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From Puberty to Mid-life: A Follow-up Study of Twins and Controls

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Abstract. During the years 1964 to 1971 a group of twins and a control group of singletons in the same classes, were followed from grade 3 at 10 years of age to grade 9 at 16 years of age in the Swedish compulsory school. The study was called the SLU-project (Skolöverstyrelsens och Lärarhögskolans Utvecklingsprojekt) and the main purpose was to study physical and mental growth during puberty as well as heredity and environment influences on these growth processes. Originally 323 twin pairs, MZ and DZ, and 1193 controls were included in the sample. Among the DZ twin pairs there were both same-sex and opposite-sex pairs. They were a nationally representative sample. Several kinds of information were collected, such as, a) Physical measurements (height and weight measurements, menarche, ratings of secondary sex characteristics); b) Ability and achievement measures (intelligence tests, standardized achievement tests); c) Self ratings; d) Ratings by teachers and classmates; e) Socioeconomic background data (fathers occupation and income). For the boys, supplementary data on physical growth and mental ability was collected on enrollment to military service at the age of 18. In this pilot-study, we have made a follow-up of the original SLU-sample after 20 years. They are now in their mid-thirties. The main purpose has been to investigate if they are willing to participate in a new study on health and well-being at mid-life.

INTRODUCTION

The results from the SLU-project are documented in two theses and in a large number of articles published in scientific journals [1,4]. Interesting problems have been illustrated and have contributed to a deeper understanding of the relation between physical and mental growth and also the influence of heredity and different environmental factors. Three major types of results have been documented in connection with the study of hereditary and environmental influences on physical and mental growth:

— Hereditary influences will vary according to the type of variable studied.

- In a more permissive environment, hereditary influences will be more conspicuous than in a restrictive environment for the same type of variable.
- Environmental stimulation will enhance physical and mental growth in both permissive and restrictive situations.

During 1991 the twins and controls were contacted. In this pilot-study we also asked some questions about their present living conditions, health, seasonal mood variations and, for the twins, the extent of contact with the twin brother or twin sister.

Specific questions

- Is there a difference in present living conditions between different twin categories and the controls?
- Is there a difference in subjective health between different twin categories and the controls?
- In what way do different twin categories and the controls experience seasonal mood variations?
- How much contact do the twins have with each other when grown up?
- Is there a difference between participants and non-participants and if so, in what respect?

MATERIAL AND METHODS

The twins and the controls are now in their mid-thirties (born 1954, 1955 and 1956). All individuals that had relatively complete data from the puberty period were contacted and asked if they were willing to participate in a new study with the purpose of studying living conditions and health at mid-life in relation to genetic and biological influences as well as childhood background factors. Originally the SLU sample consisted of 1839 individuals, but 159 were lost during the original SLU-project due to incomplete data.

An information letter attached to a questionnaire was sent out to 1680 individuals. Only a few could not be found through the Swedish central data register. The information contained a reminder of participation as a child in the SLU-project and also a description of the project. A short report on the main results of the project was also included, and the person was asked if he/she was willing to participate in a new investigation about living conditions and health at mid-life. The participants were also informed that their participation was voluntary; that they had the possibility of asking for an extract from the data register (about 25 persons used this possibility); and that the results would be treated as strictly confidential according to the rules of the Swedish data inspection authorities. All participants were offered a copy of their own height and weight graph during puberty. The questionnaire included information on civil status, number of children, education, occupation and one question about their present health situation. For the twins there were some questions about how long they have lived with their twin brother/sister, how often they have contact with each other now and if they have twins of their own.

Table 1 - Sample 1965-1991

	Original sample 1965 N = 1839	Missing persons 1965-1991 N = 159	Complete data set 1965-1971 N = 1372	Incomplete data set 1965-1971 N = 467	Obtained sample 1991 N = 1680	Positive answers 1991 N = 1114	Negative answers 1991 N = 155	Missing persons 1991 N = 411
MZM*	90	2	90	—	88	50	6	32
MZF*	92	7	88	4	85	67	3	15
DZM	138	5	134	4	133	75	17	41
DZF	132	12	132	—	120	91	9	20
DZOM*	97	14	95	2	83	58	12	13
DZOF*	97	6	94	3	91	72	10	9
Contr M	598	61	380	218	537	313	56	168
Contr F	595	52	359	236	543	388	42	113

* M = Males
 F = Females
 OM = Opposite sex, males
 OF = Opposite sex, females

After one reminder to all who did not answer and one further reminder to the twins, 1269 answers were received, ie. 75 per cent of the obtained sample. No person announced that he/she wanted to be excluded from the obtained register. A small number of the questionnaires were sent back because of failure to locate the addressees. Among those who answered (1269) 155 individuals refused further participation. Accordingly, 413 twins and 701 controls agreed to participate in a new study concerning living conditions and health at the age of 35. A description of the participants is given in Table 2.

