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Original Contribution

A Prospective Study of Childhood and Adult Socioeconomic Status and Incidence of Type 2 Diabetes in Women

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The influence of childhood socioeconomic status (SES) on incidence of type 2 diabetes mellitus has not previously been studied. The authors prospectively examined the association of childhood SES (father's occupation) with incidence of diabetes in 100,330 US women who were followed from 1980 to 2002. In 55,115 of those women, 10-year follow-up data (1992–2002) were also available on adult SES (spouse's education). In all, 6,916 new cases of type 2 diabetes were documented. Compared with women from white-collar occupational backgrounds, the multivariate-adjusted risks of diabetes were 1.08 (95% confidence interval (CI): 0.95, 1.23) among women whose fathers were laborers and 1.10 (95% CI: 1.03, 1.16) among women whose fathers were blue-collar or lower white-collar workers. Lower adult SES was associated with risk of diabetes independently of childhood SES. Compared with women whose spouses had graduate degrees, women whose spouses were high school graduates had a 1.16 times higher risk of incident diabetes (95% CI: 1.04, 1.29), while women whose spouses had college degrees were at 1.14 times the risk (95% CI: 1.01, 1.29). Compared with women with stable high SES from childhood to adulthood, women with declining SES had a 1.18 times higher risk of incident diabetes (95% CI: 1.06, 1.32). Higher body mass index among women with lower SES accounted for much of these rather modest associations between childhood and adult SES and risk of diabetes.

diabetes mellitus, type 2; incidence; social class; women

Abbreviations: BMI, body mass index; CI, confidence interval; RR, relative risk; SES, socioeconomic status.

Lower socioeconomic status (SES) is consistently related to worse health outcomes (1–3). However, there are scarce data on the relation between SES and the incidence of type 2 diabetes mellitus. Few prospective studies have examined SES in relation to diabetes incidence. A 2004 report from the Whitehall II Study described an inverse relation between employment grade and type 2 diabetes incidence, but only in men (4). In a 1980 study from United Kingdom, the incidence of type 2 diabetes was higher in towns with worse social conditions, but SES was not individually assessed (5). A follow-up of the Alameda County Study cohort in the United States showed that education, income, and occupation were associated with increased diabetes risk in unadjusted models but not in multivariate-adjusted models (6).

In addition to affecting disease incidence, compelling evidence has demonstrated that low SES adversely affects

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prognosis following the onset of many chronic diseases (1–3). Among persons with diabetes, long-term health outcomes are worse for those with low SES (7, 8). Several cross-sectional studies have also found that the prevalence of diabetes is higher in socioeconomically disadvantaged groups, and in nearly all studies this relation was independent of ethnicity (9–12). In most cases, established biologic risk factors, such as adiposity, explained the observed socioeconomic differences, although some studies have also found independent effects of psychosocial factors, such as low decision latitude at work, on diabetes prevalence (13). In the Nurses' Health Study cohort (14), as well as in some other studies (15, 16), low childhood SES has been related to an increased incidence of cardiovascular disease, but a link between childhood SES and adult diabetes has not been described previously. The Nurses' Health Study offered the possibility of addressing both issues, namely whether either childhood SES or adult SES influences the incidence of type 2 diabetes.

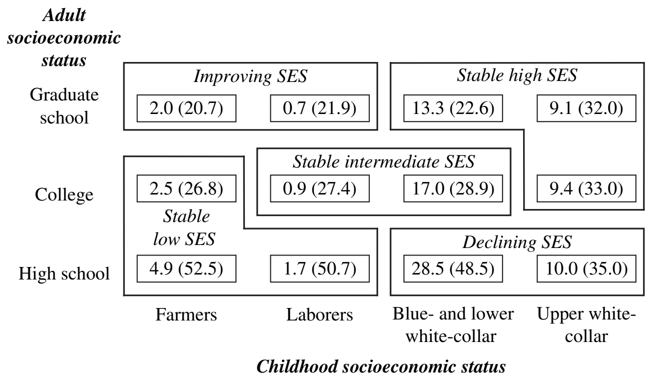

FIGURE 1. Distribution and combined categorization of childhood (1980–2002) and adult (1992–2002) socioeconomic status (SES) in 55,115 female registered nurses from the Nurses' Health Study. Data are presented as percentages of the total population and, in parentheses, according to the distribution within each one of the four childhood categories. Mantel-Haenszel chi-squared test: $p < 0.0001$.

