 Printed in Great Britain

International Journal of Epidemiology 2000;**29**:429–437

Siesta and the risk of coronary heart disease: results from a population-based, case-control study in Costa Rica

Hannia Campos[a,b] and Xinia Siles[b]

Background The siesta (afternoon nap or rest), a common traditional behaviour in tropical areas, may increase the risk of myocardial infarction (MI) since the post siesta cardiovascular response very closely resembles the period soon after waking up in the morning when the onset of acute cardiovascular events is high.

Methods We studied 505 MI survivors and 522 randomly selected controls, matched for age, gender, and area of residence, in a population-based case-control study in Costa Rica. Participation rates were 97% for cases and 90% for controls. All subjects completed a physical activity questionnaire that included occupational and leisure time components with specific questions on siesta. Five siesta frequency categories (<1/wk, 1–4/wk, 5–6/wk, daily [⩾1 h and <2 h], and daily [⩾2 h and <3:30 h]) were used to calculate the odds ratio (OR) by multiple logistic regression.

Results Compared to controls, cases were more likely to take daily siestas (44 versus 35%, $P = 0.01$), and spend more time per siesta (1:07 ± 0:04 versus 0:54 ± 0:04 h:min, $P = 0.002$). As compared to subjects with the lowest siesta frequency (<1/wk), the OR for MI among those in the highest category was 1.51 (95% CI : 1.02–2.25, *P* for trend = 0.006). After adjusting for risk factors, lifestyle, and health history the OR across the siesta categories were 1.0, 0.77, 1.28. 1.66, and 1.40 (*P* for trend = 0.02).

Conclusions Our data suggest that the practice of daily siesta is associated with increased risk of MI.

Keywords Physical activity, exercise, coronary heart disease, sleep, Latin America, Hispanic, trigger

Accepted 4 November 1999

The siesta, a traditional common practice among many healthy people worldwide, is defined as a short nap or rest usually during the afternoon. Numerous social and cultural influences, including the productive value of time are involved in determining the siesta habit, and its prevalence is strongly associated with hot, tropical regions between 30° N and S of the equator, commonly known as 'the siesta cultures'.[1] The per cent of subjects who practice siesta ⩾4 times per week ranges between 60–80% in places like Mexico, Ecuador, and Nigeria, but it is rarely practised in England, which is located 50–55° from the equator.[2] In the US, people are more likely to take a siesta at least once a week in the southern states (40–50% in Florida) than in northern regions like Illinois, Pennsylvania, New York, and Oklahoma (4–17%).[2] In NHANES I, 16% of Whites and 19% of Blacks reported that they 'often' or 'almost always' got so sleepy during the day that they *had* to take nap.[3]

Given the widespread prevalence of the siesta as a leisure time activity, it is surprising that the health implications of the siesta on coronary disease have rarely been directly addressed in epidemiological studies. While not necessarily defined as 'a siesta', involuntary napping, daytime sleepiness, or 'sleep attacks' have been described as a characteristic symptom of a variety of sleep disorders that include sleep apnoea syndrome, and are associated with cardiovascular disease morbidity and mortality.[4–6] Consistent with this finding, participants in NHANES I, who reported that they *had* to take a nap 'often' or 'almost always', were at increased risk of coronary disease, and more likely to be diabetic, overweight, hypertensive, and hypercholesterolaemic. The NHANES I result suggested that taking a siesta might not be beneficial.[3]

[a] Department of Nutrition, Harvard School of Public Health, Boston, MA 02115, USA.

[b] Proyecto Salud Coronaria, Institute of Health Research (INISA) University of Costa Rica, Costa Rica.

Reprint requests to: Hannia Campos, Department of Nutrition Room 353A, Building 2, Harvard School of Public Health, 665 Huntington Ave, Boston, MA 02115, USA. E-mail: hcampos@hsph.harvard.edu

In the context of the 'siesta cultures', the siesta is predictive of mortality among the elderly in Israel.[7] In contrast, a small case-control study in Greece suggested that the frequency and duration of siesta may protect from coronary disease.[8,9] In these studies, the siesta was not associated with self-reported night sleep disorders.[7–9]

The mechanisms by which the siesta practice may increase coronary disease are unclear. The post siesta cardiovascular response very closely resembles the period soon after waking up in the morning, since both are characterized by increases in heart rate and blood pressure, which result in increased myocardial oxygen demand.[10] This physiological response is probably responsible for the increased onset of acute myocardial infarction (MI) and other acute cardiovascular events including sudden death during the morning hours compared to the occurrence of these events at night.[11–13] Thus, it is reasonable to hypothesize that the siesta increases the exposure to a post sleep phenomena that may act as a trigger of MI.[10] To address this issue we studied whether the siesta is associated with risk of MI in a large population-based case-control study in Costa Rica.

Methods

Study population

The catchment area for this study included 18 counties in Costa Rica that covered a full range of socioeconomic levels, as well as urban, peri-urban, and rural lifestyles (Figure 1). Medical services in this area were covered by three large hospitals, which are part of the National Social Security System (CCSS) of Costa Rica. According to the area of residence, 48% of the population were expected to receive medical care at the San Juan de Dios Hospital, 42% at the Rafael Angel Calderón Guardia Hospital, and 10% at the México hospital.

