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Finnish Twins Reared Apart. IV: Smoking and Drinking Habits. A Preliminary Analysis of the Effect of Heredity and Environment

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Abstract. Data on alcohol use and smoking habits was available from the 1975 questionnaire of the entire cohort. Prior to pairwise analyses, the data of individuals was compared to that of age-sex matched groups of pairs reared together. The early separated twins had a higer alcohol consumption, while for smoking only slight differences were observed compared to twins reared together. Probandwise concordance rates were computed from smoking status (ever smoker/never smoker), alcohol use (user/nonuser) and "heavy" drinking (half-bottle of spirits on one occasion at least once a month). The following results were obtained in those pairs with the environmental dissimilarity score >15:

Age at separation	No. of cases		Smoking		Alcohol use		"Heavy" drinking	
	MZ	DZ	MZ	DZ	MZ	DZ	MZ	DZ
0 - 5	18	61	0.67	0.65	0.89	0.81	0.67	0.38
0 - 10	30	95	0.67	0.68	0.80	0.81	0.67	0.33

Key words: **Twins reared apart, Rearing environment, Adoption, Smoking, Alcohol use**

INTRODUCTION

Health related behavior on a personal level encompasses many aspects of human behavior. Two major determinants of illness, alcohol use and smoking, are complex behavior patterns that are undoubtedly influenced by environmental, familial and genetic factors. The relative importance of these factors is not very well known.

The purpose of this study is to analyse the effect of environmental and genetic factors of smoking habits and alcohol use among Finnish twins reared apart in childhood before the age of eleven years. The results are compared to twins reared together but living apart at the time of study. In an earlier paper, the preliminary characterization of the rearing environment and causes of separation was given [18].

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SUBJECTS AND METHODS

The sample of twins reared apart analysed in this paper has been described in more detail in a companion paper [19]. The sample consists of 30 monozygotic (MZA) and 95 dizygotic (DZA) pairs separated prior to age 11, with little contact after separation, as assessed by items from a rearing environment questionnaire. The data are compared to 47 monozygotic (MZT) and 135 dizygotic (DZT) pairs of similar age and sex distribution, but reared together and living apart at the time of study.

The twins had all replied to a general health questionnaire in 1975, which included items on smoking habits and alcohol use. To characterize the rearing environment of the twins, a second questionnaire was mailed in 1979 to the study sample specifically. Thus, the study variables were recorded 4 years prior to the specific study on twins separated at various ages.

A cigarette smoker was defined as a person who had smoked at least 5-10 packs of cigarettes in his whole life and had smoked daily or nearly daily. Persons not satisfying these criteria were determined to be nonsmokers. Among the nonsmokers, occasional smokers were those that had smoked more than 5-10 packs, but never smoked regularly on a daily basis. Smokers were classified as current smokers or ex-smokers depending on whether they smoked in 1975 or not. The amount then or previously smoked and the age of starting and stopping smoking were also asked. The number of regular cigar- and pipe-smokers was too small to permit inclusion in the analysis.

Alcohol use was queried by asking the amount of beer, wine and spirits consumed on average per week of month, as well as the frequency of their use. The average current consumption was transformed to give the amount in grams of alcohol per months. If no alcohol was used, these were classified as abstainers. Heavy drinking was assessed asking whether at least once a month on the same occasion at least 5 bottles of beer, a bottle of wine or half-a-bottle of spirits were consumed.

For each variable, the distributions of means for individuals were tested to examine the null hypothesis that the groups (MZA, DZA, MZT, DZT) did not differ. Chi-square or analysis of variance was used as appropriate. For genetic analyses, pairwise and probandwise concordance ratios were computed for dichotomous variables. For quantitative variables, intrapair differences and correlations coefficients were computed. A model with a heritability (h^2) effect (1 for MZ pairs, 0.5 for DZ pairs) and a common environmental effect (1 for pairs reared together, 0 for pairs reared apart) was fitted by weighted least squares analysis to the observed correlations. The model fit was assessed by a chi-square test.

RESULTS

Alcohol use was more common for men than women, there being little differences between study groups (Table 1). Heavy alcohol use was reported by about one third of men, with no significant differences between groups (Table 2). Under 5% of women in all groups were heavy users. The mean alcohol consumption in men belonging to pairs reared apart (Table 3) was over 100 g/month higher ($P = 0.23$). Also no significant differences were observed for women.

When pairwise distributions for alcohol user/nonuser status were considered, no systematic or large differences in concordance ratios among men or women were observed (Table 4). For heavy alcohol use, there were too few concordant cases among women for analysis (Table 5). For men, however, concordance was higher in MZ than DZ pairs, and in pairs raised together than in those reared apart.

