demonstrated that a 3 year diet and exercise lifestyle intervention delayed the onset of T2D and reduced the risk of developing T2D by 58%, significantly better than metformin or placebo.[3] Importantly, the lower T2D incidence for individuals in the lifestyle intervention was similar in men and women and held across all age and ethnic groups. At the study conclusion, lifestyle participants had a mean weight loss of 5.6 kg (5% of body weight), and 58% of participants were meeting the weekly goal of 150 minutes of physical activity. Even amongst those who did not meet the weight loss goal at year 1, achievement of the physical activity goal resulted in a 46% reduction in T2D incidence.

With the success of the DPP and other T2D prevention clinical trials it is now clear that healthy lifestyle behavioral change can prevent or delay the development of T2D. We are now poised to translate these clinical trials in a sustainable and community appropriate way. However, scientific evidence supporting the cost-effectiveness of *structured lifestyle interventions* is most clear when the interventions are targeted at high-risk populations. Thus, who to target and what cut-points should be used to identify individuals who would qualify for these T2D prevention programs are not trivial questions. As Figure 1 illustrates, choosing a less stringent cut-off would identify more 'at risk' individuals, and would ultimately prevent a larger number of T2D cases, but would also require more resources as it 'unnecessarily' treats individuals who would not have developed T2D. Conversely, choosing

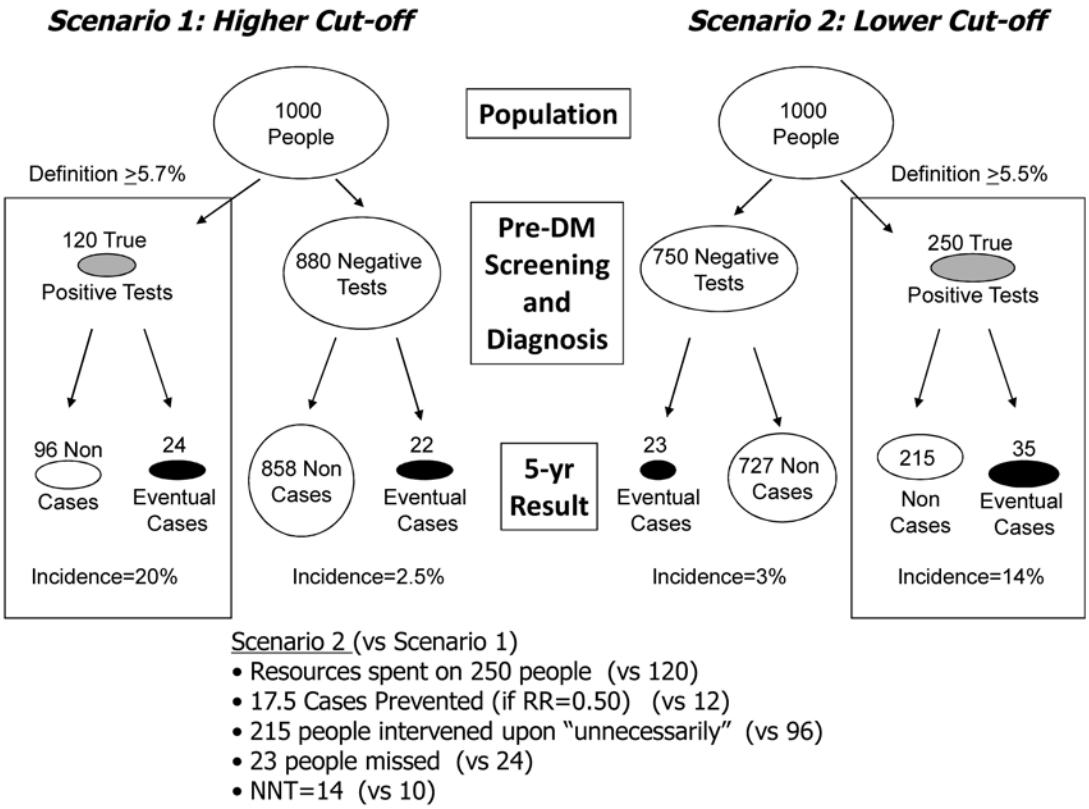

Figure 1 — Schematic illustrating the hypothetical implications of choosing a higher versus lower cut-off for pre-diabetes and initiation of T2D prevention. The figure describes the health and economic tradeoffs based on 2 hypothetical scenarios wherein 1000 adults in the general population are screened with HbA1c and people with pre-diabetes by 2 differing definitions (scenario 1:HbA1c > 5.7%; scenario 2: HbA1c 5.5%) are referred to an intervention program that reduces 5-year incidence by 50%. The number of true positive tests resulting from each scenario is based on estimates from NHANES 2005-2006 with rounding for simplicity. Incidence estimates are approximated based on results from a meta-analysis by Zhang et al.[5]

a more stringent cut-off would identify fewer 'at risk' individuals and cost less, but would miss a larger number of individuals who will eventually develop T2D. Thus, although the later model is less equitable, it is more efficient in preventing T2D. Clearly, there is no best method for screening, but the *context, capacity, and choice of* interventions will ultimately drive the thresholds for selection, diagnosis, and intervention referral.

There are some sub-populations that are in particular need of unique targeted community-based T2D prevention programs. In Canada, the rise in T2D is particularly dramatic in visible minorities (Asians, South Asians, Hispanic, and Africans), who are at significantly higher risk for developing T2D than non-Hispanic White populations.[4] This may be in part due to social, language and economic barriers that result in fewer opportunities for adequate health care or physical activity in these communities.

Since 2001, Alberta Health Services—Calgary zone, in partnership with several diverse community groups—has developed and implemented innovative, targeted and culturally competent T2D prevention and management strategies for the members of the visible minority and other vulnerable populations. The Chronic Disease Management & Prevention Program for Diverse Populations has screening and intervention programs that are delivered by multilingual and multidisciplinary teams in accessible community based sites. Currently services are available to Indo-Asian, Chinese, Vietnamese, Filipino, Spanish and homeless populations. The cultural, social and environmental differences between these groups necessitate customization and modification of the same chronic care model and approaches for relaying the same information and providing standard clinical interventions in order to meet the unique needs of each population. For example, some members of the Indo-Asian community prefer more informal and interactive class structures where participants sit on the floor with cushions, whereas some Chinese prefer a more formal classroom lecture atmosphere. Clearly, the needs of these populations extend well beyond simple language translation and targeted interventions address many complex

and often interrelated social determinants of health which impact the health of diverse and vulnerable populations.