Because of the comprehensive social services provided in Costa Rica, all those living within the defined area for this study had access to medical care in one of these hospitals without regard to their income. The total study area comprised 2225 km^2 and 1092 million people, ethnically Mestizo, (as a result of four centuries of racial tripartite mixing—Caucasian-Indian, and a small proportion of Caucasian-Black), and culturally, Hispanic American.[14] Like Hispanics living in the US,[15] almost all Costa Ricans regard themselves as 'White'.[14]

Eligible case subjects were men and women who were diagnosed as survivors of an acute MI for the first time by two independent cardiologists at any of the three recruiting hospitals in the catchment area. In order to achieve 100% ascertainment, the three hospitals were visited daily by the study fieldworkers. All cases met the World Health Organization Criteria for MI, which require typical symptoms plus either elevations in cardiac-enzyme levels or diagnostic changes in the electrocardiogram.[16] Cases were ineligible if they died during hospitalization, if they were ⩾75 years at the day of their first MI, if they were physically or mentally unable to answer the questionnaire, or if they previously participated in the study as a control. Enrolment was carried out while cases were in the hospital's step-down-unit.

One population control for each MI case survivor, matched for age (±5 years), gender, and area of residence (county), was randomly selected using the national census information available at the National Census and Statistics Bureau of Costa Rica. Control subjects were ineligible if they have ever had an acute MI, or if they were physically or mentally unable to answer the questionnaire. The control subjects were visited at their house for recruitment.

Cases and controls who agreed to participate were visited at their homes for data collection. Visits were planned so that the interviews were carried out, on average, within 3 weeks of hospital discharge (for controls, hospital discharge of the corresponding case subject) and when possible, by the same interviewer. Identical questionnaires and data collection procedures were used for cases and controls. All subjects gave informed consent to the study approved by the Ethics Committee of the Harvard School of Public Health and the National Institute of Health Research (INISA) at the University of Costa Rica.

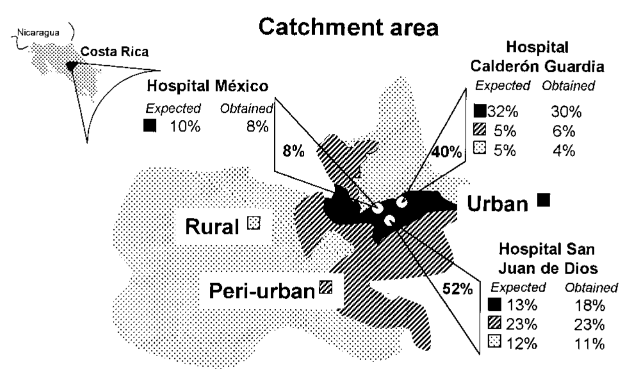

Figure 1 Expected and obtained proportion of cases of myocardial infarction (MT) in each of the three recruiting hospitals, San Juan de Dios, México, and Calderón Guardia. In the Costa Rican National Health Care System (CCSS), the residence of an individual is used to assigned a hospital for medical attention. The expected proportion of MI cases recruited in each hospital was calculated based on the population density of the geographical area assigned to each hospital by the CCSS. These expected results were defined *a priori*, to compare the expected versus the obtained sample distribution

Data collection

Data collection included a general questionnaire, anthropometric measurements, and a blood sample. The questionnaire consisted of closed questions regarding socio-demographic characteristics, smoking, socioeconomic status, and medical history including personal history of diabetes and hypertension. Self-reported diabetes and hypertension were validated using the recommended definitions by the Expert Committee on the Diagnosis and Classification of Diabetes Mellitus,[17] and the Third Joint National Committee on Detection, Evaluation, and Treatment of High Blood Pressure (JNCIII):[18] fasting capillary whole blood glucose ⩾110 mg/dl and/or taking glucose control medications; blood pressure ⩾140 mmHg for systolic and/or ⩾90 mmHg for diastolic, and/or taking anti-hypertension medications. The sensitivity, specificity, and predictive values positive (PVP) and negative (PVN) for controls were 80%, 97%, 75% and 98% for self-reported diabetes, and 52%, 96%, 93% and 70% for self-reported hypertension. Thus, the reliability of self-reported diabetes and hypertension in the Costa Rican population is high. It should be noted that a self-reported condition is an indicator of whether a subject is aware of a disease and thus more likely to have modified their lifestyle.

