

## An Active Lifestyle for Cancer Prevention

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Physical activity contributes to reduced risk and progression of certain types of cancer (1–6). American Cancer Society guidelines recommend that adults accumulate at least 150 minutes of moderate or 75 minutes of vigorous intensity physical activity per week for cancer prevention (7). In recent years, a growing body of research has focused on sitting time in relation to health. In contrast with moderate to vigorous physical activity, sitting requires very low energy expenditure (less than 1.5 metabolic equivalents) and thus is considered as sedentary behavior (8). Sedentary behavior is distinct and independent from physical activity and hence varies among physically active populations. Sedentary behavior has been linked to biomarkers of diabetes and cardiovascular disease risk (9–13) and to outcomes such as obesity (14), diabetes (15–18), some types of cancer (19), and all-cause mortality (20–22). Given these associations, American Cancer Society guidelines recommend limiting sedentary behavior such as time spent sitting, lying down, watching TV, and other forms of screen-based entertainment (7).

In this issue of the Journal, Schmid and Leitzmann report a meta-analysis of 43 published prospective studies including a total of 68 936 cancer case patients among more than 4 million individuals to synthesize the quantitative evidence on the association between sedentary behaviors and cancer risk (23). They report an increased risk of colon cancer with increased TV viewing time (relative risk [RR] comparing highest vs lowest levels of sedentary behavior = 1.54), occupational sitting time (RR = 1.24), and total sitting time (RR = 1.24). Relative risk of endometrial cancer was increased with more TV viewing time (RR = 1.66) and total sitting time (RR = 1.32). Higher overall sedentary behavior was also related to lung cancer (RR = 1.21), but not cancer of the breast, rectum, ovaries, prostate, stomach, esophagus, testes, renal cell, and non-Hodgkin lymphoma. An increase in risk with increasing sitting time (risk per 2-hour sitting time per day increase) was observed for colon cancer and endometrial cancer, but not cancer of the breast, ovary, prostate, or non-Hodgkin lymphoma. Assessing the results after stratifying the studies into higher and lower quality, the authors observed a stronger association for colon cancer in the higher quality studies.

This meta-analysis included a substantial numbers of cancer case patients and adopted appropriate analytic approaches adjusting for numerous potential confounding variables. Given the strength of the data, the dose–response relation, and the lack of heterogeneity among studies, these data support a causal relation between sedentary behavior and both colon and endometrial cancers. For other cancers that are related to obesity (breast, kidney), the association for sitting may operate through obesity-specific pathways.

What then are the implications for cancer prevention and control? Cancer prevention requires a sufficient evidence base, political will to fund programs to address the prevention potential, and a social strategy or plan by which we apply our knowledge to initiate or improve programs (24). In the early writing on health promotion, Richmond structured a social strategy as preventive services delivered by health-care providers, structural interventions to create a healthier environment, and local and individual changes to promote health (25). Currently, only a few guidelines, American Cancer Society Nutrition and Physical Activity and the UK Department of Health (7,26), specifically address the need to reduce sedentary behavior, but they offer no quantitative recommendations, nor do they outline strategies to achieve population-level improvements in reduced sitting time. Therefore, research to advance context-specific objective sedentary behavior assessment (27) is needed to inform quantitative recommendations on daily sedentary time for cancer prevention and wellness.

Perhaps the first rigorous epidemiologic study of sedentary behavior was that by Morris (28), who reported higher incidence of coronary heart disease in London bus drivers (sedentary occupation) than in bus conductors (active occupation). However, sedentary behavior is a less-developed research area compared with physical activity, which has been extensively studied since the 1960s. Technologies equip the modern society and shift the dynamic of household work, transportation, and communication and the nature of occupations; thus our daily life demands less physical activity and induces more sitting. We accumulate sedentary time from sitting at school or work, motorized transport, watching TV, computer gaming, and so on. The most frequently measured and reported behaviors are TV viewing and other screen-based behaviors with moderate reliability and validity (27). These measures relate to weight gain and diabetes risk, cardiovascular disease, and all-cause mortality (29). Measuring sedentary behavior in other domains (ie, occupational, transport) is important and requires further research to overcome the limited reliability and validity of self-report instruments and to overcome the incapability of objective instruments to inform the domains of sedentary behavior. Such data can better inform targets for prevention.

Interventions targeting sedentary behaviors in adults are scarce, despite the association of sitting with mortality being independent of physical activity (30). Settings for interventions could vary. For example, given that working adults can spend eight or more hours a day at work, the worksite is an ideal and key setting to reduce sedentary time through worksite policies or changes to the physical work environment (31,32). Such changes require a joint effort

between public health, architecture, built environment, occupational, and behavioral science researchers to understand how office layout may influence employees' activity patterns to guide the development of effective intervention (33).

