

Introduction to the Canadian 24-Hour Movement Guidelines for Children and Youth: An Integration of Physical Activity, Sedentary Behaviour, and Sleep¹

There is great desire to optimize the healthy active living behaviours of Canadian children and youth (aged 5–17 years). The way school-aged children and youth spend their time over a 24-hour period has important health implications. It is becoming clear that behaviours along the movement continuum (i.e., physical activity, sedentary behaviour, sleep) cluster and interact (Chaput et al. 2014; Tremblay et al. 2010), such that their combined effects extend beyond the individual contributions of each behaviour. However, until recently these behaviours and their relationships with various health indicators have largely been considered in isolation of one another (Chaput et al. 2014) or have attempted to statistically adjust for one another, often using inherently flawed analyses (Chastin et al. 2015; Pedisic 2014). This fragmented research and related messaging approach has resulted in a narrow focus on one hour of the 24-hour period – the recommendation to spend 60 min of each day in moderate- to vigorous-intensity physical activity (MVPA) as specified by the Canadian Physical Activity Guidelines for Children and Youth (Tremblay et al. 2011a). This approach is common among countries around the world (Kahlmeier et al. 2015; Tremblay and Haskell 2012).

Recently, separate and distinct Canadian Sedentary Behaviour Guidelines for Children and Youth were developed and released (Tremblay et al. 2011b), and while considered progress in public health messaging, they not only proliferated guidelines and created increased need for awareness, but also reinforced the disaggregation of movement behaviours that are intuitively and biologically aggregated. The natural progression of this disaggregated approach would be to develop separate guidelines for sleep and light physical activity to cover the complete 24-hour period – an approach that would be analogous to dismantling the Canada's Food Guide (Health Canada 2011) into separate guides for each food group and implying no inter-relationship between the groups. Such an approach is not only misguided, but has the potential to cause harm by implying the various movement behaviours are unrelated (e.g., as long as you get your 60 min of MVPA it does not matter how sedentary you are for the rest of the day, or if you slept well the night before).

There is growing interest and support for an integrated approach to understand and promote movement behaviours (Chaput et al. 2014; Chastin et al. 2015; Pedisic 2014; Thompson et al. 2015). Accordingly, with support and leadership from the Canadian Society for Exercise Physiology (csep.ca), the Healthy Active Living and Obesity Research Group (HALO) at the Children's Hospital of Eastern Ontario Research Institute (haloresearch.ca), The Conference Board of Canada (conferenceboard.ca), the Public Health Agency of Canada (www.phac-aspc.gc.ca/), and ParticipACTION (participaction.com), and following established guideline development procedures (Tremblay and Haskell 2012), a process to develop 24-hour movement guidelines for children and youth was undertaken. The background research focussed on school-aged children and youth at this time, and it is hoped that this process will extend to other

age groups across the lifespan (e.g., preschoolers, adults and older adults) in the future.

This supplement of *Applied Physiology, Nutrition, and Metabolism* contains a compilation of the background research, consultations, processes, and outcomes that led to the *Canadian 24-Hour Movement Guidelines for Children and Youth: An Integration of Physical Activity, Sedentary Behaviour, and Sleep* – the first such guidelines developed anywhere in the world. The supplement starts with four systematic reviews, each registered a priori in PROSPERO (www.crd.york.ac.uk/prospere/). The first review assesses the relationships between objectively measured physical activity and health indicators in school-aged children and youth (Poitras et al. 2016). This review builds on and extends the earlier review (Janssen and LeBlanc 2010) that informed the 2011 Canadian Physical Activity Guidelines for Children and Youth (Tremblay et al. 2011a). The review was limited to studies using objective measures of physical activity in an attempt to gather findings on the relationship between total physical activity, MVPA, and light physical activity, and indicators. Total physical activity and light physical activity are typically too inclusive and incidental to be accurately captured through self- or parental-report questionnaires. The second systematic review examined the relationships between objectively and subjectively measured sedentary behaviours and health indicators in school-aged children and youth (Carson et al. 2016a), and serves as an update of the systematic review that informed the 2011 Canadian Sedentary Behaviour Guidelines for Children and Youth (Tremblay et al. 2011c). The third review represents the first published systematic review on the relationships between sleep duration, measured objectively or subjectively, and a variety of health indicators in school-aged children and youth (Chaput et al. 2016). Finally, the fourth systematic review examined how combinations of objectively measured physical activity and subjectively measured sedentary behaviour and sleep were associated with important health indicators in children and youth (Saunders et al. 2016). These four systematic reviews, which assessed findings from nearly 600 published articles, provided foundational evidence for the development of the *Canadian 24-Hour Movement Guidelines for Children and Youth: An Integration of Physical Activity, Sedentary Behaviour, and Sleep*.