When we control for these conditions, we used the self-reported criteria since we were most interested in adjusting for these possible changes in lifestyle. Because it is important to exclude subjects who might have changed their habits because of knowledge or suspicion of prior coronary disease, we evaluated prior diagnosis of angina pectoris using the Rose questionnaire.[18] Physical activity was determined by asking subjects the average frequency and time spent on several occupational and leisure time activities during the last year, including specific questions on siesta. Siesta was defined as a sleep or rest period during the day, with a duration of less than 50% of the average major sleep period of an individual.[1] These activities were grouped into six categories according to their intensity, or METS (metabolic equivalents). One MET is defined as the energy expenditure for sitting quietly or approximately 1 kcal per kg^{-1} body weight per h^{-1}.[19] The categories included: (1) Lying quietly in bed: afternoon siesta (nap or rest) and night sleep (0.9 METS); (2) Sitting (1.0 METS); (3) Light indoor activity (2.4 METS); (4) Moderate outdoor activity such as gardening, light agriculture and construction, and walking on flat surfaces (3.6 METS); (5) Vigorous aerobic activity such as heavy agriculture and construction, walking uphill, climbing stairs, jogging and other sports (7.1 METS), and; (6) Strenuous anaerobic activity such as carrying, pushing and lifting heavy objects (7.8 METS). Time spent on each activity including siesta was calculated as the product of frequency (times per wk) and duration (h per time). Energy expenditure for each activity was calculated as the product of frequency, time, and intensity (METS). This questionnaire was validated by its ability to predict fitness level measured by the Harvard Step test, plasma lipids, and obesity, in our previous studies in Puriscal, Costa Rica.[20,21] Anthropometric measurements were collected by fieldworkers with subjects wearing light clothing and without shoes. All measurements were performed in duplicate and the average was used for analyses. Weight was measured on a Detecto bathroom scale that was biweekly calibrated. Body mass index (BMI) was calculated as the weight in kg divided by the square of the height in m. Blood pressure and a fasting blood sample for the lipid profile were always collected in the morning visit after subjects had voided urine and rested for 10 min. Blood pressure was taken in the seated position, in duplicate in the same arm by fieldworkers using mercury sphygmomanometers. Blood pressure and lipids among cases may have been altered by the infarction or treatment. Standardization for blood pressure measurements was based on multi-centre NHLBI DASH[22] procedures. Blood samples were centrifuged at 2500 r.p.m. for 20 min at 4°C to separate plasma, and stored at –80°C until they were transported over dry ice to the Harvard School of Public Health for analysis. Plasma triglyceride, cholesterol and high density lipoprotein (HDL) cholesterol were assayed using enzymatic reagents (Boehringer-Mannheim, Indianapolis). Cholesterol determinations in our laboratory are standardized according to the programme for research laboratories specified by the Centers for Disease Control, and the National Heart, Lung, and Blood Institute.

Data analysis

Data analysis was performed using the Statistical Analysis Systems software (SAS, Cary, NC). Two separate fieldworkers in Costa Rica entered the data twice and error checked for coding and data entry errors. Since data were edited in Costa Rica, data entry errors, questions or inconsistencies were quickly corrected and/or verified. Crude means and frequencies for health characteristics and risk factors were compared using two-sided unpaired t-tests and the Mantel-Haenszel χ^2 test. Mean daily physical activity indicators and standard errors, adjusted for the matching variables age, gender, and area of residence were calculated using linear regression. Log_e-transformations were used for the variables siesta, moderate outdoor, vigorous, and strenuous daily physical activities. Data on these variables are presented as geometric means plus or minus approximate standard errors. Multivariate analyses were carried out by multiple logistic regression with maximum likelihood estimation of the regression coefficients and their standard errors. Five siesta frequency categories (<1/wk, 1–4/wk, 5–6/wk, daily [≥1 h and <2 h], and daily [≥2 h and <3:30 h]) were used for these analyses. The relative risks were estimated as odds ratios (OR) for the lowest category of siesta frequency compared to the highest, based on the distribution among controls. Tests for trend were derived from logistic regression with a single term representing groups 1–5. This was carried out by assigning the median value of time spent on siesta to each siesta frequency category and modelling this value as a continuous variable. The variables included in each fitted model are indicated in the Tables.

Results

Case survivors and controls were recruited between December 1994 and February 1998. Table 1 shows the recruitment and health characteristics of the studied population. Of all eligible subjects, 520 cases and 531 controls completed the study. Participation was 97% for cases and 90% for controls. Cases who did not complete the study included eight subjects who died after hospital discharge and three who were too ill to participate. From those who completed the study, 15 cases and 9 controls were excluded because of missing data points in at least one of the variables in the analyses. The final sample size consisted of 522 controls and 505 MI cases. Age, gender, and area of residence were matching variables, therefore distributed identically between cases and controls. Population characteristics related to the matching by area of residence, including residential history and years of adult life living in the catchment area were very similar. The time between the onset of MI and completion of data collection was shorter in cases than controls. As expected, cases had higher prevalence of diabetes, hypertension, angina, and smoking. They also have significantly higher waist to hip ratio, but similar height, weight, and body mass index (BMI).

The obtained proportion of MI survivors recruited in each hospital was 52% for the San Juan de Dios, 40% for the Calderón Guardia, and 8% for the México (Figure 1). This distribution was comparable to the population distribution of the catchment area as assigned by the CCSS (48, 42, and 10%, respectively) and hence consistent with the population density in each county.

Demographic characteristics and socioeconomic indicators differed significantly between cases and controls (Table 2). Compared to controls, cases were more likely to be retired or had occupations in the general services such as drivers, security

Table 1 Recruitment, anthropometric, and health history of first myocardial infarction survivors and randomly selected controls[a]