The mean intrapair difference in monthly alcohol use was greater for pairs reared apart than for those reared together (Table 6). The intrapair correlation coefficient was small for both MZA and DZA pairs, but substantial in MZT and DZT pairs. The model fitted poorly for women ($P = 0.001$), but reasonably for men ($P = 0.26$). The heritability estimate for monthly alcohol consumption was 0.36 for men, and the common environment effect 0.45.

Smoking was more common among men than women (Table 7), but nonsignificant differences were observed between study groups. In men and women, respectively, 37% and 13% were current smokers, 66% and 19% had ever smoked regularly. The amount smoked daily (Table 8), the number of years smoked (Table 9), and the number of cigarette-years smoked (Table 10) did not differ between study groups considered sex-specifically. The sex differences in mean values were large for all variables.

For ever smokers, the concordance ratio for women was 0 in MZA, and about 50% in all other groups (Table 11). For men, the probandwise concordance ratio was 0.80 in MZAs and 0.74 in DZAs, as compared to a prevalence in men of 0.66. The probandwise concordance ratio in DZTs was the same as in DZAs, while the ratio in MZTs was 0.97 vs 0.80 in MZAs. For current smoking (Table 12), the MZ/DZ difference

Table 1 - Alcohol Users among Individual Twins (first member of pair)

	Men		Women	
	%	N	%	N
MZA	84.6	13	62.5	16
DZA	91.2	34	52.6	57
MZT	82.6	23	41.7	24
DZT	86.9	61	64.8	71

Table 2 - Heavy Alcohol Users among Individual Twins (first member of pair)

	Men		Women	
	%	N	%	N
MZA	38.5	13	0.0	17
DZA	47.1	34	3.5	58
MZT	26.1	23	4.2	24
DZT	33.9	62	4.7	77
χ^2_3	2.92		1.87	

Table 3 - Mean Alcohol Consumption among Individual Twins (first member of pair)

	Men g/month		Women g/month	
	Mean	SD	Mean	SD
MZA	432	416	46	74
DZA	414	430	107	235
MZT	292	425	48	80
DZT	272	311	85	227
	F (3,128)=1.44 P=0.23		F(3,167)=0.66 P=0.57	

Table 4 - Twin Pair Concordance for Drinking Status

	Both abstainers			Discordant			Both drinkers		
	M	F	Tot.	M	F	Tot.	M	F	Tot.
MZA	0	4	4	4	5	9	9	7	16
DZA	1	10	11	3	22	25	29	23	52
MZT	3	10	13	3	6	9	17	8	25
DZT	2	17	19	13	18	31	45	36	81

Probandwise (Pb) and pairwise (Pw) concordance ratios (%)

	Males		Females		Total	
	Pb	Pw	Pb	Pw	Pb	Pw
MZA	81.8	69.2	73.7	58.3	78.0	64.0
DZA	95.1	90.6	67.6	51.1	80.6	67.5
MZT	91.9	85.0	72.7	57.1	84.7	73.5
DZT	87.4	77.6	80.0	66.7	83.9	72.3

Table 5 - Twin Pair Concordance for Heavy Drinking Status

	Neither heavy drinker			Discordant for heavy drinking			Both heavy drinkers		
	M	F	Tot.	M	F	Tot.	M	F	Tot.
MZA	7	16	23	3	0	3	3	0	3
DZA	10	53	63	18	2	20	5	0	5
MZT	16	23	39	2	0	2	5	1	6
DZT	37	66	103	13	4	17	11	1	12

Probandwise (Pb) and pairwise (Pw) concordance ratios (%)

	Males		Females		Total	
	Pb	Pw	Pb	Pw	Pb	Pw
MZA	66.7	50.0			66.7	50.0
DZA	35.7	21.7	0.0	0.0	33.3	20.0
MZT	83.3	71.4			85.7	75.0
DZT	62.8	45.8	33.3	20.0	58.5	41.4

Table 6 - Intrapair Differences and Correlations for Monthly Alcohol Consumption

	Mean intrapair difference (g)		Correlation		No. of pairs	
	Men	Women	Men	Women	Men	Women
MZA	337	62	0.045	0.055	13	16
DZA	389	106	0.121	0.108	33	55
MZT	227	16	0.851	0.912	23	24
DZT	234	84	0.550	0.315	60	71

		Men	Women
h^2	=	0.36	0.55
$se(h^2)$	=	0.15	0.14
c^2	=	0.45	0.33
$se(c^2)$	=	0.14	0.14
χ^2	=	2.70	13.74
P	=	0.26	0.001