MATERIALS AND METHODS

Study population

The Nurses' Health Study was established in 1976, when 121,700 female registered nurses aged 30–55 years and residing in one of 11 US states completed a mailed questionnaire regarding medical history and lifestyle factors. The cohort has been followed up by questionnaire every 2 years. Childhood SES was reported in 1976, while dietary habits were assessed for the first time in 1980, and adult SES and data on birth weight and breastfeeding were first assessed in 1992. In the present analyses, we followed women from 1980 to 2002 to examine the association of childhood SES with diabetes and from 1992 to 2002 for adult SES. On the baseline questionnaire in 1976, each participant was asked to report her father's occupation at the time she was 16 years of age. In 1992, each participant was asked about her spouse's educational attainment. Subjects with missing information on childhood SES ($n = 11,643$) or adult SES ($n = 12,911$) or who reported having cancer, coronary heart disease, or diabetes at baseline were excluded from the analyses. In all, 100,330 women were included in the analyses of childhood SES and diabetes incidence (1980–2002), while 55,115 married or widowed women were included in the analyses of adult SES and diabetes (1992–2002). The study protocol was approved by the institutional review board of Brigham and Women's Hospital (Boston, Massachusetts).

Assessment of SES

At baseline in 1976, women were asked, ''When you were 16 years of age, what was your father's occupation?'' Written responses to this open-ended question were manually coded into eight groups (farmers, laborers, service, craftsmen, sales, clerical, managerial, and professional). We analyzed the eight groups separately as well as combined into farmers, laborers, blue- and lower white-collar workers (service, craftsmen, sales, clerical), and upper white-collar workers (managerial, professional). This method of classification is analogous to the Edwards classification of social class and follows established practice in socioeconomic research (17).

Given that the participants were a relatively homogeneous group with respect to their own level of educational attainment, we used spouse's educational level as the indicator of socioeconomic position among women who were married or widowed (14). Unmarried or divorced women (5.9 percent of the cohort) were not asked about spousal education and thus were excluded from the present analyses. Three categories of adult SES were created from responses to the question on spouse's education: high school or less, college (some course credits or a degree), and graduate school. Educational attainment is a well-accepted indicator of SES (18).

We cross-classified data on father's occupation (our indicator of childhood SES) with data on spouse's education (our indicator of adult SES). Figure 1 reveals some evidence of restricted intergenerational class mobility; that is, women from lower occupational class backgrounds were more likely to be married to spouses with lower levels of education. To examine the associations between change in SES and risk of diabetes, we created five mutually exclusive categories of women from the data in figure 1: women with stable low SES, women with stable high SES, and women with stable intermediate SES, as well as women with declining SES over the life course and women with improving SES over the life course.