The Physical Activity and Chronic Disease Unit at York University (Toronto, Canada) is currently embarking on a Pre-diabetes Detection and Physical Activity Intervention Delivery (PRE-PAID) project. This is an innovative 'targeted prevention' approach aimed at individuals of South Asian, East Asian and African-Caribbean descent. Participants are identified as having pre-diabetes using a unique risk algorithm and a "point of care" blood test (HbA1c measurement). These individuals then engage in a 6 month, community-based culturally preferred physical activity program facilitated by Certified Exercise Physiologists (CEPs) that have undergone comprehensive training based on a pre-diabetes and behavior change curriculum. These culturally preferred physical activity programs are aimed at improving blood glucose control and preventing T2D, but also to provide sustainable physical activity opportunities for these communities. By targeting specific populations and communities with highly trained CEPs, the likelihood of successful diabetes prevention programs should increase. The next phase of this project will involve large-scale training of exercise and health professionals across Ontario in order to increase accessibility and sustainability of similarly designed initiatives.

To reverse the current T2D trends will likely require interventions that balance both diffuse population approaches with more intensive high-risk targeted programs. Interventions will likely need to be refined and adapted to each local community and made more economical if they are to be sustainable and meet the specific needs of certain high-risk populations such as ethnic minorities. There are some novel ongoing community T2D prevention interventions, but clearly more work is needed to apply these programs to the larger populous.

Acknowledgments

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Recruiting Hard-to-Reach Populations to Physical Activity Studies: Evidence and Experiences

Nanette Mutrie, Charlie Foster, Paul Estabrooks, Nicola W Burton, and Graham Baker

Mutrie is Professor of Exercise and Sport Psychology, University of Strathclyde, Glasgow, Scotland. Foster is a University Research Lecturer & Programme Leader, University of Oxford, Oxford, England. Estabrooks is with the Translational Obesity Research Program, Human Nutrition, Foods, & Exercise, Virginia Tech, Blacksburg VA. Burton is a Heart Foundation Research Fellow, The University of Queensland, Brisbane, Australia. Baker is an Investigator Scientist with the Medical Research Council Social and Public Health Sciences Unit, United Kingdom.

Most researchers who are conducting research with a public health focus face difficulties in recruiting the segments of the population that they really want to reach. This symposium presented evidence and experiences on recruiting participants to physical activity research, including both epidemiological and intervention based studies. Results from a systematic review of recruitment strategies suggested that we know little about how best to recruit and highlighted the need for researchers to report this in more detail, including metrics of reach into the target population such as number, proportion, and representativeness of participants. Specific strategies used to optimise responses to a population-based mail survey were presented such as study promotion, survey design, multiple mailings, and personal engagement. Finally, using place based recruiting via schools or places of worship to target ethnic minority youth were discussed. Overall the symposium presenters suggested that we need to learn more about how best to recruit participants, in particular those typically under-represented, and that researchers need to apportion a similar amount of planning effort to their recruitment strategies as they do the their research design. Finally we made a plea for researchers to report their recruitment processes in detail.

Keywords: reach, ethnic minorities, low active, recruitment, mail survey

Reaching priority groups for physical activity studies, such as the least active or healthy, ethnic and other minority groups and/or the socioeconomically disadvantaged is challenging. The purpose of this symposium was to present evidence about effective methods of reaching these groups and achieving representative study samples, and to debate the use of various recruitment strategies.

Dr. Foster presented results from a systematic review of published literature of walking interventions, to identify recruitment strategy characteristics, impact and any differential effects among population groups. The review identified nearly 50 studies. The overall quality of studies was poor with little detail reported on who undertook recruitment, or how long was spent planning and implementing the recruitment phase. Recruitment was typically conducted where the intervention was delivered, or potential participants were required to attend or volunteer to participate in a specific location. There was a lack of conceptual clarity about the recruitment process and the development of a metric to evaluate the effectiveness of recruitment. This presentation concluded with the warning to fellow researchers to improve their recruitment practices so as to improve the generalizability of their results. Current approaches sustain the limitations and inequalities of our evidence base on the impact of interventions to promote walking to particular social groups.

Dr. Estabrooks followed up on Dr. Foster's call for systematic evaluation of the effectiveness of recruitment strategies by presenting common metrics to assess reach (i.e., number, proportion, and representativeness).[1] The presentation indicated that reach can be influenced by the characteristics of the (1) intervention, (2) recruitment protocol, and (3) research design. Using data from 2 ongoing studies, it was demonstrated that a technology-based physical activity intervention, relative to the target population, recruited a proportion of African American participants while using modest financial incentives (<USD 5/month) for weight loss in a worksite study significantly increased participant recruitment and reduced disparities in recruitment. From a recruitment protocol perspective, place-based strategies (ie, recruiting participants from a location where they already aggregate) resulted in a lower overall participation rate, but resulted in more representative samples.[2] Finally, data were presented that indicated research designs that include participant 'opt in' methods, such as mass advertising encouraging potentially eligible participants to respond, versus active outreach to potentially eligible participants, are significantly less likely to recruit representative samples.

A variety of strategies can be used to optimise participation in mail survey research.[3] Dr. Burton described the strategies used in a population-based longitudinal study with mid-age adults (HABITAT). The study achieved a baseline response rate of 68.5% (from 17,000 potential participants), and 74.0% at follow-up, with good representativeness when compared with census data. Participants were identified by grouping neighborhoods by socioeconomic disadvantage, and randomly sampling neighborhoods and then people within selected neighborhoods. Recruitment strategies include using a graphic and acronym on all project materials; advertisements promoting the study in local newspapers; and using surveys with colourful covers, iconic images, described as about "life and recreation for people age 40–65 years," and titled with the neighborhood name. Multiple personalized mailings were used with prenotice, survey package (with gratuity), thank you/reminder postcard, survey resend to non-respondents and final letter. Retention strategies include annual Christmas cards and biennial newsletters (with a reply paid change of address card for people intending to move), and a website showing maps of the study neighborhoods. The follow-up survey was revised to reduce sociodemographic items and include new items for those who had moved. Project challenges have included postage increases, inclement weather, and tension between outsourcing and maintaining control over activities.

