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Longitudinal evaluation of the effect of smoking initiation on body weight, blood pressure, and blood biochemistry ☆

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ABSTRACT

Objective. To evaluate the effect of smoking initiation on annual changes in body weight, blood pressure, and blood biochemistry.

Methods. This study analyzed the results of annual health examinations from 1991 to 2005 in male Japanese workers. Subjects who started smoking ($n=214$) initially responded as non-smokers in a self-administered questionnaire (baseline year) and then answered consistently as smokers for 3 subsequent years. Out of 2547 non-smokers, we selected 1589 controls who had data available for at least four successive years. The time course of physiological and laboratory data was analyzed using a linear mixed model.

Results. A significant temporal decrease from baseline in body mass index (first year, −0.1 kg/m^2), diastolic blood pressure (second year, −1.5 mm Hg) and γ-glutamyl transpeptidase (second year, −3.5 IU/L) was observed for subjects who started smoking. An opposite pattern was observed in non-smokers. On average, those who started smoking had significantly lower body mass index (first year, −0.2 kg/m^2; second year, −0.2 kg/m^2), systolic blood pressure (second year, −2.1 mm Hg), diastolic blood pressure (second year, −2.0 mm Hg), and γ-glutamyl transpeptidase (second year, −4.5 IU/L) than non-smokers.

Conclusion. In this study, smoking initiation did not yield clinically significant long-term benefits with respect to physiological or biochemical outcomes. These results are important because few studies have tracked these types of changes longitudinally from initiation through 3 years of follow-up.

Introduction

Previous studies have reported the adverse health effects of smoking initiation such as temporal increase in body mass index (BMI) (Cooper et al., 2003) and unfavorable changes in serum lipoprotein levels (Freedman et al., 1986). In contrast, other studies have reported significant decreases (Lissner et al., 1992) or lesser increases (Klesges et al., 1998; Sneve and Jorde, 2008) in body weight among subjects who started smoking compared with non-smokers. However, there have also been studies that failed to demonstrate such physiological changes following smoking initiation (Green and Harari, 1995; Tuomilehto et al., 1986).

As for smoking cessation, some studies (Filozof et al., 2004; Froom et al., 1998; Klesges et al., 1989; U.S. Department of Health and Human Services, 1990) but not large population-based studies (Bartholomew and Knuiman, 1998; Green and Harari, 1995) have reported increases in body weight in subjects following smoking cessation. Population-based studies (Klesges et al., 1998; Nakanishi et al., 2005; Williamson et al., 1991) have shown weight increases between 1.7 and 12.5 kg, which are approximately twice as high as values measured in subjects who continued to smoke.

We hypothesized that smoking initiation induces some decrease in body weight, resulting in physiologic or biochemical change, such as decrease in blood pressure or cholesterol level. The aim of the present study was to evaluate the effect of smoking initiation on annual measurements of body weight, blood pressure, and blood biochemistry in a Japanese population.

Materials and methods

Subjects

This study analyzed the results of annual health examinations in male workers in a Japanese steel company from 1991 to 2005. The study protocol required subjects to participate for 4 or more years during the observation period. This requirement resulted in a study cohort of 7058 subjects who first took part in the annual health

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Table 1
Baseline characteristics of subjects who started smoking and corresponding control non-smokers from 1991 to 2005, Japan.

	Subjects who started smoking		Controls (non-smokers)		*P*
	Mean	Standard deviation	Mean	Standard deviation	
Age (yrs)	32.6	11.1	41.0	10.0	<0.001
	n	%	*n*	%	
Job schedule (shift work)	90	42.1	548	34.5	0.033
Drinking (daily)	81[a]	38.6	626	39.4	0.88
Habitual exercise (absence)	87	40.7	568	35.7	0.17
Number of subjects	214		1589		

[a] Four subjects were excluded due to missing information on drinking.

examination between 1991 and 2002. More than 98% of the workers in the company underwent an annual health examination. Subjects undergoing treatment for hypertension, diabetes mellitus, cardio-cerebrovascular disease, hyperlipidemia, and/or malignant neoplasm were excluded.

The study cohort was classified each year into groups of 'smokers' or 'non-smokers' based on a self-administered questionnaire. The smokers were subjects who initiated smoking ($n=219$) during the study and who identified themselves as non-smokers at their initial examination (baseline year), but then answered consistently as smokers in the three subsequent years. Therefore, the observation period for each study subject consisted of his last non-smoking year followed by three successive smoking years. Five smokers were excluded because they started treatment for a particular disease (hypertension: $n=4$, cardio-cerebrovascular disease: $n=1$) after smoking initiation. Thus the target subjects consisted of 214 subjects who started smoking. The exclusion of these five individuals would be unlikely to cause bias because of the small number. Out of 2547 non-smokers, we selected 1589 controls who had data available for at least four successive years. For each control subject, one dataset of four successive years was randomly selected from available datasets spanning the whole observation period.

