

# EDUCATION AND MENTAL DISORDERS

A 31-year follow-up in the Northern Finland 1966 Birth  
Cohort

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OULU 2000

Suomenkielinen tiivistelmä



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**EDUCATION AND MENTAL DISORDERS**

A 31-year follow-up in the Northern Finland 1966 Birth Cohort

Academic Dissertation to be presented with the assent of the Faculty of Medicine, University of Oulu, for public discussion in the Väinö Pääkkönen Hall of the Department of Psychiatry, on December 18th, 2000, at 12 noon.

OULUN YLIOPISTO, OULU 2000

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Manuscript received: 13 November 2000  
Manuscript accepted: 17 November 2000

Communicated by  
Docent Ossi Rahkonen  
Professor Hillevi Aro

ISBN 951-42-5839-8 (URL: <http://herkules.oulu.fi/isbn9514258398/>)

ALSO AVAILABLE IN PRINTED FORMAT

ISBN 951-42-5838-X

ISSN 0355-3221

(URL: <http://herkules.oulu.fi/issn03553221/>)

OULU UNIVERSITY PRESS  
OULU 2000

## **Isohanni, Irene, Education and mental disorders. A 31-year follow-up in the Northern Finland 1966 Birth Cohort.**

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2000

Oulu, Finland

(Manuscript received: 13 November 2000)

### ***Abstract***

The current education policy in Finland tends to result in higher levels of education, and to avoid educational failures. The aim of the present study was to determine school predictors for later severe mental disorders requiring hospital treatment, and to determine whether or not severe mental disorders or smoking are associated with educational achievement.

Educational attainments were analysed in the Northern Finland 1966 Birth Cohort (n=12 058 born alive) using school performance and attained level of education. Data was collected using questionnaires as well as from national registers. Data on psychiatric morbidity was gathered from the Finnish Hospital Discharge Register. The case notes of all potential subjects were examined. Up to the end of 1994, a total of 387 subjects had received a DSM-III-R psychiatric diagnosis categorized as follows: schizophrenia (n=89), other psychoses (n=55), and non-psychotic disorders (n=243). Smoking habits were assessed at 14 and 31 years by postal questionnaires. The association between exposure, confounding and outcome variables were analysed by cross-tabulations. Regression models were fitted and adjusted for confounding.

Children not in their normal grade or not in normal school at the age of 14 years had a 2 to 8 times higher risk than those in the comparison category (in normal grade or school) to develop some form of mental disorders. Among adolescents with non-psychotic disorders, the means of school marks were lower than in the comparison category, but lower marks did not predict schizophrenia or other psychoses. 11% of the pre-schizophrenic boys had excellent mean school marks compared with only 3% of the comparison category (adjusted OR 3.8; 95% CI 1.6 – 9.3).

Over half of all those with a hospital-treated mental disorder progressed beyond basic education, but few completed their tertiary education. Early schizophrenia, (i.e. onset before 22 years of age) as well as non-psychotic cases had an approximately 3- to 6- fold adjusted odds for staying in the basic level. Persons with psychoses with an onset at age 23 or later performed nearly as well as the comparison group. Adult smoking (at age 31) and prolonged smoking (at ages 14 and 31) were associated with an approximately 2- to 6- fold, adjusted odds for educational underachievement, but not smoking only at the age of 14.

These results provide new information on the need for earlier therapeutic, rehabilitative and educational interventions directed at children with poor school performance as well as at mentally vulnerable and smoking young persons.

*Keywords:* smoking, educational attainment, school performance, schizophrenia.

## **Isohanni, Irene, Koulutus ja mielenterveyshäiriöt. Pohjois-Suomen vuoden 1966 syntymäkohortin 31 vuoden seuranta**

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2000

Oulu

(Käsikirjoitus vastaanotettu: 13 marraskuuta 2000)

### ***Tiivistelmä***

Suomalaisen koulutuspolitiikan tavoitteena on nostaa väestön koulutustasoa ja edistää jokaisen kansalaisen mahdollisuuksia edetä koulutusasteelta toiselle. Monia koulutusuraa ennustavia tekijöitä voidaan havaita jo koulu- ja nuoruusiässä. Mielenterveyshäiriöt ja haitalliset elämäntavat voivat rajoittaa mahdollisuuksia hyödyntää yhteiskunnan tarjoamaa koulutusta.