To properly analyze movement behaviours constrained to, but filling, the 24-hour period compositional analyses are recommended (Chastin et al. 2015; Pedisic 2014). Using a nationally representative sample of Canadian children and youth with directly measured health data from the Canadian Health Measures Survey (Tremblay et al. 2007), these novel compositional analyses were done, allowing an assessment of the combination or “cocktail” of movement behaviours associated with desirable indicators of health as presented in the paper by Carson et al. (2016b).

Using the draft guidelines, a series of focus group meetings were held with various stakeholder groups in sites across Canada

Corresponding author: Mark S. Tremblay (email: mtremblay@cheo.on.ca).

¹This introduction is part of a Special issue entitled *Canadian 24-Hour Movement Guidelines for Children and Youth: An Integration of Physical Activity, Sedentary Behaviour, and Sleep*.

and this rich, qualitative feedback was summarized and presented in the paper by Faulkner et al. (2016).

A summary paper in this supplement provides details on the process followed to arrive at the *Canadian 24-Hour Movement Guidelines for Children and Youth: An Integration of Physical Activity, Sedentary Behaviour, and Sleep* and presents the final guidelines and related preamble, in both English and French (Tremblay et al. 2016). Plans for the release, promotion, dissemination, and evaluation of the new guidelines are also provided in this summary paper (Tremblay et al. 2016).

The final paper of this supplement discusses the implications of these new guidelines for organizations, practitioners, and professionals in physical activity, fitness, physical education, wellness, public health, and related fields as well as issues for dissemination and implementation (Latimer-Cheung et al. 2016). Proactive educational initiatives, retraining workshops, curriculum redesign, Website updates, social marketing efforts, and creative implementation and activation initiatives are being designed to influence awareness, knowledge, understanding, beliefs, attitudes, intentions, and ultimately behaviours of intermediaries and leaders in a position to instill in the population the importance of healthy movement behaviours throughout the whole day. To make a measurable difference, a sustained integrated marketing and communications plan will be required, along with a well-resourced, sustained strategy to implement and activate the new guidelines – an essential component that has been missing from previous guideline releases.

Inactivity and sedentary behaviour levels are high among Canadian children and youth (Colley et al. 2011; ParticipACTION 2015). Sleep deprivation is also pervasive in today's society (Matricciani et al. 2012; Owens 2014). Innovative approaches facilitating nudges to habitual movement behaviours are needed to recalibrate normative movement behaviours to preserve and enhance the health and wellness of our children and youth. There is optimism that these new guidelines, encompassing an integrated, holistic approach, will stimulate future research to inform new policies, programs, and initiatives; and that new policies, programs, and initiatives will inform future research.

Mark S. Tremblay

Healthy Active Living and Obesity Research Group, Children's Hospital of Eastern Ontario Research Institute; Department of Pediatrics, University of Ottawa, Ottawa, ON K1H 8L1, Canada

Valerie Carson

Faculty of Physical Education and Recreation, University of Alberta, Edmonton, AB T6G 2H9, Canada

Jean-Philippe Chaput

Healthy Active Living and Obesity Research Group, Children's Hospital of Eastern Ontario Research Institute; Department of Pediatrics, University of Ottawa, Ottawa, ON K1H 8L1, Canada

Acknowledgements

Support for the development of the *Canadian 24-Hour Movement Guidelines for Children and Youth: An Integration of Physical Activity, Sedentary Behaviour, and Sleep* was provided by the Canadian Society for Exercise Physiology, the Healthy Active Living and Obesity Research Group at the Children's Hospital of Eastern Ontario Research Institute, the Conference Board of Canada, the Public Health Agency of Canada, and ParticipACTION.