Transportation offers another intervention target. Replacing sedentary time in transport with active commuting may require infrastructure improvement (34) and targeted behavior change program (35). More important, environmental modification and reforming social norms (ie, active transport culture) (36) may shift the overall distribution of sedentary behavior as one means to impact cancer prevention and broader health outcomes at a population level (37).

Little research focuses on interventions reducing sedentary behavior among adults, yet promising evidence from intervention studies targeting children and adolescents supports the Centers for Disease Control and Prevention Community Guide recommending behavioral interventions to reduce screen time for obesity prevention (38). Clinical-setting and population-level approaches appear to effectively reduce sedentary time and benefit weight control (39). However, there is to date limited evidence on brief office interventions supporting a role for health-care providers.

Reductions in sedentary behavior are recommended for cancer reduction and improvement in overall mortality. Strategies remain poorly defined to meet this goal independent of weight control. Priority should be placed on refining interventions, independent of physical activity and obesity prevention, to reduce sedentary time and lower cancer risk and overall mortality. These will then be integrated into a broader framework for an effective strategy to implement and monitor them to reduce the cancer burden as society continues to remove activity from how we structure our civilization.

## References

- Bernstein L, Henderson BE, Hanisch R, et al. Physical exercise and reduced risk of breast cancer in young women. *J Natl Cancer Inst.* 1994;86(18):1403–1408.
- Bernstein L, Patel AV, Ursin G, et al. Lifetime recreational exercise activity and breast cancer risk among black women and white women. *J Natl Cancer Inst.* 2005;97(22):1671–1679.
- Maruti SS, Willett WC, Feskanich D, et al. A prospective study of age-specific physical activity and premenopausal breast cancer. *J Natl Cancer Inst.* 2008;100(10):728–737.
- Wolin KY, Yan Y, Colditz GA. Physical activity and risk of colon adenoma: a meta-analysis. *Br J Cancer.* 2011;104(5):882–885.
- Wolin KY, Yan Y, Colditz GA, et al. Physical activity and colon cancer prevention: a meta-analysis. *Br J Cancer.* 2009;100(4):611–616.
- Wiseman M. The second World Cancer Research Fund/American Institute for Cancer Research expert report. Food, nutrition, physical activity, and the prevention of cancer: a global perspective. *Proc Nutr Soc.* 2008;67(3):253–256.
- Kushi LH, Doyle C, McCullough M, et al. American Cancer Society Guidelines on nutrition and physical activity for cancer prevention: reducing the risk of cancer with healthy food choices and physical activity. *CA Cancer J Clin.* 2012;62(1):30–67.
- Tremblay M. Letter to the editor: standardized use of the terms “sedentary” and “sedentary behaviours”. *Appl Physiol Nutr Metab.* 2012;37(3):540–542.
- Healy GN, Dunstan DW, Salmon J, et al. Television time and continuous metabolic risk in physically active adults. *Med Sci Sports Exerc.* 2008;40(4):639–645.
- Wijndaele K, Healy GN, Dunstan DW, et al. Increased cardiometabolic risk is associated with increased TV viewing time. *Med Sci Sports Exerc.* 2010;42(8):1511–1518.