Dr. Baker's presentation focussed on the recruitment phase of an obesity prevention study targeted towards ethnic minority children in the UK.[4] The DEAL study examined the appropriateness of 2 settings, schools and places of worship for; accessibility to children, engaging families and assessing social support networks across multiple ethnic groups. It was reported that recruitment of, and participants within, schools was relatively straightforward via targeting of high ethnically dense areas. Schools had appropriate facilities and staff and were receptive to the project content as this linked with school policies. However, recruitment of, and participants within, places of worship was a more complex and challenging process. Strategies including mass-mailing, cold-calling site visits and inter-faith forums were used to obtain the requisite number of sites. Both passive and active methods of recruiting families were utilised with varying degrees of success. He concluded that places of worship represent a promising approach to engage with ethnic minority families and provide tailored program support. However, the diversity in cultural and religious orientations, within ethnic groups thought to be homogeneous such as Indians, creates challenges for recruitment and evaluation. The importance of pilot studies examining these issues to inform the development of interventions was emphasized.

Discussion. This symposium underscored the importance of understanding the reach of physical activity research recruitment strategies, and the need to provide data on representativeness of those who participate in studies. Physical activity researchers should use consistent metrics of reach that include, but may not be limited to, number, proportion, and representativeness. Different research designs, such as hybrid preference/randomized controlled trial designs may be necessary

to truly address the reach of a given intervention rather than the reach of a research study. Future systematic research is needed to understand the characteristics of physical activity recruitment protocols, and research designs that result in optimal reach and representativeness for both epidemiological and intervention studies. In particular, methods to assess reach should include collection of information on those who are eligible but who decline to participate. Just as an intervention that is not effective cannot lead to public health impacts, a study with low reach and poor representativeness will also fail to provide meaningful data or promote positive change and, at worst, could contribute to an increase in health disparities.

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Physical Activity Promotion in Low- and Middle-Income Settings: Lessons From Brazil

Pedro C. Hallal, Rodrigo S. Reis, Mauro V.G. Barros, Markus V. Nahas, and Michael Pratt

Hallal is with the Federal University of Pelotas, Brazil. Reis is with the Federal University of Parana, Brazil, and the Pontiff Catholic University of Parana, Brazil. Barros is with the University of Pernambuco, Brazil. Nahas is with the Federal University of Santa Catarina, Brazil. Pratt is with the Centers for Disease Control and Prevention, Atlanta, GA.

The symposium aimed to discuss the challenges for the promotion of physical activity in low and middle-income settings by presenting some successful experiences currently taking place in Brazil. The first speaker focused on the Ministry of Health initiatives for physical activity promotion in Brazil. The second speaker discussed the importance of the GUIA project for the promotion of physical activity in Latin America. The third speaker presented school and worksite-based interventions currently taking place in Brazil. The fourth speaker presented a historical view of the field, and discussed the role of the Brazilian Society of Physical Activity and Health at promoting physical activity in the country.

Keywords: interventions, public health practice, health promotion, motor activity

In spite of the growing recognition that physical activity (PA) is good for health, alarming rates of physical inactivity are still observed worldwide. The World Health Organization reported in 2009 that physical inactivity accounts for more than 3 million deaths per year, the 4th leading underlying cause of mortality in the world. In Brazil, the scenario is not different, and the prevalence of physical inactivity has been shown not only to be high,[1] but also to be in the rise.[2] In order to help overcome this negative scenario, the Brazilian Ministry of Health, the Brazilian Society of Physical Activity and Health, individual researchers and institutions have been committed to help promote PA in the country over the last years.

A symposium took place on the 3rd International Congress on Physical Activity and Public Health aimed at discussing the challenges for the promotion of PA in low and middle-income settings by presenting some successful experiences currently taking place in Brazil.

The first speaker, Dr. Pedro C. Hallal, presented some of the initiatives led by the Ministry of Health aimed at achieving such a goal, including:

Funding for Local PA Interventions. Since 2005, the Ministry of Health has provided funding for local interventions in the field of PA and health. Currently, more than 1000 cities are funded in all regions of the country.

Implementation of a Surveillance System. In 2006, the VIGITEL (Surveillance System on Risk Factors for Chronic Disease through Telephone Interviews) started in Brazil. In each annual survey, approximately

54,000 individuals (around 2000 per state capital) are interviewed. A similar effort is now taking place with adolescents through the School Health National Surveillance System.

Networking. The Ministry of Health leads a massive network of researchers, practitioners and institutions in the country committed at increasing population levels of PA. The network also includes international partners, such as the U.S. Centers for Disease Control and Prevention (CDC).

Education and Capacity Building. As part of the agreement of funding to local interventions, the Ministry of Health promotes annual courses on the development and evaluation of PA interventions.

Evaluation Efforts. And last, the Ministry of Health is committed to evaluate ongoing PA interventions in the country, so that successful experiences can be disseminated. A key partner in this effort is the GUIA (Guide for Useful Interventions on Activity in Brazil and Latin America) project, which includes Brazilian and US universities, the Ministry of Health and the CDC.

The second speaker, Dr. Rodrigo S. Reis, presented the GUIA (Guide for Useful Interventions for Activity in Brazil and Latin America) project and its main results. Special emphasis was given to evaluations studies carried out in Recife and Curitiba. The next steps of the project were also presented, as well as some lessons learned over the years. The main contributions of this project highlighted in the symposium were:

Strengthening the Evidence on PA Interventions. Over the last 4 years project GUIA has shown that despite the lack of PA evidence-based interventions in the region there is a strong evidence that school-based physical education is an effective strategy to increase PA levels and also that innovative types of community interventions are taking place in the region.[3]

Capacity Building and Networking. The key players in the Brazilian PA scenario were identified and project GUIA has increased the collaboration between practitioners and scientists despite the barriers reported.[4] The exchange of junior and senior researchers between US and Brazil and also the use of new research methods (eg, systematic observation and social network analysis) are examples of approaches used in project GUIA to increase PA capacity building in Brazil.

The third speaker was Dr. Mauro V.G. Barros. He presented an overview of 2 large-scale interventions taking place in Brazil. First, he presented data from the 'Saúde na Boa' project,[5] a cross-cultural randomized school-based intervention aimed at promoting physical activity and healthy eating among adolescents. The 'Saúde na Boa' intervention was effective at reducing the prevalence of physical inactivity; the net percentage change in physical inactivity prevalence from baseline was 41.4%.