Table 2 - Number of participants

	Male	Female
Controls	313	388
MZ twins	50	67
DZ twins	133	163

It can be seen that more women than men are positive to participation (Table 2). This is true for both the twins and the controls. Sixty-nine per cent of the twins in the obtained sample were positive to participation. This proportion is somewhat higher than for the controls (65%). The number of complete twin pairs is shown in Table 3.

Table 3 - Number of participating complete twin pairs by sex and zygosity

	Male	Female	Male/Female
MZ	19	31	—
DZ	27	37	51

It can be seen from Table 3 that more female than male twin pairs agree to participate in a new study. It is also evident that the number of complete pairs is larger for the female twins, indicating a tendency for the women to give the same answer to this question.

Some questions concerning seasonal mood variations were included in the questionnaire. These questions have been used in previous studies [6]. The respondents were asked at which time of the year they were feeling at their best/worst, sleeping most/least and gaining weight. Also a general question if they were having spells of “mid-winter blues” was asked.

RESULTS

Questionnaire data

A preliminary analysis of the answers to the pilot-study questionnaire is presented.

About 60 per cent of both the twins and the controls are married and have on average two children. It is more common for the women to be married and have children compared to the men. There is an over-representation of university educated persons both among the twins and the controls. About 30 per cent of the controls have a university education; the number is a little less for the twins. Among the controls more males than females have a university education, while the opposite applies to the twins. Only 15 per cent, however, are employed in a high status profession. This indicates that about half the respondents do not have a profession in accordance with their educational level.

Less than 10 per cent did not feel well. Most of the twin pairs, both MZ and DZ twins gave the same answer to this question. Only one twin pair was still living together. Most of the twins moved apart between the ages of 18 and 20. Only a few twins had twins of their own. Most of the twins had regular contact with each other. The female MZ twin pairs have the most frequent contact, and this corresponds very well with results found by Fischbein et al [2] for younger twins.

Concerning the questions on seasonal mood variation there are some differences between twins and controls. Most of the twins feel best and sleep least during the summer, while the controls feel best and sleep least during the spring. The controls feel worst during autumn and winter and sleep most during the autumn. The twins sleep most during the winter. None mention a special season of the year when they are feeling particularly bad. There are also differences in the answers concerning weight gain. The controls answer that they gain weight mostly during the winter, while the twins do not consider the seasons to have an influence on their weight. Male twins seem to be more independent of seasonal variations than the other participants. The females, both twins and controls, appear to be more sensitive to “mid-winter blues”.

Comparison of participants and non-participants

To investigate whether the group, who had agreed to participate in a new study, is representative of the original SLU-sample, a comparison of participants and non-

Table 4 - Achievement test results: Swedish and mathematics in grade 3 and mathematics in grade 6 for participating and non-participating twins and controls

	Participants			Non-participants			t
	N	Mean	SD	N	Mean	SD	
Female twins							
Swedish gr 3	122	49.43	7.15	44	50.45	5.94	0.93
Math gr 3	131	46.53	8.03	46	48.60	7.94	-1.52
Math gr 6	165	47.45	7.66	67	46.64	7.78	0.72
Male twins							
Swedish gr 3	90	49.72	8.23	74	47.93	7.56	1.45
Math gr 3	97	51.26	8.13	74	50.30	9.42	0.70
Math gr 6	137	51.24	8.81	104	49.93	8.83	1.14
Female controls							
Swedish gr 3	215	28.80	25.97	127	32.40	25.16	-1.26
Math gr 3	215	30.80	25.32	127	32.35	23.71	0.57
Math gr 6	215	31.93	24.75	127	25.75	24.99	2.22*
Male controls							
Swedish gr 3	164	35.39	23.39	169	34.40	23.12	0.39
Math gr 3	164	37.18	23.98	169	36.98	24.09	0.08
Math gr 6	164	31.84	26.05	169	27.75	26.52	1.42

* $p < 0.05$

participants was made according to data previously collected in the original SLU-project.

A standardized achievement test in Swedish was given in grade 3 and mathematics tests were given in grade 3 and 6 (Table 4). There are no significant differences between the participating twin group and the non-participating twin group concerning the results of the achievement tests. The average result of the mathematics test for the control girls in grade 6 shows, however, a significant difference between the participating group and the non-participating group. The participating group has a higher mean compared to the group that did not agree to participate. In grade 3 the difference is in the opposite direction. The comparison was made between those who had complete data sets in the SLU-project.

