Family History of Diabetes in Relation to Different Types of Obesity and Change of Obesity During 12-Yr Period

Results from prospective population study of women in Göteborg, Sweden

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OBJECTIVE — To assess the relationship between family history and different types of obesity and change in obesity in a longitudinal population study.

RESEARCH DESIGN AND METHODS — A longitudinal population study of 1462 randomly selected women (38–60 yr old) was conducted in Göteborg, Sweden, in 1968–69. The women were restudied after 12 yr.

RESULTS — A family history of diabetes in mothers but not fathers showed, in univariate analysis, a significant positive association with obesity expressed as BMI. A family history of diabetes in the mothers was inversely related to body fat distribution expressed as WHR. No other association was observed between family history of diabetes and WHR. The association with BMI was independent of age, WHR, smoking habits, blood glucose, systolic blood pressure, serum cholesterol, serum triglycerides, maternal obesity, and the incidence of diabetes during the 12-yr follow-up period. Twelve years later, in 1980–1981, an independent association still existed between family history for diabetes and BMI measured at that examination, whereas there was no relationship with WHR. Women who had a family history of diabetes increased their BMI significantly more during the 12-yr follow-up compared with the women without a family history of diabetes, whereas there was no difference for the change of WHR. Family history of coronary heart disease and family history of cancer did not correlate to any kind of obesity.

CONCLUSIONS — These findings indicate that family history of diabetes is related to overall obesity but not to abdominal adiposity per se.

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BMI, BODY MASS INDEX; WHR, WAIST-HIP CIRCUMFERENCE RATIO; NIDDM, NON-INSULIN-DEPENDENT DIABETES MELLITUS.

Obesity is a risk factor for NIDDM in both men and women (1–3). Furthermore, subjects with a family history of diabetes are overrepresented among those who develop NIDDM (4–6). Obesity and family history of diabetes have been shown to present independent risks of diabetes in women (6,7). In this paper, we related family history of diabetes to obesity and change of obesity. We defined obesity as both general and abdominal obesity.

RESEARCH DESIGN AND METHODS

— From 1968 to 1969, we studied 1462 women in Göteborg, Sweden, aged 38, 46, 50, 54, or 60 yr. Table 1 shows the number of participants in the initial examination. The population sample was followed up on two occasions, in 1974–1975 and 1980–1981. Of those participating in 1968–1969, 1154 (78.9%) took part in 1980–1981. Further details concerning this population study have been presented elsewhere (4,8–10).

Clinical examination

In the initial study in 1968–1969 and in the study in 1980–1981, blood samples were taken after overnight fasting (8,10). Body weight was measured to the nearest 0.1 kg with a balance scale. The women wore only briefs when weighed. Body height without shoes was measured to the nearest 0.5 cm. BMI was calculated as weight/height^2 (kg/m^2).

Table 1—*Participants and participation rates in population study of women in Gothenburg, Sweden, 1968–1969*

AGE (YR)	PARTICIPANTS (N)	PARTICIPATION RATE (%)
38	372	91.4
46	431	90.0
50	398	91.3
54	180	88.7
60	81	83.5
TOTAL	1462	90.1

Waist circumference was measured to the nearest 1 mm at the level midway between the lower rib margin and the iliac crest with a steel tape measure. Hip circumference was measured in the same way at the widest point between hip and buttocks. WHR was calculated as waist circumference/hip circumference. The circumferences were measured in the erect position. All anthropometric measurements were performed by one observer. Blood pressure was measured with a mercury manometer in the seated position after ~5 min rest (11). Information about smoking habits was obtained via standardized interview (11). Obesity in the mother was estimated by a subsample of 80% of the subjects. A three-point scale was used in which the parent was described as either 1) thinner than most other mothers, 2) similar to most other mothers, or 3) fatter than most other mothers. Serum insulin concentration was only determined in the 50-yr-old women (n = 348) at one occasion (1968–1969) (4).

Clinically manifest diabetes was recorded at the initial examination in 1968–1969 and during the 12-yr follow-up. All participants were asked if they had a history of diabetes, coronary heart disease, or cancer. If a physician had set the diagnosis of diabetes, this was accepted. Women with a fasting blood glucose concentration ≥6.0 mM (107.1 mg/100 ml) in the follow-up studies and who were not known to have diabetes were referred to a special diabetes unit for further examination. In addition to women with known diabetes, individuals with two capillary whole-blood samples with fasting glucose concentrations ≥7.0 mM (125.0 mg/100 ml) also were defined as having diabetes. This is in accordance with the previous World Health Organization recommendations (12).