Secondly, he showed the logic model of the 'Lazer Ativo' project, a countrywide intervention that has been coordinated by the Brazilian Industrial Social Service, aiming to promote active and healthy lifestyles for industrial workers and their families. Comparing results from 2 statewide surveys carried out in Santa Catarina state, it was observed a reduction in leisure-time physical inactivity from 46.2% (1999) to 30.8% (2004).

The fourth speaker was Prof. Markus V. Nahas. He presented a historical view of the field in Brazil and discussed the roles of the Brazilian Society of Physical Activity and Health and the Brazilian Congress on Physical Activity and Health at promoting PA in Brazil. His final remarks mentioned the current needs and trends of this area, highlighting the tremendous development in course, with a significant partnership between the areas of Public Health and Physical Education.

The concluding remarks were from Dr. Michael Pratt. He emphasized that the Brazilian experience can be disseminated to other low and middle-income countries, which are likely to face the same challenges faced by Brazil in terms of the rapid shift from infectious to non-communicable diseases. The example of Brazil is especially interesting because of the utilization of PA as the entry point for the Ministry of Health to address the growing burden of chronic diseases. PA is an attractive focal point for public health strategies not only as a cross cutting health behavior and risk factor associated with 23 health outcomes. In addition, PA promotion programs in Brazil have focused on social mobilization, equity and synergy with movements for environmental sustainability. Thus, PA becomes the answer to a broad array of societal issues beyond disease prevention and health promotion, and can be a catalyst for multi-sectoral collaboration.

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Technology-Based Physical Activity and Exercise Interventions

Wim Stut, Annelies Goris, Jantine Schuit, and Scott Owens

Stut is with Philips Research, Eindhoven, The Netherlands. Goris is with Philips New Wellness Solutions, Amsterdam, The Netherlands. Schuit is with the National Institute for Public Health and the Environment, Bilthoven, The Netherlands. Owens is with the University of Mississippi, Oxford, MS.

Technology has the potential to greatly empower physical activity and exercise interventions. By using sensor technology, we can objectively monitor the participants' activity level or movements and provide the participants insight into their own behavior. Reasoning technology can be used to interpret the sensor data and to generate tailored feedback messages. Mobile and communication technology allow for distant coaching. And, last but not least, computer technology in general can enhance the exercise experience (eg, by embedding exercises in electronic games). This symposium presented examples of how different forms of technology have been employed to promote physical activity and exercise, as well as results on the effectiveness of these systems.

Keywords: activity monitor, Wii Fit, exercise games, activity intervention

Physical activity and exercise are essential for a healthy life. In spite of the fact that the benefits of physical activity and exercise are well-known, without appropriate support most people do not succeed in adopting and maintaining a physically active lifestyle. In recent years, a variety of computer systems and appliances have become affordable for consumers. To share the insights and results of interventions taking advantage of this trend, a symposium, "Technology-Based Physical Activity & Exercise Interventions," was held at the 3rd International Conference on Physical Activity and Public Health.

This symposium addressed the use of technology to promote physical activity and exercise. Four presentations discussed 5 interventions. Two interventions were based on physical activity monitors and offered feedback via personal websites, and 3 interventions used indoor interactive video games involving whole-body movement. Two interventions focussed on youth age 12–18, 2 interventions addressed adults, and 1 intervention dealt with families with children.

Dr. Goris presented the scientific background of DirectLife, a lifestyle activity intervention program. DirectLife consists of an activity monitor to track physical activity, a personalized web-site where the user can upload measured activity data, gets motivating feedback, a personalized plan, and help from a coach to improve on daily life physical activity behavior. The activity monitor (a tri-axial accelerometer) has been validated against doubly labeled water.[1] The algorithms translating measured accelerations into total activity energy expenditure are based on this validation study. Elements of proven behavior change models such as the 'stages-of-change' model and the I-change model have been used to develop the intervention program. The first trial with DirectLife in the Netherlands (350 employees, 43% classified as inactive) showed that inactive people increased significantly their physical activity by 10% ($P < 0.05$).[2] This increase is comparable to 30 minutes moderate intensity activity 7 days a week. Similar results were found in a second trial in the USA. From the inactive participants (69% classified as inactive) 44% increased their physical activity with DirectLife.

Prof. Schuit presented the results of 2 studies stimulating physical activity in youth. The first study investigated the effectiveness of a Physical Activity Monitor (PAM) coupled to an internet coach with personalized activity advice. After 3 months an increase of 400 minutes per week of moderate intense physical activity was found in girls ($P < 0.05$). However, the use of the PAM (65% used it regularly) and the internet coach (56% used it and 23% set a personal goal) was very poor and the investigators conclude that the feasibility of this type of interventions is poor among adolescents. The second study investigated the effectiveness of an interactive dance video game. Feasibility was tested in a home setting and multi-player group. Drop out was highest in the home group (64% vs 15%) and the effect on physical activity was highest in the multi-player group (900 min vs 380 min/week). Based on this study we conclude that stimulating physical activity using an interactive dance video game is more feasible when done in groups sessions compared to home based sessions.

Dr. Owens revealed whether using the Nintendo Wii Fit at home for 3 months leads to changes in health-related fitness. Pre- and post-intervention measurements were obtained from 8 families (21 subjects) relative to physical activity (5 days accelerometry), aerobic fitness, muscular fitness, flexibility, balance, and body composition. The only significant change for any of the fitness measures after 3 months of home Wii Fit use was for aerobic fitness in children, which increased 11.9%. Daily Wii Fit use per household declined by 82% from 21.5 ± 9.0 minutes per day during the first 6 weeks to 3.9 ± 4.0 minutes per day during the second 6 weeks. Thus, modest daily Wii Fit use may have provided insufficient stimulus for fitness changes for most components. Both the adults and children were already relatively active prior to receiving the Wii Fit. In a future study it might be useful to examine

changes in fitness variables following Wii Fit exposure in a group of sedentary individuals. Replicating the current study with a larger sample size would also be useful.

Dr. Stut reported on a study which compared a video game for strength exercises (developed by students from the Dutch HKU art school), with the Wii Fit, exercise videos, and a human trainer. In the game, situated in ancient Greece, a hero has to escape from a cyclops. The user's movements are monitored with wireless motion sensors. When doing the exercises correctly, the hero succeeds in keeping the cyclops at a distance. In a small study 16 male adults used each condition to perform 3 exercises. The participants' level of intrinsic motivation and attention was assessed with questionnaires. A multiple comparisons test revealed that the exercise game and the Wii Fit rated significantly higher on enjoyment than the exercise video ($P < 0.05$). The game also scored better than the video on dissociation, and better than the Wii Fit on distress. No statistical difference was found for perceived competence and association. Hence exercise games may motivate people to do strength exercises, but a more elaborate study is needed to assess the long-term experience and compliance.