Ascertainment of diabetes diagnosis

A validated supplementary questionnaire regarding symptoms, diagnostic tests, and hypoglycemic therapy was mailed to women who indicated on any biennial questionnaire that they had been diagnosed with diabetes during the previous 2 years. A case of diabetes was considered confirmed if at least one of the following was reported on the supplementary questionnaire: 1) classic symptoms plus elevated glucose levels (fasting plasma glucose concentration $\geq$140 mg/dl ($\geq$7.8 mmol/liter) or a randomly measured glucose concentration ≥200 mg/dl (≥11.1 mmol/liter)); 2) at least two elevated plasma glucose measurements obtained on different occasions in the absence of symptoms (fasting plasma glucose concentration ≥140 mg/dl or a randomly measured plasma glucose concentration ≥200 mg/dl, or oral glucose tolerance testing level after 2 or more hours ≥200 mg/dl); or 3) treatment with oral hypoglycemic agents or insulin. These criteria are consistent with those proposed by the National Diabetes Data Group (19). The validity of diagnosis of type 2 diabetes through the use of the supplemental questionnaire has been verified (20). In addition, another substudy assessing the prevalence of undiagnosed diabetes suggested a very low rate of false negatives (21). The diagnostic criteria for type 2 diabetes were changed in 1997 such that a lower fasting glucose level (≥126 mg/dl; 7.0 mmol/liter) would now be considered diagnostic (22). Thus, we used the American Diabetes Association criteria for diagnosis of diabetes cases after 1998 but did not revise the diagnoses of earlier cases.

Deaths occurring during follow-up were identified from the National Death Index, next of kin, or the US postal system. Using all sources combined, we estimated that mortality follow-up was more than 98 percent complete (23).

Covariates

Data on covariates were updated biennially. Age was included in 5-year categories (≤49, 50–54, 55–59, 60–64, or ≥65 years), and body mass index (BMI; weight (kg)/height $(m)^2$), based self-reported weight and height, was divided into nine categories (<21, 21.0–22.9, 23.0–24.9, 25.0–26.9, 27.0–29.9, 30.0–32.9, 33.0–34.9, 35.0–39.9, or ≥40.0). Waist and hip circumferences were first measured in 1986 and were used in the 1992–2002 follow-up of adult SES as quintiles of waist circumference and waist:hip ratio. Quintiles of leisure-time physical activity were based on hours per week (1980–1992) or metabolic equivalent units per week (1992–2002). Higher quintiles of dietary score reflected a higher ratio of polyunsaturated fat to saturated fat, higher intakes of folate and cereal fiber, a low intake of *trans*- fat, and a low glycemic load (24). Information on fat, fiber, and glycemic load was energy-adjusted. Further adjustments included alcohol consumption (0, 0.1–4.9, 5.0–14.9, or ≥15 g/day), smoking status (never, past, or current smoker (1–14, 15–24, or ≥25 cigarettes/day)), baseline hypertension (no, yes), baseline hypercholesterolemia (no, yes), family history of diabetes in a first-degree relative (no, yes), menopausal status (pre- or post-), use or nonuse of hormone replacement therapy, ethnicity (Caucasian, Hispanic, Asian, or Afro-American), participant's birth weight (≤5.5, 5.6–7, 7.1–8.5, or ≥8.6 pounds (1 pound = 0.5 kg), or not known), and whether or not the participant had been breastfed as an infant (no or unsure, yes).

Statistical analysis

Person-years for childhood SES were calculated from the return of the 1980 questionnaire to the date of diabetes diagnosis, the date of death, or June 1, 2002, whichever came first. Person-years for adult SES were calculated from the date of return of the 1992 questionnaire to the earliest of the above dates. Age-adjusted analyses were conducted with 5-year age categories and by Mantel-Haenszel methods (25). Cox proportional hazards regression was used to adjust for age and other confounding or mediating variables. Time-varying covariates (biennially updated key exposure information, categorized as described above) were introduced in stepwise fashion into the regression analyses in order to examine which of them could explain the difference in risk of incident diabetes by SES group. The most recent exposure data for each 2-year follow-up interval were used. The final models also included adjustment for either adult SES or childhood SES, depending on which of these two was the main predictor variable of interest.

In the 1980–2002 follow-up of childhood SES, we adjusted for participant's birth data (birth weight and breastfeeding) and adult SES, although these questions were asked on the 1992 questionnaire. That is, we made the assumption that retrospectively assessed birth data and attained adult SES were unchanged throughout 1980–2002. Birth circumstances do not change after birth, and educational level cannot be reduced and is unlikely to have increased further among spouses of women who had a mean age of 58 years in 1992. Statistical analyses were conducted using SAS, version 8.2 (SAS Institute, Inc., Cary, North Carolina). All p values were two-sided.

