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Diabetes
& *Metabolism*

Diabetes & Metabolism 42 (2016) 112–121

Original article

Determining the association between types of sedentary behaviours and cardiometabolic risk factors: A 6-year longitudinal study of French adults

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Received 23 March 2015; received in revised form 28 July 2015; accepted 6 August 2015

Available online 26 September 2015

Abstract

Aim. – This study identified the longitudinal associations between leisure-time sedentary behaviours [television (TV) viewing, computer use and reading (h/week)] and cardiometabolic risk factors, including the metabolic syndrome.

Methods. – A total of 2517 participants (mean \pm SD age: 55.5 ± 4.9 years) were assessed in 2001 and in 2007 for physical activity and leisure-time sedentary behaviours, anthropometry, body composition, blood pressure, fasting blood glucose and lipids, using standardized methods. Multivariate generalized linear (beta, 95% CI and *P* values) and logistic (OR and 95% CI) regression models were used to assess cross-sectional associations between sedentary behaviours and cardiometabolic risk factors, while a 6-year longitudinal study explored these associations as well as the odds of developing the metabolic syndrome, as defined by the NCEP ATP III.

Results. – Increased TV viewing time over the follow-up period was positively associated with increases in body mass index (BMI; $P < 0.01$) and percent body fat ($P < 0.001$), and marginally with waist circumference ($P = 0.06$). Reverse associations were also found, with changes in BMI, percent fat mass and waist circumference positively associated with TV viewing and computer use. Associations between reading and cardiometabolic risk factors were less consistent. Each 1-h/week increase in baseline TV viewing and in reading was associated with an increase in the chances of developing the metabolic syndrome (OR = 1.031, 95% CI: 0.998–1.060, $P = 0.07$; and OR = 1.032, 95% CI: 1.002–1.065, $P = 0.02$; respectively).

Conclusion. – The present study data emphasizes the notion of differential associations of specific sedentary behaviours with cardiometabolic risk factors. They are also evidence that different longitudinal associations should be taken into account when designing public health objectives of interventions aimed at improving cardiometabolic health.

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Keywords: Cardiometabolic risk factors; Longitudinal study; Metabolic syndrome; Sedentary behaviours; Television viewing

1. Introduction

Over the past decade, a new paradigm has emerged in the field of physical activity and metabolic health: sedentary behaviour

[1,2]. This is commonly defined as time spent doing activities that require an energy expenditure of 1.0 to 1.5 times resting energy expenditure and where sitting or lying down is the dominant position [3]. This concept is now increasingly being recognized as an important risk factor for a large number of chronic conditions, leading to the development of objective and subjective assessment methods to capture different aspects of sedentary behaviour [4]. While objective measures, such as accelerometers, quantify sedentary activities globally

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without differentiating between domains, subjective measures (such as questionnaires) categorize sedentary behaviour as discretionary and non-discretionary. Sedentary activities in discretionary time typically include occupations, such as watching television (TV), reading, using a computer or playing video games. Non-discretionary sedentary activities are behaviours, such as sitting down at work, school or while commuting in cars and buses. Over the past few decades, time budget analyses have shown an overall decreasing trend in time spent being physically active in parallel with an increasing trend in time spent sedentarily [5]. Although sedentary behaviour appears to be an important determinant of poor health independently of physical activity, the relationship is complex because it depends on the type of sedentary behaviour and age group under study [6].

In adults, a number of cross-sectional studies have assessed the relationships between sedentary behaviour and risk factors of either type 2 diabetes (T2D) or cardiovascular disease [the metabolic syndrome, overweight/obesity, elevated systolic and diastolic blood pressure, fasting/postprandial hyperglycaemia, increased triglycerides and low high-density lipoprotein (HDL) cholesterol] [7–13], and have consistently shown that spending excessive time engaged in sedentary behaviours can have a negative impact on these health outcomes. Although identifying the sedentary behaviour specifically associated with the subsequent metabolic risk is an important first step in designing targeted preventative interventions in ageing populations, to date, there has been no longitudinal epidemiological study to assess sedentary behaviours other than TV viewing or periods of sitting as exposure. On the other hand, a few studies have explored the converse hypothesis that cardiometabolic risk factors can lead to more sedentary behaviours, thereby implying that having a cardiometabolic disease (such as being overweight or having T2D) can affect sedentary behaviours. However, the results of these studies have been contradictory, with evidence of both positive [14,15] and null [7,16] associations.