Tämän tutkimuksen tavoitteena oli selvittää pohjoissuomalaisten nuorten peruskoulumenestystä ja koulutustasoa ja niiden yhteyttä sairaalassa hoidettuihin mielenterveyshäiriöihin. Lisäksi selvitetiin tupakoimnin yhteyttä aikuisiän koulutustasoon. Tarkoituksena oli löytää koulutus- ja mielenterveysongelmia ennakoivia ja niiltä suojaavia tekijöitä.

Tutkimusjoukko muodostui Pohjois-Suomen vuoden 1966 syntymäkohortista (n=12 058). Tutkitavien biologisia ja psykososiaalisia tekijöitä on seurattu raskausajasta alkaen 31-vuotiaaksi. Lisäksi aineistona olivat valtakunnallisen yhteishakujärjestelmän tiedosto ja tilastokeskuksen koulutustilastot. Tiedot psykiatrisissa sairaaloissa hoidetuista henkilöistä vuoteen 1994 saakka (n=387) kerättiin sairaaloiden hoitoilmoitusrekisteristä. Kaikkien psykiatrisen kliinisen diagnoosin saaneiden henkilöiden tutkimusdiagnoosit (DSM-III-R) tarkastettiin sairauskertomusten perusteella. Riskitekijöiden itsenäistä ja yhteisvaikutusta analysoidessa sovellettiin regressiomalleja. Tulokset esitetään tunnuslukujen ja ristiintaulukoinnin avulla.

Luokalle jääneillä ja 14-vuotiaana erityiskouluissa olleilla oli 2–8-kertainen vaara sairastua myöhemmin sairaalassa hoidettuihin mielenterveyshäiriöihin. Huonot kouluarvosanat 16-vuotiaana ennustivat aikuisiän ei-psykoottisia häiriöitä, mutta eivät psykooseja. Erinomaisesti koulussa menestyneillä pojilla oli nelinkertainen vaara sairastua skitsofreniaan. Etenkin varhain, 16–22-vuotiaana, alkaneet aikuisiän sairaalassa hoidetut mielenterveyshäiriöt olivat yhteydessä aikuisiän alhaiseen koulutustasoon. Säännöllinen tupakointi 31-vuotiaana sekä 14- ja 31-vuotiaana oli yhteydessä aikuisiän alhaiseen koulutustasoon, muttei säännöllinen tupakointi 14-vuotiaana, joka päättyi ennen 31 vuoden ikää.

Tutkimuksen tuottamia tietoja voidaan käyttää kehitettäessä ja arvioitaessa sosiaali- ja terveydenhuollon eri alueiden, esimerkiksi koulu- ja opiskelijaterveydenhuollon toimintaa, samoin suunniteltaessa ja arvioitaessa terveyden edistämiseen tähtäviä toimenpiteitä koulutusjärjestelmässä. Tavoitteena on, että ehkäisevä toiminta voidaan kohdentaa mahdollisimman varhaisessa vaiheessa aikuiselämän koulutusta vaarantaviin riskitekijöihin.

Asiasanat: koulumenestys, tupakointi, skitsofrenia, suoritettu tutkinto

## Acknowledgements

This work was carried out jointly at the Department of Psychiatry, and the Department of Public Health Science and General Practice, University of Oulu, as a part of the Northern Finland 1966 Birth Cohort Study.

First of all, my deepest and warmest thanks are due to my supervisor, Professor (emerita) Paula Rantakallio for providing me the opportunity to begin this work and for her immense knowledge and vast experience of the many facets of epidemiological research. She displayed far-sightedness and sensitivity in planning the Northern Finland 1966 Birth Cohort Study and in collecting the data in the early 1960s. My sincere thanks are also due to her for allowing me the use of the valuable data of the Cohort. With optimism and skill she has guided and supported me from the very beginning to the completion of this work.

I wish to express my sincere gratitude to my other supervisor, Professor Marjo-Riitta Järvelin of the Department of Public Health Science and General Practice, University of Oulu and Imperial College School of Medicine, London, for her never-failing patience, advice and support during this work. Despite her many international involvements she has found the time for me to discuss and provide feedback. She has taught me much of epidemiology and the process of the scientific work.

I am also deeply grateful to my third supervisor, Docent Pentti Nieminen, Medical Faculty, University of Oulu. He has been one of my most influential teachers, aiding me in learning a logical and critical way of thinking as well as providing valuable advice on data management and interpretation.

I am most grateful to my co-author, Professor Peter Jones of the University of Cambridge, UK, for his most valuable collaboration in the project and in the original publications. His insight and expert knowledge of epidemiological research have been invaluable for this work. I wish to also thank my other co-authors: Professor Matti Isohanni, Jari Jokelainen, BSc, as well as Tim Croudace, PhD, University of Cambridge, UK. Their extensive knowledge and generous help was of great significance.