Statistical methods

A general linear model was used to test for associations between family history and indicators of obesity after adjustment for age and other continuous variables, and least-square means were calculated. Two-tailed Student's t tests were used, and $P < 0.05$ was considered significant. Women who had diabetes mellitus at the initial study (n = 12) and who developed diabetes during the 12-yr follow-up period (n = 43) were excluded from statistical analyses.

RESULTS

Family history of diabetes

Of 1415 women initially free from signs of diabetes mellitus on whom we obtained valid follow-up data, 43 (3.0%) developed diabetes mellitus during the 12-yr follow-up period. Of these 1415 women, 117 (8.3%) reported diabetes among their mothers, 47 (3.3%) among their fathers, and 163 (11.5%) reported a family history of diabetes in any of their parents at the time of the baseline study. Another 38 women reported a family history of diabetes in siblings, giving a total family history of diabetes in 14.2% of the women.

Family history of coronary heart disease and cancer

A family history of coronary heart disease in any of their parents was reported by 437 (30.9%) women, and a family history of cancer was reported by 368 (26.0%) women.

Family history of diabetes in relation to cardiovascular risk factors

Table 2 shows the age-specific P values for the correlations between family history of diabetes and different variables studied. Family history of diabetes was correlated significantly to serum triglycerides measured in 1980–1981 (P = 0.02). No other significant correlations were observed.

Family history of diabetes in relation to obesity

Table 3 shows least-square mean ± SE values for the two aspects of obesity (BMI and WHR) at the examinations in 1968–1969 and 1980–1981 in women with and without a family history of diabetes. In all analyses, age and other types of obesity were included as potential confounders. BMI was significantly higher in women with a family history of diabetes among their mothers ($P < 0.01$) compared with women who had no history of diabetes, whereas WHR was significantly lower in women with a family history of diabetes among their mothers ($P < 0.05$). Waist circumference measured in 1968–1969 did not differ significantly in women with and without a history of diabetes when univariate analysis was performed; however, when adjustment was made for BMI, waist circumference was significantly lower in women with a family history of diabetes among their mothers (least-square means 71.8 and 73.1 mm, respectively, $P < 0.05$). In 1980–1981, BMI also was increased significantly in women with a family history of diabetes among their mothers compared with women without a family history of diabetes ($P < 0.05$). The group of women who either had a family history of diabetes among their mothers, fathers, or siblings also had a significantly increased BMI ($P < 0.05$) in 1980–1981. No significant differences were observed concerning WHR in 1980–1981.

Table 2—*P values for correlations between family history of diabetes and different variables studied in 1968–1969 and 1980–1981 when age is taken into account as background variable*

	P VALUE	
	1968–1969	1980–1981
SYSTOLIC BLOOD PRESSURE	>0.20	>0.20
SERUM TRIGLYCERIDES	0.13	0.02
SERUM CHOLESTEROL	>0.20	>0.20
BLOOD GLUCOSE	0.11	>0.20
SERUM INSULIN	0.11*	

* Negative correlation.

Table 3—*Least-square mean ± SE values of 2 aspects of obesity (BMI and WHR) at 1968–1969 and 1980–1981 examinations and change of BMI and WHR, respectively, between 2 examinations in women with and without a family history of diabetes*

	Family history of diabetes				No family history of diabetes
	Mother	Father	Siblings	Either	
BMI 1968–1969†	25.1* ± 0.41	24.1 ± 0.73	23.6 ± 0.55	24.4 ± 0.24	23.9 ± 0.13
BMI 1980–1981†	25.9‡ ± 0.48	25.4 ± 0.85	25.4 ± 0.71	25.6‡ ± 0.28	24.8 ± 0.16
Change of BMI†	1.2 ± 0.27	1.1 ± 0.47	2.1* ± 0.38	1.4‡ ± 0.16	1.0 ± 0.09
WHR 1968–1969§	0.73‡ ± 0.006	0.75 ± 0.010	0.75 ± 0.008	0.74 ± 0.003	0.74 ± 0.002
WHR 1980–1981§	0.81 ± 0.008	0.83 ± 0.015	0.80 ± 0.012	0.81 ± 0.005	0.81 ± 0.003
Change of WHR§	0.08 ± 0.008	0.08 ± 0.013	0.05 ± 0.011	0.07 ± 0.004	0.07 ± 0.002

Means adjusted for age and other type of obesity at corresponding time.
* $P < 0.01$, ‡$P < 0.05$, vs. women with no family history of diabetes.
† BMI means adjusted for WHR.
§ WHR means adjusted for BMI.

