EDITORIAL

Sedentary Behaviour and Biomarkers of Cardiometabolic Health Risk in Adolescents: An Emerging Scientific and Public Health Issue

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A highlight of this issue of *Revista Española de Cardiología* is the report of original research by Martínez-Gómez et al,[1] in which they examine the associations of objectively assessed sedentary time (too much sitting, as distinct from too little exercise) and body fatness with cardiovascular risk factors in a subsample of 201 adolescent participants of the Madrid AFINOS study. The key scientific features of their investigation are the objective measurement of ambulatory movement (and non-movement) using accelerometers, from which they derive the amount of time spent sedentary. In their study, they conducted careful anthropometric measurements to determine central and overall adiposity, and measured a range of biomarkers of cardiovascular risk. They report significant associations of time spent sedentary and body fatness with biomarkers of cardiovascular risk in this group of young people aged 13 to 16 years.

What is Sedentary Behaviour, as Distinct From the Lack of Physical Activity?

Sedentary behaviours are those pursuits which generate very low energy expenditures.[2] They include behaviours that involve sitting or reclining (but not standing), and occur across the domains of work (including paid and unpaid), travel, and leisure-time. Time spent in these behaviours is regarded as sedentary time. Common sedentary behaviours, such as television (TV) viewing time, sitting at school, and computer use have metabolic equivalent (MET) values in the range of 1-1.5.[2] In contrast, moderate-to-brisk-paced walking involves an energy expenditure of some 3-5 METs; running and vigorous sports can involve energy expenditures of 8 METs or more.[2]

SEE ARTICLE ON PAGES 277-85

Research on physical activity and health has in the main concentrated on quantifying the amount of time spent in activities involving these higher levels of energy expenditure (>3 METs), labeling those with no participation as "sedentary."[3] However, this definition ignored the substantial contribution that light-intensity (1.6-2.9 METs) activities make to overall daily energy expenditure,[4] as well as the potential health benefits of participating in these light intensity activities, rather than being sedentary (which from our perspective is prolonged sitting time, as distinct from not engaging in physical activity).[5,6] Furthermore, although individuals can be both sedentary and inactive, there is also the potential for high sedentary time and high exercise time to co-exist, for example among athletes in training who must spend significant amounts of time in rest and recovery from intense physical efforts. Physiologically, distinct effects are observed between prolonged sedentary time and too little exercise.[7] These findings have been supported by population-based epidemiological research, which has generally reported the associations of sedentary time with health outcomes to be independent of physical activity (exercise) levels. Indeed, detrimental associations of TV viewing time with cardiometabolic biomarkers have been observed even in those that meet the public health guidelines for physical activity (and would thus be considered "active").[8]

Increasingly, sedentary behaviours are ubiquitous and environmentally-driven.[9] The economic, social, and physical environments in which modern humans now move very little and sit a great deal within the contexts of their daily lives have been evolving rapidly, and particularly so since the

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middle of the last century. These changes in personal transportation, communication, workplace and domestic entertainment technologies have been associated with significantly-reduced demands for human energy expenditure, because they all require prolonged sitting. Such environmental and social changes have been identified as the cause of the low levels of physical activity that characterise people's usual ways of life in urban, suburban, and rural environments.

Adolescents as a Key Target Group

In the 2003-2004 US National Health and Nutrition Examination Survey (NHANES), older adolescents (16-19 years) were the second most sedentary group on average, after older adults (≥60 years).[10] As young people begin to approach their adult physical stature and move into adult-like daily occupations (including long school hours) and social roles, they become increasingly susceptible to these pervasive influences to spend their time in sedentary behaviours: or, too much sitting.

The study by Martínez-Gómez et al focuses on this important socio-demographic group.[1] Their findings raise significant concerns about the early development of behaviour patterns and body habitus attributes that may significantly increase the risk of major chronic diseases (particularly type 2 diabetes, cardiovascular disease, and breast and colon cancer). While these diseases may not manifest themselves until later in adult life, it seems that not only the behavioural basis, but also the biological precursors for these chronic diseases may be established during adolescence.

As Martínez-Gómez and colleagues highlight,[1] the majority of studies that have examined the relationship of sedentary time with cardiometabolic health in children and adolescents have been conducted under the framework of the European Youth Heart Study (EYHS): a cross-sectional population study investigating the personal, environmental and lifestyle factors that may influence cardiovascular disease risk factors in children aged 9 and 15 years. The findings from the current study build on those from the EYHS, and extend them to examining significant health risks among adolescents 13 to 16 years, as well as additional biomarkers, such as apolipoprotein. It is important now to broaden these findings beyond the highly-informative cross-sectional findings that are now reported, by following-up and reassessing these young people as they transition through the various stages of adolescence and beyond. Additionally, it is important to further examine how the relationships may vary by gender, by age, and by race/ethnicity, and to examine how the relevant health behaviours (such as diet, exercise, and sedentary time) may interact.

Building the Evidence Base: Extending Beyond the Cross-Sectional Study

Sedentary behavior research is in its early stages, and is probably 20 years behind physical activity research in terms of valid and reliable measurement, and, understanding the behavioural determinants and the efficacy and effectiveness of interventions. Thus, it is important to build a solid base for this new area of research through developing a more-extensive body of epidemiological findings on how sedentary behavior findings may be linked to a range of health outcomes, within different population groups for whom genetic, cultural, social, and environmental exposures will be different in scientifically-important ways.

However, it is also imperative that this new field of research moves quickly to go beyond the inherent logical limitations of cross-sectional studies: to prospective study designs to examine the long-term effects of sedentary behavior on health; to experimental studies to further understand the physiological mechanisms that may underpin the findings; and, to intervention studies examining the feasibility of changing sedentary behaviors, and the associated health outcomes of any change.

Two recent, longitudinal studies have highlighted the potential importance of sedentary behaviours on health. In a follow-up of Australian Diabetes, Obesity and Lifestyle Study (AusDiab) participants over 6.5 years, high levels of television viewing time were significantly associated with increased all-cause and cardiovascular disease mortality.[11] The adverse consequences of prolonged sitting time have been reinforced by follow-up findings on participants in the Canada Fitness Surveys that have been carried out since 1980s.[12] Those who initially reported that they spent the majority of their day sitting had significantly poorer long-term mortality outcomes; importantly, the sitting time-mortality relationships were apparent even among those who were physically active, and were stronger among those who were overweight or obese.[12]

As Martínez-Gómez et al argue, it seems likely that there is a unique physiology of sedentary time, within which biological processes that are distinct from traditionally-understood exercise physiology may be operating.[1] The groundbreaking laboratory studies of Hamilton et al, provide important insights into the possible mechanisms that may underlie the associations observed.[7] In their series of studies, lipoprotein lipase (LPL) regulation was identified as a key pathway through which sedentary time (involving prolonged postural unloading of large