RESULTS

For the analyses of childhood SES and risk of incident diabetes, the study population consisted of 100,330 women aged 34–59 years in 1980, for whom complete data were available. The age-adjusted characteristics of the women by childhood SES at baseline are presented in table 1. Women with lower childhood SES had a higher mean BMI and lower alcohol consumption, and fewer were past smokers, while more had baseline hypertension or hypercholesterolemia (p for trend <0.001 for all). In the total population, daily consumption of *trans*- fat and dietary fiber was approximately 4.0 g and 14 g, respectively, and the ratio of polyunsaturated fat to saturated fat was 0.35, but there were no differences between the eight categories defined by father's occupation. Moreover, there was no difference in current smoking or postmenopausal hormone therapy; nearly 30 percent of the women smoked and 19 percent used hormones. Higher childhood SES was associated with lower birth weight ($p < 0.0001$) and lower prevalence of breastfeeding during infancy ($p < 0.0001$).

The analyses of childhood SES included 2,060,853 person-years of follow-up from 1980 to 2002 and 6,916 incident cases of type 2 diabetes (table 2). The age-adjusted analyses showed an increased risk of diabetes among women whose fathers were laborers, service workers, craftsmen, or salesmen, with relative risks between 1.55 (95 percent confidence interval (CI): 1.35, 1.78) and 1.32 (95 percent CI: 1.16, 1.49), compared with women whose fathers had professional backgrounds. After further adjustment for BMI, the relative risks varied between 1.27 (95 percent CI: 1.11, 1.46) and 1.22 (95 percent CI: 1.12,

TABLE 1. Age-adjusted baseline characteristics of 100,330 female registered nurses according to childhood socioeconomic status, assigned on the basis of father's occupation, Nurses' Health Study, 1980

Father's occupation	Age (years)	Body mass index*	Physical activity (hours/week)	Glycemic load†	Alcohol consumption (g/day)	Past smoking (%)	Hypertension (%)	Hypercholesterolemia (%)
Farmer	48.4	24.3	4.3	84	4.9	22.7	33.5	42.5
Laborer	46.6	24.7	3.9	88	5.5	24.2	36.4	42.2
Service worker	46.2	24.6	3.9	86	6.5	26.7	33.7	39.3
Craftsman	45.9	24.7	3.8	87	5.3	24.6	33.6	41.7
Salesman	46.0	24.4	3.9	86	6.1	25.8	33.3	40.6
Clerical worker	45.7	24.0	3.9	85	7.4	28.4	31.2	39.4
Manager	45.6	23.9	4.1	85	7.4	28.6	30.3	39.1
Professional	45.3	23.7	4.2	85	7.8	27.9	29.7	38.1

* Weight (kg)/height (m)^2.

† Sum of (glycemic index for individual foods × carbohydrate content of the food item) for each food. Values were energy-adjusted.

1.34) for the same categories, except for the group whose fathers were service workers, for which the result became nonsignificant. After multivariate adjustment, the risks remained elevated for women whose fathers were craftsmen (RR = 1.12, 95 percent CI: 1.02, 1.23) or salesmen (RR = 1.15, 95 percent CI: 1.05, 1.26). Adjustment for BMI accounted for the largest attenuation of relative risks associated with childhood SES.