	Control	Case	*P*-value[b]
Participation			
Eligible (N)	589	548	–
Contacted N (%)	589 (100)	542 (99)	–
Accepted N (%)	531 (90)	531 (97)	–
Completed the study N (%)	531 (90)	520 (95)	–
Final sample size for analysis in this study N (%)[a]	522 (89)	505 (92)	
Matching variables			
Age (years)	57 ± 11[c]	57 ± 11	
Gender (% female)	26	26	
Current residence (%)			
Urban	56	56	
Peri-urban	29	29	–
Rural	15	15	–
Residence history (% living in catchment area)			
During infancy (⩽5 years)	68	62	–
Childhood and adolescence (5–18 years)	73	68	–
Most of adult life (18+ years)	96	92	–
Years of adult life living in catchment area	27 ± 11	26 ± 12	–
Health insurance (% yes)			
Job-based national health system, CCSS[d]	89	90	0.6
Government-based welfare programme	2	6	
No insurance	9	4	
Hospitalization for MI[e] cases (days)	–	15 ± 9	–
Days between myocardial infarction and completion of data collection	31 ± 15[f]	26 ± 10	0.0001
Height (cm)	163.4 ± 9	162.7 ± 9	0.2
Weight (kg)	69 ± 13	69 ± 13	0.6
Body mass index (BMI)[g]	25.7 ± 4.1	25.9 ± 3.9	0.4
Obesity % (BMI >25)	55%	56%	0.7
Waist-to-hip ratio	0.93 ± 0.07	0.95 ± 0.07	0.0001
Hypertension (%)	26	42	0.001
Diabetes (%)	11	24	0.001
Angina—as assessed by Rose questionnaire (%)	5	12	0.001
Cigarette-smoking habits ⩾1 per day (%)			
Current smokers	28	44	0.001
Ex-smokers	37	26	
Age started smoking whole cigarette (years)	17 ± 7	17 ± 6	0.2
Age quit smoking in ex-smokers (years)	38 ± 13	43 ± 13	0.0009

[a] For this analysis, 8 controls and 15 cases were excluded because of missing data points in at least one value.

[b] We used unpaired t-tests for the continuous values and the Mantel-Haenzsel χ^2 test.

[c] Plus-minus values are means ± SD.

[d] National Social Security System (CCSS) of Costa Rica.

[e] Myocardial infarction.

[f] For controls, days were calculated from the date of myocardial infarction of their matched case for proportions. *P*-values were not calculated for variables used in or derived from matching.

[g] Weight in kg divided by the square of the height in m.

officers, and other self-employed occupations (tailors, hairdressers, shoe repair, etc.). In contrast, controls were more likely to be professionals or hold labour intensive blue collar and agricultural jobs. Cases were also less educated, more likely to be divorced, separated or in common law relationships, less likely to attend religious services, and had a lower socioeconomic status than controls.

The prevalence of those taking a siesta at least once per week was 70% for controls and 73% for cases. Among those taking a siesta, cases were more likely to spend more time per siesta (1:07 ± 0:04 versus 0:54 ± 0:04 h:min, $P = 0.002$), compared to controls (Table 3). In contrast, cases spent significantly less time on light indoor physical activities compared to controls. Light indoor activities accounted for 44% of the daytime 'active'

Table 2 Socioeconomic indicators of first myocardial infarction survivors and randomly selected controls[a]

	Control N = 522	Case N = 505	*P*-value[b]
Occupation (%)			0.007
Home-makers	19	19	
Professional (arts, sciences, law, religion, academia)	11	8	
White collar (managers, administrators, merchants)	25	23	
Blue collar and agriculture	18	13	
General services (transportation, security, grooming)	11	17	
Retired	16	19	
Unemployed and students	0	1	
Education (years)	7.9 ± 5.5	7.3 ± 5.0	0.06
Marital status (%)			0.001
Married	74	69	
Common law	3	8	
Divorced or separated	5	10	
Single or widowed	18	13	
Religion (% attending services)			0.02
Once or more times per week	57	50	
Less than once per week	13	12	
No religion or only in special events	30	38	
Socioeconomic status indicators			
Monthly household income ($)	567 ± 493	458 ± 433	0.0002
Monthly household utilities and telephone ($)	42 ± 33	37 ± 28	0.007
Home owners (%)	90	80	0.001
Home area (no. rooms)	5.9 ± 1.7	5.3 ± 1.8	0.0001
No. of inhabitants per home	4.3 ± 1.9	4.2 ± 2.0	0.21
House construction material index[c]	14.6 ± 3.2	14.1 ± 3.4	0.005
Household electrical appliance index[c]	33 ± 19	29 ± 20	0.0002

[a] Plus-minus values are means ± SD.

[b] Calculated by visual identification of types of construction materials or electrical appliances.

[c] We used unpaired t tests for the continuous values and the Mantel-Haenzel χ^2 for proportions.

Table 3 Daily physical activity in cases of myocardial infarction and randomly selected controls[a]

	Time spent h:min per day		Energy expended kcal per kg per day	
	Control N = 530	Case N = 520	Control N = 530	Case N = 520
Lying quietly in bed, 0.9 METS[b]				
Siesta[c]	0:54 ± 0:04	1:07 ± 0:04*	0.84 ± 0.04	1.00 ± 0.04*
Night sleep	7:11 ± 0:04	7:05 ± 0:04	6.50 ± 0.05	6.33 ± 0.07
Sitting, 1.0 MET	6:07 ± 0:07	6:13 ± 0:7	6.14 ± 0.17	6.21 ± 0.17
Light indoor activity, 2.4 METS	4:38 ± 0:07	4:10 ± 0:09**	10.85 ± 0.33	9.74 ± 0.33**
Moderate outdoor activity, 3.6 METS	1:44 ± 0:07	1:41 ± 0:07	5.72 ± 0.41	5.47 ± 0.40
Vigorous aerobic activity, 7.1 METS	0:08 ± 0:004	0:06 ± 0:005**	0.99 ± 0.05	0.78 ± 0.05**
Strenuous anaerobic activity, 7.8 METS	0:03 ± 0:004	0:04 ± 0:005	0.29 ± 0.03	0.35 ± 0.04
Total daytime activity	14:27 ± 0:20	14:11 ± 0:20	1.81 ± 0.04	1.64 ± 0.04*

[a] Plus-minus values are means ± SEM adjusted for matching variables age, gender, and area of residence.

