Estimated replacement effects of accelerometer-derived physical activity and self-reported sleep duration on chronic disease biomarkers

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Journal of Science and Medicine in Sport, 2012-12-01, Volume 15, Pages S76-S76, Copyright © 2012

Introduction: Across a 24-hour day, time is disproportionately distributed between sleep, sedentary time (sitting or lying with low energy expenditure), light-intensity activity, and moderate-vigorous intensity activity (MVPA). Individually, physical activity and healthful sleep (~8 hr/night) are beneficially associated, while sedentary time is detrimentally associated, with health outcomes. The relationship between these behaviors may also be important, with preliminary evidence suggesting physical activity and healthful sleep are related. However, the magnitude and direction of these relationships, and their impact on health outcomes, are unclear. This study explored the impact of alternating the time spent in these different behaviors (sleep, sedentary time, light-intensity time, MVPA time) on chronic disease biomarkers.

Methods: Data from the cross-sectional, 2005–2006 US National Health and Nutritional Examination Survey (NHANES) were analyzed, adjusting for the complex sampling design. Adults aged 30 to 74 years with 4 + days of accelerometer data and self-reported sleep duration were included in analyses (N = 3,238). Adults with sleep disorders and pregnant/lactating women were excluded. Cardiovascular (Framingham Risk Score and homocysteine levels), adiposity (body mass index and waist circumference), inflammatory (C-reactive protein), insulin resistance (HOMA-IR and HOMA-B), and hyperinsulinemia biomarkers were examined. Isotemporal substitution methods were used to estimate replacement effects for accelerometer-derived activity (MVPA: > 1951 cpm; light-intensity: 100–1951 cpm; sedentary: < 100 cpm) and reported sleep time (duration, sleep onset latency) variables on selected biomarkers.

Results: After adjustment for study covariates (age, gender, ethnicity, income, smoking, depression, and energy intake) and time spent in other activities, replacing 30 min/day of sedentary time with 30 min/day of MVPA was associated with improved levels for all biomarkers (p < 0.02 to 0.0001) with the exception of homocysteine. Replacing 30 min/day of sedentary time with 30 min/day of extended sleep duration was associated with improved cardiovascular (p < 0.04 to 0.01), insulin resistance (p < 0.05 to 0.0004), and hyperinsulinemia (p = 0.03) biomarkers, but not adiposity or inflammatory biomarkers. Light intensity activity and sleep onset latency replacement effects were equivocal across biomarkers.
Discussion: On average, replacing sedentary time with accelerometer-derived MVPA or self-reported sleep duration, even after controlling for other activities, was associated with improvements in a range of important biomarkers associated with cardiovascular disease and diabetes. Future research should explore these replacement associations longitudinally using objective methods to assess sleep parameters.