The eight categories of father's occupation were also collapsed into four (17); the results are presented in table 3. After multivariate adjustment, the relative risk was 1.10 (95 percent CI: 1.03, 1.16) for the blue- and lower white-collar category (service workers, craftsmen, salesmen, and clerical workers). The increased risk of diabetes among women from lower occupational class backgrounds was independent of adult SES. Adjustment for BMI again resulted in the largest attenuation of relative risks. We found similar results when the clerical group was included in the reference category of upper white-collar occupations. Data on adult SES were available for fewer women than was the case

TABLE 2. Relative incident risk of type 2 diabetes among 100,330 female registered nurses according to childhood socioeconomic status, assigned on the basis of father's occupation, Nurses' Health Study, 1980–2002

Father's occupation	No. of cases	Person-years of follow-up	Age-adjusted		Age- and body mass index*-adjusted		Multivariate-adjusted	
			RR†	95% CI†	RR	95% CI	RR‡	95% CI
Farmer	597	191,284	1.10	0.98, 1.22	1.00	0.90, 1.12	0.95	0.85, 1.06
Laborer	294	70,160	1.55	1.35, 1.78	1.27	1.11, 1.46	1.09	0.95, 1.25
Blue- or lower white-collar occupation								
Service worker	420	118,551	1.32	1.16, 1.49	1.10	0.98, 1.25	1.03	0.91, 1.16
Craftsman	1,359	338,153	1.51	1.37, 1.66	1.24	1.13, 1.36	1.12	1.02, 1.23
Salesman	1,988	528,811	1.41	1.29, 1.54	1.22	1.12, 1.34	1.15	1.05, 1.26
Clerical worker	660	229,894	1.08	0.97, 1.21	1.02	0.92, 1.14	1.00	0.90, 1.12
Upper white-collar occupation								
Manager	954	339,442	1.06	0.96, 1.17	1.03	0.93, 1.14	1.01	0.91, 1.12
Professional	644	244,558	1.00		1.00		1.00	

* Weight (kg)/height (m)^2.

† RR, relative risk; CI, confidence interval.

‡ Adjusted for age group (≤49, 50–54, 55–59, 60–64, or ≥65 years), body mass index (<21, 21.0–22.9, 23.0–24.9, 25.0–26.9, 27.0–29.9, 30.0–32.9, 33.0–34.9, 35.0–39.9, or ≥40.0 kg/m^2), physical activity (quintiles of hours/week), quintile of dietary score (glycemic load, *trans*- fat, polyunsaturated:saturated fat ratio, and dietary fiber), alcohol consumption (0, 0.1–4.9, 5.0–14.9, or ≥15 g/day), smoking status (never, past, or current smoker (1–14, 15–24, or ≥25 cigarettes/day)), baseline hypertension, baseline hypercholesterolemia, family history of diabetes, menopausal status (pre- or post-), use of hormone replacement therapy, ethnicity (Caucasian, Hispanic, Asian, or Afro-American), birth weight, breastfeeding, and husband's education. The multivariate-adjusted analysis was performed in 55,115 women.

TABLE 3. Relative incident risk of type 2 diabetes among 100,330 female registered nurses according to childhood socioeconomic status, in four combined categories assigned on the basis of father's occupation, Nurses' Health Study, 1980–2002

Father's occupation	No. of cases	Person-years of follow-up	Age-adjusted		Age- and body mass index*-adjusted		Multivariate-adjusted	
			RR†	95% CI†	RR	95% CI	RR‡	95% CI
Farmer	597	191,284	1.06	0.96, 1.16	0.98	0.89, 1.08	0.94	0.86, 1.04
Laborer	294	70,160	1.50	1.32, 1.69	1.25	1.10, 1.41	1.08	0.95, 1.23
Blue- or lower white-collar occupation	4,427	1,215,409	1.32	1.25, 1.40	1.16	1.16, 1.23	1.10	1.03, 1.16
Upper white-collar occupation	1,598	584,000	1.00		1.00		1.00	

* Weight (kg)/height (m)^2.

† RR, relative risk; CI, confidence interval.