[b] MET indicates metabolic equivalent. One MET is defined as the energy expenditure for sitting quietly or approximately 1 kcal per kg^{-1} body weight per h^{-1}.

[c] Mean values are given for those who reported siesta (day nap and/or rest) at least once per week, which includes 70% of controls and 73% of cases. For a detailed distribution of siesta frequency in cases and controls see Table 5.

* $P \leqslant 0.005$, ** $P \leqslant 0.05$ for differences between cases and controls.

Table 4 Relation of daily physical activity and potential risk factors of myocardial infarction to siesta frequency in randomly selected controls

	Siesta frequency Median time (h:min) per siesta				
	<1 week (0:00) N = 154	1–4 weeks (0:19) N = 80	5–6 weeks (0:45) N = 107	Daily (1:30) N = 94	Daily (2:12) N = 87
Other daily activities					
Mean time (h:min) per day					
Night sleep	7:12	7:15	7:08	7:04	7:02
Sitting	5:52	6:14	6:11	6:28	6:05
Light indoor	5:28	4:21	4:20	4:06	4:32
Moderate outdoor	1:43	1:50	1:28	2:09	1:50
Vigorous aerobic	0:08	0:08	0:09	0:10	0:06
Strenuous anaerobic	0:05	0:05	0:05	0:06	0:04
Potential risk factors					
% of total within quintile					
Gender (% female)	27	26	26	20	30
Area of residence (%urban)	51	56	61	57	56
Current smokers (⩾1 per day)	27	29	23	30	32
History of diabetes	11	9	6	15	17
History of hypertension	26	23	26	24	32
Possible angina[a]	5	5	7	2	3
Occupation					
Home-makers	19	21	19	14	25
Professionals and white collar	9	16	15	7	8
White collar	28	21	24	30	17
Blue collar and agriculture	18	16	17	18	20
General services	13	18	7	5	15
Retired	12	8	19	24	15
Mean within quintile					
Age (years)	56	57	56	57	58
Education (years)	7.0	7.9	9.6	8.5	6.6
Monthly income (US$)	487	567	706	637	471
Body mass index[b]	25.9	24.8	25.7	25.5	26.7
Systolic blood pressure (mmHg)	134	135	134	133	134
Diastolic blood pressure (mmHg)	84	83	84	82	84
Triglyceride (mmol/l)	2.22	2.46	2.26	2.38	2.48
LDL[c] cholesterol (mmol/l)	3.13	3	3.21	2.82	2.92
HDL[d] cholesterol (mmol/l)	1.06	1.06	1.14	1.09	1.03

[a] Defined using the Rose questionnaire.

[b] Weight (kg) divided by the square of the height (m).

[c] Low density lipoprotein.

[d] High density lipoprotein.

To convert values to mg/dl, multiply triglyceride by 88.57 and cholesterol by 38.7.

energy expenditure, while sitting accounted for 25%. Overall, total daytime physical activity, expressed as kcal per kg per day was significantly lower in cases compared to controls (1.64 versus 1.81). This difference was mostly accounted for by more siesta and less light indoor activity in the cases compared to controls.

As shown in Table 4, increased siesta frequency was associated with less time sleeping at night, decreased light physical activity and more time sitting. Compared to those who did not take a siesta, those who took long daily siestas had a somewhat higher prevalence of smoking, diabetes, and hypertension, as well as a higher BMI and plasma triglycerides, and low density lipoprotein (LDL) and HDL cholesterol concentrations.

Table 5 summarizes various logistic regression models that controlled simultaneously for the matching variables (age, gender, and area of residence), and the matching variables plus environmental factors, health history and coronary disease risk factors. The prevalence of taking daily siestas was significantly higher in cases than controls (44 versus 35%, $P = 0.01$). As compared with subjects in the lowest frequency category (<1/wk), the OR for those taking long daily siestas was 1.51 (95% CI : 1.02–2.25, P for trend = 0.006). Adjusting for the