The objectives of the present longitudinal study of ageing French adults were to assess:

- the cross-sectional and longitudinal reciprocal associations between three different leisure-time sedentary behaviours (TV viewing, computer use and reading) with various cardiometabolic risk factors;
- the associations between these three baseline sedentary behaviours and the 6-year odds of developing the metabolic syndrome, as defined by the US Third National Cholesterol Education Program Adult Treatment Panel (NCEP ATP III) guidelines.

2. Methods

2.1. Study design and population

Participants were selected from the *Supplémentation en Vitamines et Minéraux Antioxydants* (SU.VI.MAX; Supplementation with Antioxidant Vitamins and Minerals) cohort. The design, methods and rationale of this study are described elsewhere [17]. Initially, it was designed as a randomized,

double-blind, placebo-controlled primary prevention trial to test the efficacy of daily supplementation with antioxidant vitamins and minerals at nutritional doses in reducing the incidence of ischaemic heart disease, cancer and overall mortality [18]. Following a 5-month nationwide multimedia campaign that included TV, radio and newspapers, volunteers (not selected for any specific risk factors) were recruited in 1994–1995 for a planned follow-up period of 8 years (men: ages 45–60 years; women: ages 35–60 years). Each participant underwent a yearly visit that alternated between clinical examination and blood sampling for biological measurements. From the full SU.VI.MAX cohort ($n = 13,017$), 6850 participants agreed to be included in a post-supplementation observational follow-up and were recruited into the SU.VI.MAX 2 study (2007–2009). All procedures involving human subjects' protection were approved by the Ethics Committee for Studies with Human Subjects at Paris–Cochin Hospital (CCPPRB; n° 706 and n° 2364, respectively, for the two studies) and the *Commission nationale de l'informatique et des libertés* (CNIL; n° 334641 and n° 907094, respectively; National Commission for Information Technology and Civil Liberties).

Of the 13,017 participants initially included in the SU.VI.MAX study, the present analyses focused on those with available data from physical activity questionnaires filled out in both 2001 and 2007 ($n = 3458$) that were ≥ 45 years old at study entry (to obtain a similar age range for both genders; $n = 3006$). In addition, participants who reported being confined to bed for >4 weeks in the year prior to completing the questionnaires were excluded ($n = 165$), as were participants who failed to provide information on all socio-economic variables ($n = 324$), thus obtaining a final sample of 2517 participants (1311 men and 1206 women) with an age range of 45 to 65 years.

2.2. Physical activity and sedentary behaviours

Physical activity and leisure-time sedentary behaviour were assessed in 2001 and 2007 using a French-validated self-administered version [19] of the Modifiable Activity Questionnaire (MAQ) [20]. This instrument assesses physical activity over the past 12 months in various domains of everyday life. Physical activity assessment using the MAQ has been validated against energy expenditure measurements using the double-labelled water technique, and the test–retest properties of the questionnaire have been reported [21]. The questionnaire has been described in detail elsewhere [20]. Briefly, participants were asked to report all leisure-time physical activities performed at least 10 times for 10 min/session during the past 12 months. Detailed information was collected concerning the type of leisure-time activity (such as walking, cycling, swimming, gardening). The frequency and duration of each activity was also reported. In addition, the questionnaire included items for time usually spent (in h/day and min/day) at home watching TV/videos, using a computer or playing video games, or reading for leisure. The time spent at each leisure-time sedentary occupation was used in the study analyses. Finally, assessment of occupational physical activity was based on the number of hours

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