‡ Adjusted for age group ($\leq$49, 50–54, 55–59, 60–64, or $\geq$65 years), body mass index (<21, 21.0–22.9, 23.0–24.9, 25.0–26.9, 27.0–29.9, 30.0–32.9, 33.0–34.9, 35.0–39.9, or $\geq$40.0 kg/m^2), physical activity (quintiles of hours/week), quintile of dietary score (glycemic load, *trans*- fat, polyunsaturated:saturated fat ratio, and dietary fiber), alcohol consumption (0, 0.1–4.9, 5.0–14.9, or $\geq$15 g/day), smoking status (never, past, or current smoker (1–14, 15–24, or $\geq$25 cigarettes/day)), baseline hypertension, baseline hypercholesterolemia, family history of diabetes, menopausal status (pre- or post-), use of hormone replacement therapy, ethnicity (Caucasian, Hispanic, Asian, or Afro-American), birth weight, breastfeeding, and husband's education. The multivariate-adjusted analysis was performed in 55,115 women.

for childhood SES—that is, the final multivariate analysis in tables 2 and 3 was performed in the smaller group of 55,115 women—but the relative risks did not change when adult SES was excluded as an adjustment factor. The relative risks of diabetes, adjusted only for birth weight and breastfeeding, were 1.08 (95 percent CI: 0.91, 1.28) for women whose fathers were farmers, 1.34 (95 percent CI: 1.06, 1.70) for women whose fathers were laborers, and 1.32 (95 percent CI: 1.19, 1.46) for women whose fathers were blue-collar or lower white-collar workers.

We then examined adult SES in relation to diabetes risk (table 4). During 524,637 person-years of follow-up for adult SES (1992–2002), we documented 2,457 cases of type 2 diabetes. Women who had spouses with lower educational attainment had a higher BMI, lower physical activity, lower dietary *trans*- fat and fiber, lower alcohol consumption, and higher frequencies of smoking, hypertension, and hypercholesterolemia, while fewer used hormone replacement therapy. The lowest level of husband's education (high school) was associated with an age-adjusted relative risk of diabetes of 1.79 (95 percent CI: 1.61, 2.00). Adjustment for BMI attenuated the relative risk to 1.33 (95 percent CI: 1.19, 1.48), while additional multivariate adjustment attenuated the risk further (RR = 1.16, 95 percent CI: 1.04, 1.29). Increased multivariate risk was also found for the women with college-educated husbands (RR = 1.14, 95 percent CI: 1.01, 1.29) as compared with those whose husbands had a graduate school education. These associations were independent of childhood SES. In line with the results of childhood SES, the relative risk for adult SES was most markedly

TABLE 4. Relative incident risk of type 2 diabetes among 55,115 female registered nurses according to adult socioeconomic status, assigned on the basis of husband's education, Nurses' Health Study, 1992–2002

Husband's educational level	No. of cases	Person-years of follow-up	Age-adjusted		Age- and body mass index*-adjusted		Multivariate-adjusted	
			RR†	95% CI†	RR	95% CI	RR‡	95% CI
High school	1,359	234,755	1.79	1.61, 2.00	1.33	1.19, 1.48	1.16	1.04, 1.29
Any college	673	156,689	1.34	1.19, 1.52	1.21	1.07, 1.37	1.14	1.01, 1.29
Graduate school	425	133,193	1.00		1.00		1.00	

* Weight (kg)/height (m)^2.

† RR, relative risk; CI, confidence interval.

‡ Adjusted for age group ($\leq$49, 50–54, 55–59, 60–64, or $\geq$65 years), body mass index (<21, 21.0–22.9, 23.0–24.9, 25.0–26.9, 27.0–29.9, 30.0–32.9, 33.0–34.9, 35.0–39.9, or $\geq$40.0 kg/m^2), physical activity (quintiles of hours/week), quintile of dietary score (glycemic load, *trans*- fat, polyunsaturated:saturated fat ratio, and dietary fiber), alcohol consumption (0, 0.1–4.9, 5.0–14.9, or $\geq$15 g/day), smoking status (never, past, or current smoker (1–14, 15–24, or $\geq$25 cigarettes/day)), baseline hypertension, baseline hypercholesterolemia, family history of diabetes, menopausal status (pre- or post-), use of hormone replacement therapy, ethnicity (Caucasian, Hispanic, Asian, or Afro-American), birth weight, breastfeeding, and childhood socioeconomic status (father's occupation).