Table 5 Odds ratio for myocardial infarction according to siesta frequency

	Odds ratio (95% CI) for siesta frequency Median time (h:min) per siesta					
	<1 week (0:00)	1–4 weeks (0:19)	5–6 weeks (0:45)	Daily (1:30)	Daily (2:12)	*P*-value for trend
Case/Control (N)	134/154	56/80	92/107	112/94	111/87	0.01
Univariate model[a]	1.00	0.80 (0.50–1.22)	1.02 (0.69–1.50)	1.30 (0.88–1.92)	1.51 (1.02–2.25)	0.006
Basic model[b]	1.00	0.79 (0.50–1.28)	1.08 (0.71–1.63)	1.44 (0.95–2.18)	1.54 (1.01–2.34)	0.006
Basic model plus light physical activity and night sleep	1.00	0.77 (0.48–1.25)	1.05 (0.69–1.60)	1.39 (0.92–2.11)	1.46 (0.96–2.23)	0.01
Basic model plus lipids[c]	1.00	0.72 (0.43–1.19)	1.24 (0.80–1.91)	1.49 (0.97–2.30)	1.44 (0.93–2.23)	0.01
Basic model plus history of diabetes, hypertension, and angina[d]	1.00	0.77 (0.46–1.28)	1.10 (0.71–1.71)	1.55 (1.01–2.40)	1.44 (0.92–2.26)	0.01
Basic model plus all other parameters included in the models above	1.00	0.77 (0.50–1.31)	1.28 (0.81–2.03)	1.66 (1.05–2.62)	1.40 (0.88–2.24)	0.02

[a] The univariate model only includes the matching variables age, gender, and area of residence.

[b] The basic model includes the matching variables plus smoking, income, education, blood pressure and BMI (weight[kg]/height[m]^2).

[c] Lipids include triglyceride, low density lipoprotein cholesterol and high density lipoprotein cholesterol.

[d] Angina as assessed by the Rose questionnaire.

variables in the basic model (smoking, income, education, blood pressure, and BMI) did not change this association (OR = 1.54). Adjusting for light physical activity and night sleep which were inversely related to siesta time attenuated the OR for the highest siesta category to 1.46, but the trend remained statistically significant. This effect was not further modified when other daily activities such as sitting and vigorous physical activity were added to the model. We also adjusted for plasma lipids to evaluate whether the association between siesta and MI was mediated by the well-known effects of physical activity on plasma lipids. This adjustment also attenuated the OR for long daily siestas (from 1.54 to 1.44) and slightly increased the OR for short daily siestas (from 1.44 to 1.49), but the *P* for trend remained statistically significant ($P = 0.01$). Because subjects who are aware of having a disease such as diabetes or hypertension, or who may have felt debilitated by angina could modify their lifestyle in ways that will directly affect the current study, we repeated the multivariate analyses controlling for these diseases. This adjustment attenuated the OR for long daily siestas to 1.44, but significantly increased the OR for short daily siestas to 1.55, (95% CI : 1.01–2.40, *P* for trend 0.01). When all risk factors in the basic model, physical activity, lipids and health history were adjusted, the OR across siesta categories were 1.0, 0.77, 1.28, 1.66, and 1.40 (*P* for trend = 0.02).

Discussion

In this large case-control study in Costa Rica, we observed that taking long daily siestas is associated with increased risk of coronary disease compared taking a siesta less than once per week. Adjusting for coronary disease risk factors including physical activity, lipids, health history and other lifestyle and environmental factors did not appreciably modify this association.

The association between increased siesta time and coronary disease is plausible because of the substantial evidence indicating that inactivity increases the risk of coronary disease.[23–25] Accordingly, NHANES I results showed an association between daytime somnolence and increased cardiovascular risk factors that mediate the effect of physical activity on coronary disease including high blood pressure and serum cholesterol levels, obesity, and diabetes.[3] Consistently, we found that subjects taking longer daily siestas had increased prevalence of hypertension, diabetes, increased BMI and plasma triglycerides. Adjusting for these parameters decreased the OR among those taking long daily siestas (from 1.51 to 1.44). Interestingly, the OR among those taking shorter daily siestas, was increased from 1.30 to 1.55 after adjustment.

The association of an afternoon siesta with coronary disease could also be explained, in part, by the surge in heart rate and blood pressure observed during the period soon after the siesta, which closely resembles the period soon after waking up in the morning.[10] The morning waking hours are characterized by an increased onset of acute MI and other acute cardiovascular events including sudden death when compared to the occurrence of such events at night.[11–13] Increases in heart rate and blood pressure, which result in increased myocardial oxygen demand, may act as triggers of these phenomena in the morning.[10] Thus, the daily siesta, in addition to being part of a more sedentary lifestyle, may increase coronary disease risk by triggering cardiac events.

Although we cannot rule out the possibility that some underlying sleep-related diseases explained the need for a siesta among some subjects in this population, our data suggest that these potential causes are probably minor given our study results. The prevalence of severe daytime sleepiness (daily daytime sleep for at least one h) is 5.5% in England.[26] Daytime somnolence two or more times per week is more prevalent among patients with obstructive sleep apnoea (19%), but this disorder would account for less than 4% of the general population.[4] In our study at least 70% reported taking a siesta at least once per week, and 35–44% reported taking daily siestas. Sleep disorders (either too short or too long night sleep) have also been associated with daytime somnolence and with increased risk of coronary disease, stroke, and mortality.[3,27,28] However, we did not find a strong correlation between siesta and hours of night sleep (7:02 versus 7:12 h:min per day) in the highest compared to the lowest siesta frequency category, consistent with previous reports.[8,9] Furthermore, a significant association between siesta and night sleep was still present when night sleep was adjusted for. The time spent on daily siestas in this report was obtained predominantly at the expense of less time spent on light indoor physical activities. Thus, our findings could not be explained solely on the basis of underlying sleep disorders among those who are more likely to have a siesta. Our data suggest that the daily siesta is a common leisure time sedentary behaviour that increases the risk of coronary disease in cultures where the siesta is tolerated. The choice of taking a siesta could be modified by physical activity promotion education programmes since it is well recognized that habitual moderate physical activity can significantly reduce the risk of coronary disease morbidity and mortality and improve longevity.[23–25]