Family history of diabetes in relation to change of obesity

Table 3 shows mean ± SE values for change of BMI and WHR, respectively, between the two examinations in 1968–1969 and 1980–1981. Women with a family history of diabetes increased the BMI during the 12-yr follow-up significantly more ($P < 0.05$) than women without a family history of diabetes. The increase in BMI also was significant in women with a history of diabetes among siblings when siblings were studied separately. The average weight gain during the 12-yr period among women with a family history of diabetes was 2.6 kg compared with a weight gain of 2.0 kg among women without a history of diabetes (Table 3). No difference in increase of WHR during that period was found between the groups.

Further multivariate analyses

All significant associations remained when smoking, blood glucose concentration, systolic blood pressure, WHR, serum triglycerides, and serum cholesterol were included in the multivariate analysis. The main conclusions were unchanged after also controlling for mothers' body size.

Family history of coronary heart disease and family history of cancer

No significant associations were observed when relating family history of coronary heart disease or cancer with BMI, WHR, smoking, blood glucose concentration, systolic blood pressure, serum triglycerides, serum cholesterol, and serum insulin, all measured at the examination in 1968–1969.

CONCLUSIONS— A relationship between obesity and diabetes has been well established. It also has been shown that offspring of Pima Indian women with diabetes during pregnancy are more obese as young adults than the offspring of nondiabetic women (15). Fujimoto et al. (16) have shown that the relationship between diabetes mellitus and differences in general adiposity and differences of body fat distribution are more apparent in men without a family history of diabetes than in those with a family history (16). In a study by Haffner et al. (17), people with a positive parental history of diabetes had a more atherogenic pattern of cardiovascular risk factors compared with those without a parental history of diabetes (17). In this study, we related not only family history of diabetes to obesity on one occasion but also to an examination 12 yr later. Furthermore, we related family history of diabetes to change of obesity during the 12-yr follow-up. The systematic sampling method, based on date of birth and a high participation rate (90.1%), ensured that the participants were a representative cross-section of women from the community of the ages studied.

This study shows that family history of diabetes is related to overall obesity expressed as BMI. Surprisingly, no positive relationship was seen between family history of diabetes and WHR. Some evidence indicates that abdominal obesity, characterized as a high WHR, is at least partly a genetically determined trait (18). However, in this study, general obesity, expressed as BMI, seems to be related more strongly to maternal history of diabetes than WHR. Also, increased BMI in nondiabetic subjects was related to a family history of diabetes. Another study found no evidence for a relationship between family history for NIDDM and dietary habits or nutrient intake (19). This suggests that our findings of an association between family history for diabetes and general obesity probably are

not attributable to different dietary habits. We reported previously that both BMI and WHR are associated significantly and independently with incidence of diabetes in this population study (3).

The importance of a maternal history of diabetes observed in this paper has been described recently (20). In a study of 347 patients with diabetes mellitus who had first-degree relatives with diabetes, mothers were implicated in significantly more cases than fathers in patients with a single affected parent, which is consistent with our observations. In conclusion, a link between maternal history of diabetes and general obesity was shown in this study but not with centralized obesity.

We hypothesize that the associations between a subject's BMI and her mother's diabetic status is attributable to confounding by obesity in the mother. We examined this possibility in a subsample of subjects who answered questions regarding familial obesity. Although obesity in the mother (according to the subject's recollection) was associated positively with both diabetes in the mother and a subject's own BMI, a statistically independent association remained between BMI and maternal diabetes after adjustment for maternal obesity (along with the 7 other covariates included previously). This independent association strengthens the evidence that a familial predisposition to diabetes plays a role in the occurrence of obesity in women.

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