For all the subjects, their type of job schedule (i.e., shift work or day work) was determined from payment ledgers that came out in May of each year. The study protocol was approved by the Ethics Review Board of the Graduate School of Medicine, Chiba University.

Measurements

The following data were collected for all subjects during the annual health examinations: age, body mass index (BMI), systolic blood pressure (SBP), and diastolic blood pressure (DBP). In addition, laboratory tests for hemoglobin, total serum cholesterol, high-density lipoprotein (HDL) cholesterol, aspartate aminotransferase (AST), alanine aminotransferase (ALT), γ-glutamyl transpeptidase (GGT), hemoglobin A1c (HbA1c), creatinine, and uric acid (UA) were also performed. Health examinations were carried out between 9 a.m. and 3 p.m. throughout the study period. No measurements were taken within 30 min of a subject either eating a meal or performing heavy physical activity.

Subjects' medical history, drinking and smoking and whether they exercise regularly were determined using a self-administered questionnaire. The questionnaires were distributed to the workers as part of legally required annual health examinations for workers, to be filled out by them before the examination. Then, completed questionnaires were collected directly from workers by the healthcare administration medical staff at the place of the annual health examination. Therefore, coworkers of subjects were unaware how subjects answered the questionnaire. We gave assurances in the questionnaire that the answers would remain confidential and that answers would not lead to any unequal treatment in the workplace.

At the start of follow-up, we used a self-administered questionnaire that was originally prepared for health maintenance of workers by an occupational physician, based on the situation and medical needs in the workplace with reference to previous studies. (Belloc and Breslow, 1972; Hagihara and Morimoto, 1991) Smoking was assessed from responses to the question "are you a regular smoker?" Drinking was assessed from responses to the question "do you drink daily?" Exercising was assessed from responses to the question "do you exercise regularly?" Subjects' responses were confirmed by individual interviews conducted by occupational health physicians.

Statistical analysis

We investigated the time course of physiological and laboratory data using a linear mixed model. (Fitzmaurice et al., 2004) For each outcome variable a model with time (baseline, first, second, and third year), as the repeated measure factor, was constructed. Smoking status was included in the model as a fixed effect. Age at baseline, type of job schedule, drinking and exercise were included as covariates. Subjects' ID was included as a random effect to account for the variability due to individual differences between subjects. The interaction of time with smoking status was also assessed to test

Table 2
Time course of physiological data in smokers vs. non-smokers from 1991 to 2005 in Japan.

Variables		Baseline data Mean (SE)	1-year change[a] (Adjusted mean)	2-year change[a] (Adjusted mean)	3-year change[a] (Adjusted mean)	Significant change from baseline within group[b]
Body mass index (kg/m^2)	Started smoking	23.5 (0.2)	−0.1 (23.4)	−0.1 (23.5)	+0.1 (23.6)	0–1
	Non-smokers	23.8 (0.1)	+0.1 (23.8)	+0.1 (23.8)	+0.1 (23.9)	0–1, 0–2, 0–3
	Difference between groups[c]	−0.2 ($P=0.30$)	−0.2 ($P=0.004$)	−0.2 ($P=0.009$)	−0.1 ($P=0.28$)	
Systolic blood pressure (mm Hg)	Started smoking	126.7 (1.0)	+0.5 (127.2)	−0.9 (125.9)	+1.7 (128.4)	0–3
	Non-smokers	127.6 (0.4)	+0.4 (128.0)	+1.2 (128.8)	+1.7 (129.3)	0–2, 0–3
	Difference between groups[c]	−0.9 ($P=0.42$)	+0.0 ($P=1.00$)	−2.1 ($P=0.02$)	+0.0 ($P=0.98$)	
Diastolic blood pressure (mm Hg)	Started smoking	77.9 (0.7)	+0.6 (78.5)	−1.5 (76.4)	+0.4 (78.3)	0–2
	Non-smokers	78.4 (0.3)	+0.1 (78.4)	+0.5 (78.8)	+0.9 (79.2)	0–2, 0–3
	Difference between groups[c]	−0.5 ($P=0.54$)	+0.5 ($P=0.44$)	−2.0 ($P=0.001$)	−0.5 ($P=0.44$)	

All data are adjusted for mean baseline age (40.0 years), day work, not drinking every day and exercised regularly.
[a] Change from baseline data.
[b] Only the significant relationships ($P<0.05$) are shown.
[c] For 1-year, 2-year and 3-year changes, these values represent the effect of starting smoking on each variable compared to non-smoking.