Table 7 - Cigarette Smoking among Individual Twins (first member of pair)

		Non smoker	Occassional	Ex-smoker	Current smoker	Total
Men						
	MZA	3	0	1	9	13
	DZA	9	1	13	11	34
	MZT	9	0	5	9	23
	DZA	21	2	19	19	61
Women						
	MZA	15	1	1	0	17
	DZA	43	0	5	10	58
	MZT	22	0	1	1	24
	DZA	55	1	5	11	72

$\chi^2_9 = 10.3$ (men) and 10.4 (women)

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was more substantial for men, but not for women. Because the number of smokers among women was small, the smoking quantitative variables were analysed pairwise only for men (Table 13). The basic model for the number of years smoked was rejected ($P = 0.008$). For the number of cigarettes smoked daily, the model fit was adequate ($P = 0.38$), yielding an heritability estimate of 0.54 and a common environment effect of 0.19. For the cigarette-years smoked, the model fit was poorer ($P = 0.10$), the heritability estimate 0.62 and the common environment effect 0.20.

Table 8 - Mean Number of Cigarettes/Day among Individual Twins (first member of pair)

	MZA	DZA	MZT	DZT	F-Test
Men	14.6	13.1	9.4	10.1	$F(3,126) = 1.30$, $P = 0.28$
Women	0.15	3.5	0.8	2.2	$F(3,166) = 2.47$, $P = 0.06$

Table 9 - Mean Years of Cigarette Smoking among Individual Twins

	MZA	DZA	MZT	DZT	F-Test
Men	10.7	15.0	13.5	10.6	$F(3,126) = 0.96$, $P = 0.41$
Women	2.0	3.2	1.7	2.5	$F(3,164) = 0.33$, $P = 0.81$

Table 10 - Mean Number of Cigarette-Years among Twin Individuals (first member of pair)

	MZA	DZA	MZT	DZT	F-Test
Men	198	297	196	182	$F(3,125) = 1.40$, $P = 0.24$
Women	5	50	27	33	$F(3,163) = 0.76$, $P = 0.52$

Table 11 - Twin Pair Concordance for Ever Cigarette Smoking

	Neither ever smoker			Discordant			Both ever smokers		
	M	F	Tot.	M	F	Tot.	M	F	Tot.
MZA	1	12	13	4	4	8	8	0	8
DZA	4	39	43	12	10	22	17	6	23
MZT	8	21	29	1	2	3	14	1	15
DZT	16	46	62	18	15	33	26	8	34

Probandwise (Pb) and pairwise (Pw) concordance ratios (%)

	Males		Females		Total	
	Pb	Pw	Pb	Pw	Pb	Pw
MZA	80.0	66.7	0.0	0.0	66.7	50.0
DZA	73.9	58.6	54.5	37.5	67.6	51.1
MZT	96.6	93.3	50.0	33.3	90.9	83.3
DZT	74.3	59.1	51.6	34.8	67.3	44.2

Table 12 - Twin Pair Concordance for Current Cigarette Smoking

	Neither current smoker			Discordant			Both current smokers		
	M	F	Tot.	M	F	Tot.	M	F	Tot.
MZA	4	13	17	4	3	7	5	0	5
DZA	15	44	59	14	7	21	4	4	8
MZT	11	22	33	5	1	6	7	1	8
DZT	28	53	81	23	10	33	9	6	15

Probandwise (Pb) and pairwise (Pw) concordance ratios (%)

	Males		Females		Total	
	Pb	Pw	Pb	Pw	Pb	Pw
MZA	71.4	55.5	0.0	0.0	58.8	41.7
DZA	36.4	22.2	53.3	36.4	43.2	27.6
MZT	73.7	58.3	66.7	50.0	72.7	57.1
DZT	43.9	28.1	54.5	37.5	47.6	31.2

Table 13 - Intrapair Differences and Correlations for Smoking Variables in Male Twin Pairs

Years smoked

	Mean intrapair difference (yr)	Correlation	No. of pairs	
MZA	9.0	0.044	13	$h^2 = 0.62$, se $(h^2) = 0.16$
DZA	12.2	0.223	33	$c^2 = 0.27$, se $(c^2) = 0.16$
MZT	3.0	0.913	23	$\chi^2 = 9.55$ P $= 0.008$
DZT	8.5	0.332	58	