References

Carson, V., Hunter, S., Kuzik, N., Gray, C.E., Poitras, V.J., Chaput, J.-P., et al. 2016a. Systematic review of sedentary behaviour and health indicators in school-aged children and youth: an update. *Appl. Physiol. Nutr. Metab.* **41**: This issue. doi:10.1139/apnm-2016-0630.

Carson, V., Tremblay, M.S., Chaput, J.-P., and Chastin, S.F.M. 2016b. Associations between sleep duration, sedentary time, physical activity and health indicators among Canadian children and youth using compositional analyses. *Appl. Physiol. Nutr. Metab.* **41**: This issue. doi:10.1139/apnm-2016-0026.

Chaput, J.-P., Carson, V., Gray, C., and Tremblay, M.S. 2014. Importance of all movement behaviors in a 24 hour period for overall health. *Int. J. Environ. Res. Public Health*, **11**: 12575–12581. doi:10.3390/ijerph111212575. PMID:25485978.

Chaput, J.-P., Gray, C.E., Poitras, V.J., Carson, V., Gruber, R., Olds, T., et al. 2016. Systematic review of the relationships between sleep duration and health indicators in school-aged children and youth. *Appl. Physiol. Nutr. Metab.* **41**: This issue. doi:10.1139/apnm-2015-0627.

Chastin, S.F.M., Palarea-Albaladejo, J., Dontje, M.L., and Skelton, D.A. 2015. Combined effects of time spent in physical activity, sedentary behaviors and sleep on obesity and cardio-metabolic health markers: a novel compositional data analysis approach. *PLOS ONE*, **10**(10): e0139984. doi:10.1371/journal.pone.0139984. PMID:26461112.

Colley, R.C., Garriguet, D., Janssen, I., Craig, C.L., Clarke, J., and Tremblay, M.S. 2011. Physical activity of Canadian children and youth: Accelerometer results from the 2007 to 2009 Canadian Health Measures Survey. *Health Rep.* **22**(1): 15–24. PMID:21510586.

Faulkner, G., White, L., Riazi, N., Latimer-Cheung, A., and Tremblay, M.S. 2016. Canadian 24-Hour Movement Guidelines for Children and Youth: Exploring the perceptions of stakeholders regarding their acceptability, barriers to uptake, and dissemination. *Appl. Physiol. Nutr. Metab.* **41**: This issue. doi:10.1139/apnm-2016-0100.

Health Canada. 2011. Eating well with Canada's Food Guide. Health Canada, Ottawa, Ont., Canada. HC Pub. 4651.

Janssen, I., and Leblanc, A.G. 2010. Systematic review of the health benefits of physical activity and fitness in school-aged children and youth. *Int. J. Behav. Nutr. Phys. Act.* **7**: 40. doi:10.1186/1479-5868-7-40. PMID:20459784.

Kahlmeier, S., Wijnhoven, T.M.A., Alpiger, P., Schweizer, C., Breda, J., and Martin, B.W. 2015. National physical activity recommendations: systematic overview and analysis of the situation in European countries. *BMC Public Health*, **15**: 133. doi:10.1186/s12889-015-1412-3. PMID:25879680.

Latimer-Cheung, A.E., Copeland, J., Fowles, J., Zehr, L., Duggan, M., and Tremblay, M.S. 2016. The Canadian 24-Hour Movement Guidelines for Children and Youth: Implications for practitioners, professionals, and organizations. *Appl. Physiol. Nutr. Metab.* **41**: This issue. doi:10.1139/apnm-2016-0086.

Matricciani, L., Olds, T., and Petkov, J. 2012. In search of lost sleep: secular trends in the sleep time of school-aged children and adolescents. *Sleep Med. Rev.* **16**: 203–211. doi:10.1016/j.smrv.2011.03.005. PMID:21612957.