While we found an association between daily siestas and coronary disease, no association or a trend towards a beneficial effect was observed among those who reported having a siesta 1–4 times per week compared to those who reported taking a siesta less than once per week. This finding contrasts the study in Greece where they observed a protective effect of siesta on coronary disease among subjects who took daily afternoon siestas of 85 min. However, the Greek study did not control for physical activity and 63% of their population were engaged in manual labour compared to only 18% in the present study. It is possible that in Greece, those who are more physically active were also more likely to have a siesta. Short prophylactic naps can increase alertness and counteract the effects of sleep deprivation, but increasing the nap duration does not seem to further increase alertness.[29,30] Thus, to take a short siesta 1–4 times per week may have a neutral effect on risk of coronary disease, and this habit could be beneficial because of positive effects on daily work performance.

As with many epidemiological studies of physical activity, inaccuracies in measurement and the cross-sectional case-control study design are a limitation of our study. Biased interviews could have occurred because interviewers could not be blinded as to the case-control status. Biased reporting could have occurred if cases were more likely to remember certain health behaviours that affect disease compared to controls, as studies on diet and coronary disease have shown.[31] However, we have no reason to believe that the case subjects or interviewers would selectively recall or report more time spent on siestas as opposed to light physical activity, since none of these activities are considered coronary disease risk factors among the Costa Rican general population. We also did not find major differences in the total daily time reported for daily activities in cases versus controls (21:16 versus 21:46 h:min). In our study, interviewer bias was minimized by not informing the fieldworkers about the major hypothesis of the study. More importantly, the overall association between physical activity and coronary disease found in our study is consistent with the general consensus, thus validating the accuracy of siesta reporting.[23–25] Since random misclassification of physical activity could decrease the ability to detect associations with coronary disease, our findings on coronary disease, siesta and physical activity are striking. These findings could not be explained by confounding by other coronary disease risk factors, although we cannot exclude the possibility that some residual confounding may have persisted.

There have been no previous large epidemiological studies on the effects of siesta on acute coronary disease. As many as 250 000 deaths per year in the US are attributable to a lack of regular physical activity.[32,33] Ethnic minority populations in the US are less active than Caucasians,[15,34] and are more likely to originate from countries that are part of the 'siesta culture'.[2,15] Our results suggest that recommendations to substitute daily siesta time for more physically active leisure time activities may be worthwhile in preventing coronary disease, particularly amongst cultures were siesta is a socially acceptable behaviour.

Acknowledgements

This work was supported by research grant HL 49086 from the National Institutes of Health. We are indebted to the study participants for their commitment to the study; to the fieldworkers of the Proyecto Salud Coronaria, Carlos Hidalgo, Disney Rodríguez, Jorge Mora, Guillermo Monge, Adrián Xiles, José Alberto Marín, and Mercedes Núñez for their effort, commitment and dedication to the data collection; to the directors and staff of the emergency, cardiology, coronary, and intensive care units of the hospitals San Juan de Dios, Rafael Angel Calderón Guardia, and México for their efforts in recruitment of case subjects; and to the Centro Nacional de Estadística y Censos de Costa Rica for their help in making the recruitment of controls possible.

References

1 Dinges DF. Napping patterns and effects in human adults. In: Dinges DF, Broughton RJ (eds). *Sleep and Alertness. Chronobiologicals, Behavioral, and Medical Aspects of Napping*. New York: Raven Press, 1989, pp.171–204.

2 Webb WB, Dinges DF. Cultural perspectives on napping and the siesta. In: Dinges DF, Broughton RJ (eds). *Sleep and Alertness. Chronobiologicals, Behavioral, and Medical Aspects of Napping*. New York: Raven Press, 1989, pp.247–66.

3 Qureshi AI, Giles WH, Croft JB, Bliwise DL. Habitual sleep patterns and risk for stroke and coronary heart disease: 1 10-year follow-up from NHANES I. *Neurology* 1997;**48:**904–11.

4 Young T, Palta M, Dempsey J, Skatrud J, Weber S, Badr S. The occurrence of sleep-disordered breathing among middle-aged adults. *N Engl J Med* 1993;**328:**1230–35.

5 Hung J, Whitford EG, Parsons RW, Hillman DR. Association of sleep apnoea with myocardial infarction in men. *Lancet* 1990;**336:**261–64.

6 Partinen M, Guilleminault C. Daytime sleepiness and vascular morbidity at seven-year follow-up in obstructive sleep apnea patients. *Chest* 1990;**97:**27–32.

7 Bursztyn M, Ginsberg G, Hammerman-Rozenberg R, Stessman J. The siesta in the elderly. Risk factor for mortality? *Arch Intern Med* 1999;**159:**1582–86.

8 Trichopoulos D, Tzonou A. Siesta and risk of coronary heart disease. *Stress Med* 1988;**4:**143–48.

9 Kalandidi A, Tzonou A, Toupadaki N *et al.* A case-control study of coronary heart disease in Athens, Greece. *Int J Epidemiol* 1992;**21:** 1074–78.