TABLE 5. Relative incident risk of type 2 diabetes among 55,115 female registered nurses according to combined childhood and adult socioeconomic status, Nurses' Health Study, 1992–2002

Change in SES* from childhood to adulthood	Age-adjusted		Age- and body mass index†-adjusted		Multivariate-adjusted	
	RR*	95% CI*	RR	95% CI	RR‡	95% CI
Stable low SES	1.51	1.28, 1.78	1.18	1.00, 1.39	1.01	0.90, 1.25
Stable intermediate SES	1.49	1.31, 1.70	1.29	1.13, 1.47	1.21	1.06, 1.38
Declining SES	1.80	1.61, 2.00	1.34	1.20, 1.49	1.18	1.06, 1.32
Improving SES	0.89	0.64, 1.24	0.90	0.65, 1.26	0.91	0.65, 1.28
Stable high SES	1.00		1.00		1.00	

* SES, socioeconomic status; RR, relative risk; CI, confidence interval.

† Weight (kg)/height (m)^2.

‡ Adjusted for age group ($\leq$49, 50–54, 55–59, 60–64, or $\geq$65 years), body mass index (<21, 21.0–22.9, 23.0–24.9, 25.0–26.9, 27.0–29.9, 30.0–32.9, 33.0–34.9, 35.0–39.9, or $\geq$40.0 kg/m^2), physical activity (quintiles of hours/week), quintile of dietary score (glycemic load, *trans*- fat, polyunsaturated:saturated fat ratio, and dietary fiber), alcohol consumption (0, 0.1–4.9, 5.0–14.9, or $\geq$15 g/day), smoking status (never, past, or current smoker (1–14, 15–24, or $\geq$25 cigarettes/day)), baseline hypertension, baseline hypercholesterolemia, family history of diabetes, menopausal status (pre- or post-), use of hormone replacement therapy, ethnicity (Caucasian, Hispanic, Asian, or Afro-American), birth weight, and breastfeeding.

attenuated after adjustment for BMI. Additional adjustments for waist circumference and waist:hip ratio produced similar relative risks. When waist:hip ratio was added with BMI and the other variables, the relative risk for women with high-school-educated spouses was 1.17 (95 percent CI: 1.05, 1.31), and for women with college-educated spouses it was 1.14 (95 percent CI: 1.01, 1.29).

We then analyzed life-course trajectories of SES (table 5). Compared with women with stable high SES, women with stable intermediate SES (RR = 1.21, 95 percent CI: 1.06, 1.38) or declining SES (RR = 1.18, 95 percent CI: 1.06, 1.32) had an increased risk of diabetes in adulthood.

DISCUSSION

In the present study, we found that both low childhood SES and low adult SES were associated with increased risk of developing type 2 diabetes among women. Established biologic or lifestyle risk factors for diabetes did not fully explain these increases. However, the risk increases were modest and were markedly attenuated after adjustment for BMI. Nonetheless, the range of potentially confounding and intermediate variables that we included in the regression models could not fully account for the observed associations between childhood and adult SES and incidence of diabetes.

To our knowledge, this is the first prospective study to examine childhood SES and incidence of diabetes. Higher degrees of adult social deprivation have been previously linked to higher prevalence of diabetes (9–12), and in such deprived groups of people with diabetes, the risks for long-term complications are also higher (7, 8). Our study extends these findings by showing that the incidence of diabetes is higher among persons with lower childhood or adult socioeconomic circumstances. Furthermore, women with a socioeconomic position that declined from childhood to adulthood had an increased risk of developing diabetes, while women who improved their SES did not differ in risk from those with a stable high SES over the life course.