Owens, J., and the Adolescent Sleep Working Group; Committee on Adolescence. 2014. Insufficient sleep in adolescents and young adults: an update on causes and consequences. *Pediatrics*, **134**: e921–e932. doi:10.1542/peds.2014-1696. PMID:25157012.

ParticipACTION. 2015. The biggest risk is keeping kids indoors. The 2015 ParticipACTION Report Card on Physical Activity for Children and Youth. ParticipACTION, Toronto, Ont., Canada.

Pedisic, Z. 2014. Measurement issues and poor adjustments for physical activity and sleep undermine sedentary behaviour research – the focus should shift to the balance between sleep, sedentary behaviour, standing and activity. *Kinesiology*, **46**(1): 135–146.

Poitras, V.J., Gray, C.E., Borghese, M.M., Carson, V., Chaput, J.-P., Janssen, I., et al. 2016. Systematic review of the relationships between objectively-measured physical activity and health indicators in school-aged children and youth. *Appl. Physiol. Nutr. Metab.* **41**: This issue. doi:10.1139/apnm-2015-0663.

Saunders, T.J., Gray, C.E., Poitras, V.J., Chaput, J.-P., Janssen, I., Katzmarzyk, P.T., et al. 2016. Combinations of physical activity, sedentary behaviour and sleep: relationships with health indicators in school-aged children and youth. *Appl. Physiol. Nutr. Metab.* **41**: This issue. doi:10.1139/apnm-2015-0626.

Thompson, D., Peacock, O., Western, M., and Batterham, A.M. 2015. Multidimensional physical activity: an opportunity, not a problem. *Exerc. Sport Sci. Rev.* **43**(2): 67–74. doi:10.1249/JES.0000000000000039. PMID:25607280.

Tremblay, M.S., and Haskell, W.L. 2012. From science to physical activity guidelines. In *Physical Activity and Health*. 2nd ed. C. Bouchard, S.N. Blair, and W.L. Haskell. Human Kinetics Publishers, Champaign, Ill., USA. pp. 359–378.

Tremblay, M.S., Wolfson, M., and Connor Gorber, S. 2007. Canadian Health Measures Survey: background, rationale and overview. *Health Rep.* **18**(Suppl): 7–20. PMID:18210866.

Tremblay, M.S., Colley, R.C., Saunders, T.J., Healy, G.N., and Owen, N. 2010. Physiological and health implications of a sedentary lifestyle. *Appl. Physiol. Nutr. Metab.* **35**(6): 725–740. doi:10.1139/H10-079. PMID:21164543.

Tremblay, M.S., Warburton, D.E.R., Janssen, I., Paterson, D.H., Latimer, A.E., Rhodes, R.E., et al. 2011a. New Canadian physical activity guidelines. *Appl. Physiol. Nutr. Metab.* **36**(1): 36–46. doi:10.1139/H11-009. PMID:21326376.

Tremblay, M.S., LeBlanc, A.G., Janssen, I., Kho, M.E., Hicks, A., Murumets, K., et al. 2011b. Canadian sedentary behaviour guidelines for children and youth. *Appl. Physiol. Nutr. Metab.* **36**(1): 59–64. doi:10.1139/H11-012. PMID:21326378.

Tremblay, M.S., LeBlanc, A.G., Kho, M.E., Saunders, T.J., Larouche, R., Colley, R.C., et al. 2011c. Systematic review of sedentary behaviour and health indicators in school-aged children and youth. *Int. J. Behav. Nutr. Phys. Act.* **8**: 98. doi:10.1186/1479-5868-8-98. PMID:21936895.

Tremblay, M.S., Carson, V., Chaput, J.-P., Dinh, T., Duggan, M., Faulkner, G., et al. 2016. Canadian 24-Hour Movement Guidelines for Children and Youth: An Integration of Physical Activity, Sedentary Behaviour, and Sleep. *Appl. Physiol. Nutr. Metab.* **41**: This issue. doi:10.1139/apnm-2016-0151.