Conclusion. This symposium discussed various innovative technologies to engage people in physical activity and exercise. Not surprisingly, technology itself is no silver bullet and does not guarantee high compliance. One study showed that activity monitors did not stimulate physical activity in youth, whereas another study showed that just providing an exercise system without background information and instructions did hardly improve fitness. On the other hand, the activity intervention program DirectLife succeeded in letting inactive people increase their activity to the recommended level by combining activity monitors, behaviour change models, and a mix of automated and human coaching. Besides, making exercising more fun by means of games seems promising. Nevertheless, more research is needed to determine which forms of technology are most appropriate, depending on the target group, situation, and personal preferences.

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Sedentary Behavior in Adults: Longitudinal, Experimental, and Intervention Evidence

Neville Owen, Ulf Ekelund, Marc Hamilton, Paul Gardiner, and David W. Dunstan

Owen is with The University of Queensland, Brisbane, Australia. Ekelund is with the MRC Epidemiology Unit, Cambridge, United Kingdom. Hamilton is with the Pennington Biomedical Research Center, LA. Dunstan is with the Baker IDI Heart and Diabetes Institute, Melbourne, Australia. Gardiner is with The University of Queensland, Brisbane, Australia.

This symposium brought together European, North American and Australian researchers conducting studies on sedentary behavior and health (put simply, *too much sitting*, as distinct from *too little physical activity*). Presentations highlighted recent key findings. These included an overview of evidence on longitudinal relationships of sedentary behavior with risk biomarkers and health outcomes; new findings from large population-based epidemiological studies, confirming negative health impacts. Experimental studies were reported, examining underlying 'inactivity physiology' mechanisms, and recent evidence from studies involving the experimental manipulation of immobility in animal and human models was outlined; the relevant mechanisms appear to involve the regulation of skeletal muscle lipoprotein lipase, which in turn has deleterious consequences for plasma triglyceride catabolism and HDL cholesterol. Preliminary findings from a clinical-laboratory experimental trial examining the impact of 'breaking-up' prolonged sitting time were reported, showing positive trends which further support the scientific case that prolonged sitting results in deleterious metabolic processes. The symposium concluded with a report on the findings from a feasibility study of a social-cognitive/behavioral-choice intervention to reduce prolonged sitting in older adults, showing significant changes in accelerometer-measured sedentary time, from pre-to post-intervention.

Keywords: prospective studies, inactivity physiology, sitting, behavioral change

"Longitudinal Relationships of Sedentary Behavior With Risk Biomarkers and Health Outcomes," by Ulf Ekelund. In a study of 8800 adult Australians followed for 6.6 years and including 284 deaths, a 1-hour increment in TV viewing per day was associated with 11% and 18% increased risk of death from all-causes and cardiovascular disease, respectively.[1] Slightly lower effect estimates were observed in a study including 13,197 middle-aged UK adults free from disease at baseline; over a period of 9.5 years there were 1270 deaths and the risk of all-cause and CVD mortality was increased by 4% and 7% for every hour per day increase in TV viewing.[2] It is less clear whether sedentary behavior predicts gain in body weight. Two studies have shown higher levels of TV viewing to predict the development of obesity, but 3 studies have observed no such association; 1 study has found that BMI and fat mass at baseline predicted higher levels of objectively measured sedentary time. In adults with a family history of diabetes, accelerometer-measured time spent sedentary did not predict insulin resistance at follow up when time spent in moderate and vigorous intensity activity was taken into account. In contrast, another study with healthy adults found time spent sedentary predicted insulin resistance after more than 5 years, independent of fat mass and time spent in moderate-to-vigorous physical activity. Differences between studies may be explained by different study populations, different length of follow up and possibly most importantly, different assessment methods for measuring sedentary time. In summary, higher amounts of time spent viewing TV appear to be associated independently with premature death. Relevant findings are not yet formally conclusive as to whether time spent sedentary predicts weight gain and metabolic dysfunction (for example, insulin resistance).

"Experimental Studies Examining Underlying 'Inactivity Physiology' Mechanisms," by Marc Hamilton. Several tenets of the inactivity physiology paradigm have been conceptualized to help guide further research.[3] Sedentary behaviors produce muscular inactivity in the postural muscles of the legs and can produce biological responses that are remarkably potent and qualitatively distinct from exercise. Since the inactivity physiology paradigm was defined explicitly in 2004,[3] experimental studies needed to directly test hypotheses about prolonged sitting have been lagging behind the emergence of observational associations. We have been testing in human trials if sitting is a direct cause for insulin resistance and other unhealthy responses. One of the first pieces of evidence providing a molecular explanation for how low-intensity and intermittent contractile activity may be sufficient to short-circuit unhealthy acute 'sedentary signals' came from a series of studies regarding the regulation of skeletal muscle lipoprotein lipase, and in turn plasma triglyceride catabolism and HDL cholesterol levels.[3,4] Taken together, the emerging experimental inactivity physiology trials are focused either on testing how sedentary behaviors may at times have more potent responses than do traditional exercise physiology responses, and also how these effects of inactivity may be caused by cellular mechanisms qualitatively distinct from exercise responses.[4] The goal of this work is to provide novel preventive medicine recommendations focused on how best to limit the health hazards of prolonged sitting. These recommendations on physical *in*activity will surely be quite different from the existing aerobic exercise recommendations that advise the public to take part in leisure time moderate-vigorous physical activity.[4]

"Impact of 'Breaking-Up' Prolonged Sitting Time: Experimental Evidence," by David Dunstan. Recent epidemiological findings have identified that regularly breaking up sedentary time is beneficially associated with body mass index, waist circumference, postprandial glucose, and triglycerides;[5] and, in addition to the known benefits of moderate-intensity activity, even light-intensity activities are beneficially and independently associated with such biomarkers. We are currently pursuing the 'breaks in sedentary time' hypothesis via an experimental trial in overweight adults age 45–65 years recruited from the general community. The aim is to understand whether prolonged sitting has real deleterious metabolic consequences, and whether breaking up sitting time with regular activity breaks, through either short duration light-intensity or through moderate-intensity activity, can lead to an improved metabolic profile. Preliminary analyses suggest that there are positive trends, showing that at least for glucose and insulin, both light-intensity and moderate-intensity, short-duration breaks may attenuate the acute metabolic effects occurring with prolonged sitting. This highlights the importance of progressing to well-controlled human experimental trials in order to move the science move closer to identifying the potential 'causal' relationships of prolonged sitting with deleterious metabolic consequences, and the potential benefits for cardio-metabolic health of breaking up prolonged sitting time.