10 Mulcahy D, Wright C, Sparrow J *et al.* Heart rate and blood pressure consequences of and afternoon siesta (snooze-induced excitation of sympathetic triggered activity). *Am J Cardiol* 1993;**71:**611–14.

[11] Rocco MB, Barry J, Campbell S *et al.* Circadian variation of transient myocardial ischemia in patients with coronary artery disease. *Circulation* 1987;**75:**395–400.

[12] Willich SN, Linderer T, Wegscheider K, Leizorowicz A, Alamercery I, Schroder R. Increased morning incidence of myocardial infarction in the ISAM Study: absence with prior beta-adrenergic blockade. *Circulation* 1989;**80:**853–58.

[13] Muller JE, Ludmer PL, Willich SN *et al.* Circadian variation in the frequency of sudden cardiac death [see comments]. *Circulation* 1987; **75:**131–38 (Comment on: *Circulation* 1994;1989:2948–1999).

[14] Hall C. *Costa Rica. A Geographical Interpretation in Historical Perspective. Dellplain Latin American Studies, No. 17*. Boulder, CO: Westview Press, Inc., 1985.

[15] Keenman NL, Taylor-Murray E, Truman BI. *Chronic Disease in Minority Populations: African Americans, American Indians and Alaska Natives, Asians and Pacific Islanders, Hispanic Americans*. Atlanta: US Department of Health and Human Services. Public Health Service. Centers for Disease Control and Prevention, 1994.

[16] Tunstall-Pedoe H, Kuulasmaa K, Amouyel P, Arveiler D, Rajakangas A-M, Pajak A. Myocardial infarction and coronary deaths in the World Health Organization MONICA project. Registration procedures, event rates, and case-fatality rates in 38 population from 21 countries in four continents. *Circulation* 1994;**90:**583–612.

[17] Report of the Expert Committee on the Diagnosis and Classification of Diabetes Mellitus. *Diabetes Care* 1998;**21:**S5–S22.

[18] Rose GA, Blackburn H, Gillum RF, Prineas RJ. *Cardiovascular Survey Methods. 2nd Edn*. Geneva: World Health Organization, 1982.

[19] Ainsworth BE, Haskell WL, Leon AS *et al.* Compendium of physical activities: classification of energy costs of human physical activities. *Med Sci Sports Excerc* 1993;**25:**71–80.

[20] Campos H, Bailey SM, Gussak LS, Siles X, Ordovas JM, Schaefer EJ. Relationships of body habitus, fitness level, and cardiovascular risk factors including lipoproteins and apolipoproteins in a rural and urban Costa Rican population. *Arteriosclerosis* 1991;**11:**1077–88.

[21] Campos H, Mata L, Siles X, Vives M, Ordovas JM, Schaefer EJ. Prevalence of cardiovascular risk factors in rural and urban Puriscal, Costa Rica. *Circulation* 1992;**85:**648–58.

[22] Appel LJ, Moore TJ, Obarzanek E *et al.* A clinical trial of the effects of dietary patterns on blood pressure. *N Engl J Med* 1997;**336:** 1117–24.

[23] Pate RR, Pratt M, Blair SN *et al.* Physical activity and public health. A recommendation from the Centers for Disease Control and Prevention and the American College of Sports Medicine [review]. *JAMA* 1995;**273:**402–07.

[24] Physical Activity and Cardiovascular Health. National Institutes of Health Consensus Development Panel on physical activity and cardiovascular health [review]. *JAMA* 1996;**276:**241–46.

[25] US Department of Health and Human Services. *The Effects of Physical Activity on Health and Disease, in Physical Activity and Health*. A Report of the Surgeon General. Pittsburgh: Superintendent of Documents, 1996.

[26] Ohayon MM, Caulet M, Philip P, Guilleminault C, Priest RG. How sleep and mental disorders are related to complaints of daytime sleepiness. *Arch Intern Med* 1997;**157:**2645–52.

[27] Partinen M, Putkonen PT, Kaprio J, Koskenvuo M, Hilakivi I. Sleep disorders in relation to coronary artery disease. *Acta Med Scand Suppl* 1982;**660:**69–83.

[28] Wingard DL, Berkman LF. Mortality risk associated with sleep patterns among adults. *Sleep* 1983;**6:**102–07.

[29] Lumley M, Roehrs T, Zorick F, Lamphere J, Roth T. The alerting effects of naps in sleep-deprived subjects. *Psychophysiology* 1986;**23:**403–08.

[30] Gillberg M, Kecklund G, Axelsson J, Åkerstedt T. The effects of short daytime nap after restricted night sleep. *Sleep* 1996;**19:**570–75.

[31] Giovannucci E, Stampfer MJ, Colditz GA *et al.* A comparison of prospective and retrospective assessments of diet in the study of breast cancer. *Am J Epidemiol* 1993;**137:**502–11.

[32] Hahn RA, Teutsch SM, Rothenberg RB, Marks JS. Excess deaths from nine chronic diseases in the United States. *JAMA* 1986;**264:**2654–59.

[33] McGinnis JM, Foege WH. Actual causes of death in the United States. *JAMA* 1993;**270:**2207–12.

[34] DiPietro L, Caspersen C. National estimates of physical activity among white and black Americans. *Med Sci Sports Excerc* 1991;**23(Suppl.):** S105–12.