A large portion of the risks found may be attributed to BMI differences across socioeconomic groups, thus pointing to the need to reduce the burden of overweight and obesity through lifestyle changes in lower socioeconomic groups. Since trajectories of overweight tend to be established during adolescence (26), this suggests the importance of preventive efforts targeted toward earlier periods in the life course. The nonsignificant risk observed in the farming category may be due to the broad range of economic positions in this group, because the occupation of farmer is known to be heterogeneous—individuals can be farm laborers (low SES) or farm owners (high SES) (14, 17). We did not relate diabetes incidence to mother's occupation, since the vast majority of the respondents' mothers were homemakers (14). However, father's occupation has previously been used as an indicator of childhood SES in the Nurses' Health Study (14) and other studies (17).

In the Whitehall II Study, men working at lower employment grades in the British civil service had a higher incidence of diabetes than those working at higher employment grades, after adjustment for multiple biologic or social risk factors (4). Work-related effort–reward imbalance was the only psychosocial factor related to incidence of diabetes in men. In women, no such relation was seen. However, women reporting a high degree of material problems (based on financing, housing, and neighborhood difficulties) had an increased diabetes incidence, but after age adjustment only. That study included fewer than 2,700 women and had a relatively low attendance rate at follow-up (4). In the Alameda County Study, comprising nearly 6,200 men and women, there were unadjusted associations between education, income, and occupation and risk of diabetes (6). A low level of education was also associated with increased diabetes risk after adjustment for age, gender, race, and marital status (6).

The strengths of the present study included the extensive numbers of women studied and the fact that we updated data on most exposures every 2 years. Respondents were a relatively homogenous group of women based on their own educational attainment and occupation (all were registered nurses at enrollment), and hence their economic well-being was determined more by their spouses' education, which was the predictor we used in this analysis. No difference in multivariate-adjusted risk of diabetes was seen when the women's own educational attainment (3-year diploma or master's degree vs. doctorate) was used instead of their spouses' education (data not shown).

Limitations of our study included the fact that we lacked data on income, which may vary even within similar strata of education. However, other studies have shown a moderate degree of correlation between education, occupation, and income (17, 18). Another limitation of our study is that our assessment of adult SES was limited to women who were married or widowed at baseline in 1992, and data on spouse's education were missing for unmarried or divorced women. Our finding of the ''independent'' influence of childhood and adult SES is also limited by the fact that we used different indicators to assess childhood SES (father's occupation) and adult SES (spouse's educational attainment). This was necessitated by the fact that childhood SES was retrospectively recalled by the women in the cohort when they were adults. Inquiring about father's occupation during childhood is less prone to error and misclassification than asking about father's educational attainment or income. However, the difference in methods of assessing childhood and adult SES could have resulted in residual confounding of the association between father's occupation and risk of diabetes by other, unmeasured aspects of childhood SES.

None of the traditional risk factors could fully explain the relation between lower childhood or adult SES and higher incidence of diabetes. The magnitudes of the increased risks were small, but the weak associations for both childhood and adult SES may still have been due to residual confounding or unmeasured confounding variables or intermediate covariates. Although self-reports of BMI have been validated in the Nurses' Health Study against measured BMI and the correlations have been found to be very good (27), we acknowledge that self-reported BMI may still be biased according to SES and that misclassification could result in residual confounding. One may also argue that adjustment for baseline hypertension, hypercholesterolemia, or BMI represents statistical overadjustment (i.e., adjusting for the pathways through which childhood and adult SES can lead to increased risk of diabetes).

Socioeconomic deprivation may cause not only a deficit of material assets but also possibly increased levels of psychosocial vulnerability and mental stress. This has been partly described for men in the Whitehall II Study, though not for women (4). In a Swedish study, psychosocial factors such as low decision latitude at work and low sense of coherence accounted for some of the socioeconomic differences in type 2 diabetes prevalence in women (13).

In summary, this study indicates that women with lower childhood or adult SES have an increased risk of developing type 2 diabetes. Differences in biologic risk factors, notably BMI, and differences in lifestyle (i.e., physical exercise and dietary habits) should receive priority in interventions designed to reduce socioeconomic disparities in diabetes incidence among women.

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