"An Intervention to Reduce and Break Up Sitting Time in Older Adults: Feasibility and Efficacy," by Paul Gardiner. The feasibility of a behaviorally-based intervention to reduce and interrupt prolonged sitting has been examined in non-working older adults. A quasi experimental (pre-post) study was conducted with 59 participants (75% women, mean age 74 years; range 60–92) over a 2-week period. During the single face-to-face session, participants were guided through a workbook and received feedback on their objectively measured sedentary time, discussed barriers and benefits of reducing sitting time, identified enjoyable non-sedentary pursuits and developed an action plan using goal setting on a tracker. Sedentary time was assessed as the percentage of accelerometer wear time that was below 100 counts per minute). Mean reduction in sedentary time from

pre- to post-intervention was 3.2%, (or 30 minutes per day when standardized to 16 hours of waking time). Recommendations for future randomized controlled trials were outlined: initial face-to-face session, longer intervention with more sessions to achieve maintenance of behavior change, targeting social support, the use of inclinometers to measure changes in sitting, and exploring associations of reductions in sitting time with health outcomes such as physical functioning and biomarkers of cardio-metabolic health.

Conclusions. Overall, this symposium provided a perspective on scientific strategy and the relevant methodological considerations in undertaking prospective epidemiological, experimental, and intervention research on sedentary behavior; the potential physiological/biological mechanisms linking sedentary behavior to detrimental health outcomes; and, the research needed to inform potential future changes in public health guidelines and policies relating to sedentary behavior in community and workplace settings.

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Physical Activity Intervention Strategies for Aboriginal Peoples Living in Canada

Peter T. Katzmarzyk, Anthony Hanley, Lynn Lavallée, and Lucie Lévesque

Katzmarzyk is with Pennington Biomedical Research Center, Baton Rouge, LA. Hanley is with the Dept of Nutritional Sciences, University of Toronto, Ontario, Canada. Lavallée is with the School of Social Work, Ryerson University, Toronto, Ontario, Canada. Lévesque is with the School of Kinesiology and Health Studies, Queen's University, Kingston, Ontario, Canada.

Aboriginal peoples living in Canada are the direct descendents of the original inhabitants of North America, and they represent a growing segment of the population. In recent decades, there is evidence that Aboriginal peoples have higher rates of obesity and metabolic disorders than the general Canadian population, indicating that physical activity may have a central role to play in health maintenance. A symposium was organized with the goal of providing the international delegation of the Third International Congress on Physical Activity and Public Health with an overview of research issues and opportunities to work in partnership with Aboriginal peoples living in Canada. These partnerships are viewed as vital in understanding the barriers and facilitators to physical activity among Aboriginal peoples, and ultimately in reducing health disparities that currently exist.

Keywords: obesity, diabetes, ethics, community

Aboriginal peoples living in Canada represent a growing segment of the population, and they have a distinct cultural heritage as the descendents of the original inhabitants of North America. Under the Canadian Constitution, there are 3 recognized groups of Aboriginal peoples living in Canada, including First Nations, Métis, and Inuit. These 3 separate peoples have their own unique heritage, languages and cultural practices and the variation within these 3 groups is also quite vast. Overall, Aboriginal peoples comprise approximately 4% of the Canadian population, and their growth rate between 1996 and 2006 was nearly 6 times faster than the rest of the population (45%% versus 8%).[1] There is accumulating evidence that Aboriginal peoples have higher rates of obesity and metabolic disorders than the general Canadian population, including metabolic syndrome, diabetes and cardiovascular diseases. Given the central role of physical activity in the prevention and treatment of chronic diseases, there is strong potential that physical activity interventions will be effective in improving the health of Aboriginal peoples.

This symposium was organized with the goal of providing the international delegation of the Third International Congress on Physical Activity and Public Health with an overview of research issues and opportunities with working in partnership with Aboriginal peoples living in Canada. Dr. Peter Katzmarzyk presented national data on physical activity levels and obesity among Aboriginal peoples, Dr. Lynn Lavallée presented the latest information on ethical considerations in working with Aboriginal peoples, Dr. Lucie Lévesque

highlighted recent publications and resource kits that are available to help researchers and practitioners develop interventions and programs specific to Aboriginal communities, and Dr. Anthony Hanley presented an overview and some results from a long-term research collaboration between researchers and the Sandy Lake Aboriginal population in Northern Ontario, Canada.

Dr. Peter Katzmarzyk provided an overview of the current national data on physical inactivity and obesity among Aboriginal peoples. Data from the 2004 Canadian Community Health Survey indicate that Aboriginal men, women, boys and girls living off-reserve have higher levels of overweight and obesity than the non-Aboriginal population.[2] Further, the on-reserve Aboriginal population appears to have even higher rates of overweight and obesity. Although there do not appear to be large differences in levels of physical activity among Aboriginal and Non-Aboriginal Canadians, there is a strong relationship between physical activity and obesity in both groups. Irrespective of ethnic origin, those people who are inactive have 2.0 (95% confidence interval: 1.5–2.7) times the odds of being obese compared to someone who is physically active.[2] Given the higher rates of obesity and metabolic disease among Aboriginal peoples, physical activity likely has an even more important role to play with respect to health outcomes in this cultural group.

Dr. Lynn Lavallée welcomed the delegation to the traditional lands of the Mississauga of the New Credit First Nation. She provided an overview of some of the ethical requirements for working in research partnerships with Aboriginal communities in Canada. A long history of distrust towards scientific researchers exists from the point of view of Aboriginal peoples, as a result of some highly controversial cases in which data or samples from Aboriginal peoples were used for purposes that were not originally agreed to by the community. These cases have lead ultimately to a number of documents which define principles for working in partnership with Aboriginal peoples. Several universities and community/research partnership groups have developed their own guidelines for conducting research with Aboriginal peoples, and the Canadian *Tri-Council Policy Statement on Ethical Conduct for Research Involving Humans*[3] includes information on good practices for research with Aboriginal communities, and a formal policy section on this topic is currently being drafted. In general there is an epistemological and ideological divide between researchers and Aboriginal communities that must be overcome to create successful partnerships. Scientific rigor and objectivity may not be terms that mesh well with Aboriginal values and customs, and lifestyle that are conducive to partnering with Aboriginal communities.