The intelligence test (Table 5) is composed of three types of tests, verbal ability, inductive reasoning and numerical perception. Some significant differences between participants and non-participants, particularly for the males, are illustrated. Male par-

Table 5 - Ability test results in the SLU-project for participating and non-participating twins and controls

	Participants			Non-participants			t
	N	Mean	SD	N	Mean	SD	
Female twins							
Verbal ability	222	26.27	6.41	85	26.14	4.57	0.17
Inductive reasoning	222	18.74	5.76	84	18.77	5.46	0.05
Numerical perception	222	30.09	7.06	85	29.28	7.94	0.83
Male twins							
Verbal ability	181	26.78	6.60	135	25.86	7.62	1.12
Inductive reasoning	181	18.56	6.24	135	16.53	6.08	2.90**
Numerical perception	181	27.91	7.75	134	25.43	7.63	2.82**
Female controls							
Verbal ability	198	28.78	6.19	90	26.78	6.64	2.42*
Inductive reasoning	201	19.97	5.59	91	19.89	5.75	0.11
Numerical perception	198	30.48	7.34	90	31.06	6.68	0.66
Male controls							
Verbal ability	150	28.31	6.25	142	27.33	6.17	1.34
Inductive reasoning	150	19.55	5.99	142	17.99	5.65	2.29*
Numerical perception	150	28.84	6.76	142	28.25	6.87	0.73

* $p < 0.05$ ** < 0.01

ticipants seem to be a positively selected group with respect to ability test results. For the female controls a similar trend can be seen concerning verbal ability.

Height growth had been measured from 10 to 16 years for the girls and from 10 to 18 years for the boys in the original SLU-project. At the age of 10.5 to 11.5 there is a difference for twin boys between the participating group and the non-participating group. Those who agreed to participate were at that age on average 2 cm taller than the non-participants. This difference is seen again at the age of 18 years (6 cm). Also among the twin girls there is a difference in the same direction concerning height between the groups when at the age of 9.5 - 10 years old (4-8 cm).

In all it can be said that the greatest difference between the participating group and the non-participating group is sex. Considerably more women than men are willing to participate in a new investigation at the age of 35. Concerning test results and physical growth data there are some significant differences between participants and non-participants indicating that the former are a positively selected group. This is particularly evident for the males.

DISCUSSION

The purpose of this pilot-study has been to recontact the twins and controls in the Swedish SLU-project and find out who was willing to participate in a new study. At the same time some questions were asked concerning present living conditions, health, seasonal mood variations and contact with the other twin. This was a unique opportunity, after 20 years, to investigate the relationship between hereditary and environmental influences at puberty and at mid-life.

Of the original SLU-sample (1839 individuals), 159 went dispersed during the project leaving data incomplete. Seventy-five per cent of the obtained sample (1680) in 1991 returned the questionnaire. Only 9 per cent (155) declined to participate in a new study. The remaining 16% did not answer at all.

There was no difference between twins and controls concerning living conditions with respect to civil status and having children. It was more common for the women to be married and have children than for the men. One reason for this could be due to longer education for the men. It is also normal for males to be older than females when they marry.

Self reported health shows no difference between twins and controls. Very few respondents do not feel well. Different seasons seem to influence twins and controls in a somewhat different way. Male twins are of the opinion that the seasons do not influence the mood. The females, however, both twins and controls, appear to be more sensitive to "mid-winter blues" compared to the males. In Sweden autumn and winter are very dark and it is common for people to be influenced by this.

The twins have regular contact with each other as adults. The female MZ twin pairs have the most frequent contact. This is in accordance with results from other twin studies of younger twins [2]. The comparison of participants and non-participants in the new study shows some significant differences concerning test results collected during puberty. The participating group has a higher mean compared to the non-participating group, particularly for the male twins.

Among the non-participants of this pilot study, more men declined to participate and did not return the questionnaire, compared to the women. Consequently, there are more women who are positive to participation in a new study. Possibly one reason for this is that men at the age of 35 are in the middle of their career. We also know that more men than women at this age are in a risk group concerning drug and alcohol abuse and premature death.

In the Malmö-investigation [3], a longitudinal Swedish study, 25 per cent of the male original sample did not respond to a health investigation at the age of 55, and differed already from the main population at the age of 10 concerning school achievement. They also had, on average, shorter education and lower income than those who participated in the investigation. A follow-up questionnaire study at the age of 35 had also shown these non-participants to be more at risk for future problems and premature death. Another longitudinal Swedish study, the UGU-project (Utvärdering Genom Uppföljning) included an investigation of young people with low or short education. An analysis of missing data was made on the results answered in a questionnaire at 23 years of age. The drop off was 50 per cent, which indicated that this group is especially difficult to reach in longitudinal studies.

In this study, the positive attitude of the women to participate in a new study is more pronounced compared with the men and particularly when we compare complete pairs which indicates that the female twins tend to be more concordant in this respect.

The data of the SLU-project offered the possibility to compare background information on participants and non-participants thus making it possible to study heredity-environment influences for both groups.

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