No. of cigarettes smoked daily

	Mean intrapair difference (cigs)	Correlation	No. of pairs	
MZA	8.2	0.235	12	$h^2 = 0.54$, se $(h^2) = 0.17$
DZA	9.8	0.340	33	$c^2 = 0.19$, se $(c^2) = 0.15$
MZT	3.7	0.764	22	$\chi^2 = 1.95$ P $= 0.377$
DZT	7.0	0.395	60	

Pack years smoked

	Mean intrapair difference (cigarette-years)	Correlation	No of pairs	
MZA	191	0.126	12	$h^2 = 0.62$, se $(h^2) = 0.16$
DZA	236	0.372	33	$c^2 = 0.20$, se $(c^2) = 0.15$
MZT	86	0.851	22	$\chi^2 = 4.53$ P $= 0.104$
DZT	154	0.396	58	

DISCUSSION

Twin studies of cigarette smoking and use of alcohol have been carried out to obtain estimates of the relative roles of environmental and genetic factors in the variation of the traits, while some studies have attempted to explain the relationship of these factors to disease in twin pairs.

For alcohol use, data from twins raised together have indicated a modest genetic influence on consumption patterns of a social level. In the USA, Loehlin [20] found a heritable component to alcohol use in young adult twins. In Sweden, Kaij [16] studied twin pairs with alcohol abuse, while Jonsson and Nilsson [14] studied the alcohol consumption of twin pairs in the Swedish Twin Registry. In a study of male twin pairs born in 1920-1929 in Finland, Partanen et al [22] found significant genetic components for amount and frequency of alcohol consumption, but not for the social consequences of drinking. In a comparative study of Finnish and Swedish adult twins, Kaprio et al [17] found a familial effect for both sexes, but evidence for a genetic effect was found for men only.

In this study, concordance ratios for alcohol use were not higher for MZ than for DZ pairs, either totally considered or broken down by sex. Thus, no support for a genetic effect on alcohol use is given. When mean monthly alcohol consumption was considered, the fit of the model was adequate for men, but not for women. The heritability estimate was 0.36 for men, indicating some genetic influence. The estimate for the common environment (familial or otherwise shared) effect was greater (0.45), however. As twin data tend to overestimate heritability and underestimate the common environment effect, the latter is probably greater than 50%. Among twins reared apart, the literature is fairly sparse. In 19 sets of MZA twins, 7 were both nondrinkers, 3 both heavy drinkers, 6 both moderate and 3 discordant [8].

Alcoholism was not assessed in this study, and the criteria for heavy alcohol use permit many social drinkers to be included. Adoption studies by Schuckit et al [24], Goodwin et al [12], Bohman [1] and Cadoret and Gath [2] also suggest an heritable component to alcoholism. A recent twin study by Gurlin et al [13], however, did not find any differences in concordance for alcoholism in MZ and DZ pairs. In this study, the MZ concordance ratios both in twins reared apart and in twins reared together were higher than for DZ twins, suggesting some genetic influence on heavy drinking in men.

Smoking is a complex behavior operating on both a psychological and a physiological level. Commencement, maintenance and cessation of the smoking habit probably all have their own determinants [26]. Therefore, to unravel the genetic, familial and environmental components of these fractions is a challenging task.

Earlier twin studies have indicated a greater similarity for MZ than DZ twins in both small [4-6,9-11,27] and large series [3,7,17,23]. For initiation of smoking, peer effects are important, and the more similar environment of MZ than DZ pairs may be a confounder for the genetic interpretation of the results of twins reared together. Eysenck [7] found a significant role for the effects that could be linked to peer influences in his smoking study of twins.

Earlier data on smoking habits of twins reared apart mostly indicate a high concordance for smoking status and amount consumed. Shields [25] found that 67% of his 42 pairs were very similar in smoking habits, while 14% were dissimilar. In 6 of 9 pairs in the Juel-Nielsen study [15] both twins were smokers. Before these figures can be interpreted, one should be cognizant of the prevalence of smoking in the population. If smoking is highly prevalent, MZ concordance will be high even in the absence of genetic effects. This study showed no difference between MZ and DZ pairs in the concordance for having ever smoked. This would suggest that the determinants of starting smoking are nongenetic, given the power of this relatively small sample to detect effects. There were differences in the concordance for current smoking status, suggesting possible genetic influences on maintaining smoking.

In the volunteer twin sample analysed by Eysenck and Eaves [7], the heritability estimate for age at onset of smoking was about 0.2 and around 0.35 for average consumption, depending on the model fitted to the data. For the quantitative variables of amount and duration smoked, the genetic analyses in men suggest a substantial genetic component; ie, once a person starts smoking, the amount smoked daily is under some genetic control. There thus seem to be different genetic influences on the various components of the smoking habit.

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