Dr. Lucie Lévesque highlighted the availability of resources for physical activity among Aboriginal peoples. The Aboriginal peoples experience in Canada in recent decades has been one of colonization, in which they have lost many of their traditions and traditional activities, which have been supplanted by "western" cultures. However, sport and recreation are viewed as "powerful medicine that can prevent many of the social ills facing Aboriginal peoples, and foster community healing."[4] Many Indigenous communities and organizations have expressed their support for re-claiming their cultural identity, enhancing self-determination, and re-establishing cultural practices lost through the residential school system and colonization. There are many resources available, developed in collaboration with Aboriginal communities, to engage Indigenous communities in physical activity, sport, and recreation. Individuals interested in partnering with local Aboriginal communities are encouraged to seek out these resources and tool-kits, many of which are listed on the Active Circle website (http://www.activecircle.ca/en/resources).

Dr. Anthony Hanley provided an overview of the long-standing partnership between researchers at the University of Toronto, University of Western Ontario, Johns Hopkins University, and the Aboriginal community in Sandy Lake First Nation, Ontario (Sandy Lake Health and Diabetes Project). The Sandy Lake Health and Diabetes Project is a model program for the development of research partnerships with Aboriginal communities.[5] The project was initiated in 1991, and has involved ethnographic fieldwork, epidemiological studies, culturally-appropriate community intervention development and evaluation, and school curriculum development and evaluation. The results of this partnership have identified a very high prevalence of diabetes in the community, in addition to a high prevalence of overweight, physical inactivity, poor diet and smoking. There have been several promising developments in physical activity intervention strategies, including those connected with the school curriculum as well as strategies targeting environmental barriers to physical activity. Regarding physical activity interventions among Aboriginal Canadians in general, several challenges remain, including sustainability, funding, and gaining a broader application.

In summary, this symposium highlighted the potential role for physical activity in improving the health of Aboriginal peoples in Canada, and highlighted some of the practical implications of developing research partnerships between scientists and Aboriginal communities. These partnerships are viewed as vital in understanding the barriers and facilitators to physical activity among Aboriginal peoples, and ultimately in reducing health disparities that currently exist.

Acknowledgments

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Enhancing the Effectiveness of the PAR-Q and PARmed-X Screening for Physical Activity Participation

Darren E. R. Warburton, Veronica K. Jamnik, Shannon S. D. Bredin, and Norman Gledhill

Warburton is with the Cardiovascular Physiology and Rehabilitation Laboratory, and the Experimental Medicine Program, Faculty of Medicine, at the University of British Columbia, Vancouver, Canada. Warburton and Bredin are with the Physical Activity and Chronic Disease Prevention Unit, University of British Columbia, Vancouver, Canada. Bredin is also with the Cognitive and Functional Learning Laboratory, University of British Columbia, Vancouver, Canada. Jamnik and Gledhill are with the Dept of Kinesiology and Health Science, and the Physical Activity & Chronic Disease Unit, at York University, Toronto, Canada.

This symposium provided a detailed overview of the evidence-based consensus approach that was undertaken to examine, revise and enhance the Physical Activity Readiness Questionnaire (PAR-Q) and the Physical Activity Readiness Medical Examination (PARmed-X) screening tools for physical activity (PA) participation. The presenters discussed the systematic reviews (and the supporting level and grade of evidence) that led to the development of a new PA clearance protocol involving risk stratification and a decision-tree process. The evidence-based support for the role of Qualified Exercise Professionals in PA participation clearance was also highlighted. The presenters addressed how the new decision trees and risk stratification strategies were used to create the new PAR-Q+ and an interactive computer program (ePARmed-X+) that replaces the original PARmed-X serving to clear individuals for either unrestricted or supervised PA participation, or to direct them for a medical examination. Finally, they recounted how this information has been implemented on a community basis through the Physical Activity Support Line. Collectively, this symposium underscored how a systematic review and consensus process (conforming to the Appraisal of Guidelines for Research and Evaluation (AGREE) Instrument) were employed to develop a sound evidence base for an enhanced PA participation clearance process for asymptomatic and symptomatic participants.

Keywords: screening, exercise, PAR-Q, PARmed-X, adverse events, risk stratification, physical activity, exercise, health, chronic disease

The Physical Activity Readiness Questionnaire (PAR-Q) and the Physical Activity Readiness Medical Examination (PARmed-X) are the primary screening tools for physical activity (PA) participation. Although the forms are currently used worldwide, feedback from fitness professionals, PA participants, physicians, and various organizations has identified limitations to their utility and effectiveness. In short, the clearance process is not working as intended and at times is a barrier to PA participation for those individuals most in need of increased PA.

This symposium provided details on the systematic review process and resultant revision of the PAR-Q and PARmed-X. In the "Chronicle of the Journey; From Identifying the Problem to Conducting the Project," Dr. Gledhill discussed how the original PAR-Q and PARmed-X forms were based on expert opinion rather than a systematic evidence-based approach, which has remained a large obstacle in receiving acceptance from the medical community. As well, the purposely conservative clearance process is often a barrier to adopting an active lifestyle, particularly in those individuals who would see marked health benefits from PA (such as the elderly, young children, and those with chronic conditions). Other key concerns included 1) lack of recognition for the important role of Qualified Exercise Professionals (QEP) in health screening and interventions, 2) improper use of the clearance tools, 3) inadequate education and preparation of many front-line fitness practitioners who use the tools, and 4) PARmed-X clearance could only be provided by physicians who find it cumbersome to use.

Dr. Gledhill outlined how experts in various chronic conditions which have large population attributable risks[1] (ie, diseases of the cardiovascular system, metabolic disorders, cancer, respiratory disease, stroke, spinal cord injury, musculoskeletal disorders, and cognitive and psychological conditions) were recruited to conduct systematic reviews for evidence-based risk assessment and recommendations for PA clearance.