- Stamatakis E, Hamer M, Mishra GD. Early adulthood television viewing and cardiometabolic risk profiles in early middle age: results from a population, prospective cohort study. *Diabetologia.* 2012;55(2):311–320.
- Pinto Pereira SM, Ki M, Power C. Sedentary behaviour and biomarkers for cardiovascular disease and diabetes in mid-life: the role of television-viewing and sitting at work. *PLoS One.* 2012;7(2):e31132.
- Yates T, Khunti K, Wilmot EG, et al. Self-reported sitting time and markers of inflammation, insulin resistance, and adiposity. *Am J Prev Med.* 2012;42(1):1–7.
- Cameron AJ, Welborn TA, Zimmet PZ, et al. Overweight and obesity in Australia: the 1999–2000 Australian Diabetes, Obesity and Lifestyle Study (AusDiab). *Med J Aust.* 2003;178(9):427–432.
- Hu FB, Li TY, Colditz GA, et al. Television watching and other sedentary behaviors in relation to risk of obesity and type 2 diabetes mellitus in women. *JAMA.* 2003;289(14):1785–1791.
- Hu FB, Leitzmann MF, Stampfer MJ, et al. Physical activity and television watching in relation to risk for type 2 diabetes mellitus in men. *Arch Intern Med.* 2001;161(12):1542–1548.
- Ford ES, Schulze MB, Kroger J, et al. Television watching and incident diabetes: Findings from the European Prospective Investigation into Cancer and Nutrition-Potsdam Study. *J Diabetes.* 2010;2(1):23–27.
- Krishnan S, Rosenberg L, Palmer JR. Physical activity and television watching in relation to risk of type 2 diabetes: the Black Women's Health Study. *Am J Epidemiol.* 2009;169(4):428–434.
- Lynch BM. Sedentary behavior and cancer: a systematic review of the literature and proposed biological mechanisms. *Cancer Epidemiol Biomarkers Prev.* 2010;19(11):2691–2709.
- Dunstan DW, Barr EL, Healy GN, et al. Television viewing time and mortality: the Australian Diabetes, Obesity and Lifestyle Study (AusDiab). *Circulation.* 2010;121(3):384–391.
- Wijndaele K, Brage S, Besson H, et al. Television viewing time independently predicts all-cause and cardiovascular mortality: the EPIC Norfolk study. *Int J Epidemiol.* 2010;40(1):150–159.
- Katzmarzyk PT, Church TS, Craig CL, et al. Sitting time and mortality from all causes, cardiovascular disease, and cancer. *Med Sci Sports Exerc.* 2009;41(5):998–1005.
- Schmid D, Leitzmann M. Television viewing and time spent sedentary in relation to cancer risk: a meta-analysis. *J Natl Cancer Inst.* 2014;106(7):dju098 doi:10.1093/jnci/dju098.
- Atwood K, Colditz GA, Kawachi I. From public health science to prevention policy: placing science in its social and political contexts. *Am J Public Health.* 1997;87(10):1603–1606.
- Richmond J, Kotelchuck M. Coordination and development of strategies and policy for public health promotion in the United States. In: Holland W, Detel R, Know G, eds. *Oxford Textbook of Public Health.* Oxford: Oxford University Press; 1991.
- Department of Health. *UK Physical Activity Guidelines.* London: Department of Health; 2011.
- Atkin AJ, Gorely T, Clemes SA, et al. Methods of measurement in epidemiology: sedentary behaviour. *Int J Epidemiol.* 2012;41(5):1460–1471.
- Morris JN, Heady JA, Raffle PA, et al. Coronary heart-disease and physical activity of work. *Lancet.* 1953;265(6795):1053–1057.
- Grontved A, Hu FB. Television viewing and risk of type 2 diabetes, cardiovascular disease, and all-cause mortality: a meta-analysis. *JAMA.* 2011;305(23):2448–2455.
- Patel AV, Bernstein L, Deka A, et al. Leisure time spent sitting in relation to total mortality in a prospective cohort of US adults. *Am J Epidemiol.* 2010;172(4):419–429.
- van Uffelen JG, Wong J, Chau JY, et al. Occupational sitting and health risks: a systematic review. *Am J Prev Med.* 2010;39(4):379–388.
- Carnethon M, Whitsel LP, Franklin BA, et al. Worksite wellness programs for cardiovascular disease prevention: a policy statement from the American Heart Association. *Circulation.* 2009;120(17):1725–1741.
- Smith L, Ucci M, Marmot A, et al. Active buildings: modelling physical activity and movement in office buildings. An observational study protocol. *BMJ Open.* 2013;3(11):e004103.

34. Yang L, Sahlqvist S, McMinn A, et al. Interventions to promote cycling: systematic review. *BMJ*. 2010;341:c5293.
35. Ogilvie D, Egan M, Hamilton V, et al. Promoting walking and cycling as an alternative to using cars: systematic review. *BMJ*. 2004;329(7469):763–766.
36. Buehler R, Pucher J. Walking and cycling in Western Europe and the United States: trends, policies, and lessons. *Transport Res News*. 2012;280:34–42.
37. Colditz GA. Cancer culture: epidemics, human behavior, and the dubious search for new risk factors. *Am J Public Health*. 2001;91(3):357–359.
38. Centers for Disease Control and Prevention. *The Guide to Community Preventive Services*. <http://www.thecommunityguide.org/obesity/behavioral.html>. Accessed April 29, 2014.
39. DeMattia L, Lemont L, Meurer L. Do interventions to limit sedentary behaviours change behaviour and reduce childhood obesity? A critical review of the literature. *Obes Rev*. 2007;8(1):69–81.

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### Notes

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