Dr. Gledhill also highlighted the resultant changes in PA clearance, including the development of an effective risk continuum from lower through intermediate to higher risk (see Figure 1). The PAR-Q+ contains a broader range of questions that should result in more persons (estimated at 98%) being cleared for intensity and mode appropriate PA participation. Individuals with a specific chronic condition will complete further probing questions or be referred to an online program (ePARmed-X+). The

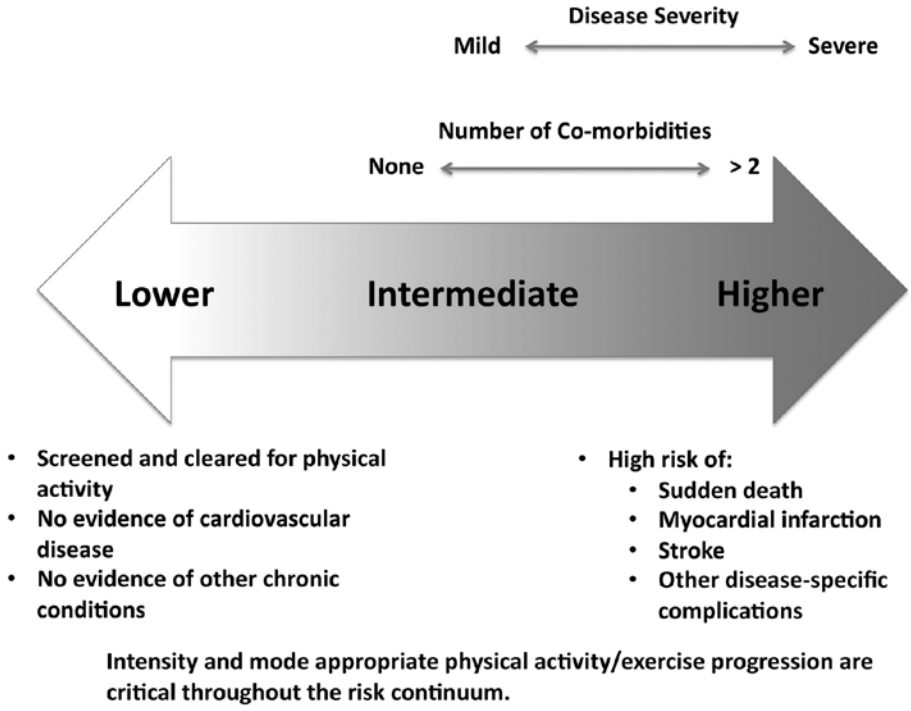

Figure 1 — Example risk continuum.

ePARmed-X+ will probe for additional information then possibly clear the participant without or with restrictions, such that only a minority (estimated at 1–2%) of respondents will be referred for additional medical probing and/or testing prior to becoming much more physically active. Dr. Gledhill concluded by emphasizing the need to update the PA clearance process every 5 years owing to the ever-changing evidence base.

Dr. Jamnik focused on the "Systematic Reviews, Levels and Grade of Evidence and the AGREE(ment) Process." The systematic reviews would also attend to eliminating the age restrictions on PAR-Q, weigh the risks versus benefits of PA participation, provide a risk stratification and best practice for each condition, and evaluate of the role of the university-trained QEP (eg, CSEP-Certified Exercise Physiologist). The Consensus Recommendations were formulated from the systematic reviews and the associated consensus deliberations in accordance with the AGREE guidelines providing a strong evidence base to revise the PAR-Q, create decision trees, and develop the new ePARmed-X+.

Dr. Warburton overviewed the "Evidence-Based Guidelines and the revised PAR-Q and PARmed-X Clearance Process" and how the systematic review evidence was used to create the new PAR-Q+ and ePARmed-X+ that now allow many individuals normally screened out of PA to be screened (often self-screened) back into PA activity/exercise. The revisions were based on approximately 900 articles from more than 500,000 retrieved articles, reflecting clearly the strong evidence-base upon which these recommendations and consequent changes to the screening resources were made.

This overwhelming evidence indicates that the risks associated with being physically inactive are markedly higher than the small transient risks seen after acute exercise (in asymptomatic and symptomatic populations across the lifespan).[2] Dr. Warburton argued, "For most persons living with a chronic condition, if habitual PA not facilitated, their risk of an adverse event and/or premature mortality increases greatly." Additionally, an evidence-based risk continuum (Figure 1) was created wherein 1) low risk persons may exercise at low to moderate intensities with minimum supervision, 2) intermediate risk persons should exercise under the guidance of a QEP, and 3) high risk persons should exercise in a medically supervised setting that includes a QEP. Other recommendations include 1) the evidence does not support the current age restrictions of the PAR-Q, 2) QEPs are critical in the PA participation clearance process and exercise testing/training,[3,4] and 3) national certification, advanced clinical training, and standardized written and practical examinations are recommended for QEPs. Dr. Warburton also emphasized the need for the development of clinical exercise guidelines for chronic conditions to refine and enhance exercise prescriptions.

Dr. Bredin discussed "What we have learned from using the PAR-Q+ and ePARmed-X+ in the community: the Physical Activity Support Line (PAL; www.physicalactivityline.com)" to facilitate PA at the population and community level. The PAL is a

free resource for evidence-based PA information and professional guidance for individuals to become more physically active. This telehealth program provides the latest information in exercise prescription and PA participation for a variety of conditions. QEPs operating the phone lines and answering emails make use of the evidence-based decision trees to guide persons to become PA. More than 120 fact sheets have been generated based on the findings of the systematic reviews and PAL.

Conclusion and Knowledge Translation. In summary, a research team (headed by Drs. Darren Warburton, Norman Gledhill, Veronica Jamnik, and Don McKenzie) in collaboration with the CSEP Health & Fitness Program engaged specialists from various clinical areas and through an evidence-based consensus process revised the PAR-Q form (now called the PAR-Q+) and created a new online screening program for individuals with chronic conditions (the ePARmed-X+).

The new evidence-based PA participation clearance process will enhance the ability of individuals around the world to engage in safe and effective PA. The anticipated impact of this PA clearance on an international stage is remarkable. For instance, the PAR-Q form is the mandatory pre-exercise screening form used in the majority of exercise facilities in Canada and is downloaded approximately 2.5 million times per year by Canadians. Approximately 25 million worldwide use the PAR-Q, as it is the standard pre-participation screening form in the United States, the United Kingdom, Israel, Australia, and various other countries. With the development of the PAR-Q+ and the ePARmed-X+ we anticipate that more than 50 million people worldwide will make use of these new resources. Therefore, the potential legacy of these PA clearance resources for healthy living is clear.

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