Professor Hillevi Aro, Tampere School of Public Health, University of Tampere and Docent Ossi Rahkonen, Department of Social Policy, University of Helsinki, have care-

fully reviewed the manuscript and provided fruitful feed-back. I wish to express my sincere thanks for their valuable advice and constructive criticism.

Many persons at the Departments of Psychiatry, University of Oulu and Oulu University Hospital, especially its Research and Development Unit, have supported this work: Professor Matti Joukamaa, Docent Juha Moring and Marja-Leena Mielonen, MN. I wish to express my sincere thanks to Helinä Hakko, PhD, and student (education) Sirpa Ahvenlampi. Without their help this thesis would not have reached its final form. I am grateful to Ms. Minna Lakkapää, Ms. Pirkko Kaan, Mr. Alpo Peltoniemi and Ms. Eeva Turtinen for helping me with several practical details.

I wish to warmly thank Michael Spalding, MD, who did the linguistic revisions in the thesis. Also I want to thank application designer Markku Koironen and Ms. Tuula Ylitalo for their co-operation during this thesis.

I am most grateful to the staff at the office of the Rector of the Oulu Polytechnic, and especially those at the office of the student affairs, for creating a warm atmosphere in which to work, as well as the other persons in the Polytechnic. Docent, Rector Lauri Lantto, has given useful and critical comments at different stages. I wish to express my gratitude for his supportive views. I am particularly grateful to Maire Mäki, PhD for her valuable and warm support and for our interesting conversation on the process of the thesis. I owe a special thanks to Anne-Maria Haapala, MSc and Ms. Pirjo Karttunen for their help in many ways during these years. I also want to thank Annikki Lämsä, LicEd for her supportive attitude to my research work, especially when I began the study. Taina Ahlholm, MEd and Jouko Karhunen, MSc stood in for me when I was on research leave. I warmly thank for that. Docent Pirkko Remes and Pirkko Pietiläinen, MSc have given useful comments on my thesis. I thank them for those.

I wish to express my gratitude to Professor (emeritus) Pekka Tienari and Ms. Helena Tienari for their supportive and constructive views at different stages of my professional and family life. My warmly thanks are due to Kaisa Koivisto, MN. I always remember the inspiring discussion we had. I would like to thank Ms. Raija and Atte Kyllönen, MD and Ms. Leena and Professor Frej Stenbäck for a stimulating social life.

I wish to declare my gratitude to my original family. I will give my dearest thanks to my mother Lyyli and my father Edvard Heikkilä for their love all of my life. I wish to thank my sister, Anne-Marie and her husband, Harri Ojala and their children and my brothers, Veijo and Matti, and their families for their warm support.

Finally, my warmest thanks belong to my husband, Professor Matti Isohanni, for his special support and, for always being available in the desperate times when nothing was going right. I would especially thank my daughter Minna and her husband Tero Helynen and my sons Jaakko and Juha and his cohabitant Maria Santalo for making life worth living during the busy years that I have spent working on this dissertation.

The psychiatric research team and other parts of the Northern Finland 1966 Birth Cohort Study have been generously supported by grants from the Academy of Finland, the Sigrid Juselius Foundation, the Theodore and Vada Stanley Foundation (USA), the Ministry of Social Welfare and Health, the Oulu University Hospital and the Oulu Polytechnic. I am grateful that I could utilize the results of this funding in my work.

Oulu, November 2000 Irene Isohanni

## Abbreviations

CI	Confidence interval
DSM-III-R	Diagnostic and Statistical Manual of Mental Disorders, Third Edition, Revised
FHDR	The Finnish Hospital Discharge Register
ISCED	International Standard Classification of Education
IQ	Intelligence Quotient
OR	odds ratio
SES	Socio-economic status



## **List of original papers**

This thesis is based on the following original articles:

- I. Isohanni I, Järvelin M-R, Nieminen P, Jones P.B, Rantakallio P, Jokelainen J & Isohanni M (1998) School performance as a predictor of psychiatric hospitalization in adult life. A 28-year follow-up in the Northern Finland 1966 Birth Cohort. *Psychol Med* 28:967-974.
- II. Isohanni I, Järvelin M-R, Jones P.B, Jokelainen J & Isohanni M (1999) Can excellent school performance be a precursor of schizophrenia? A 28-year follow-up in the Northern Finland 1966 birth cohort. *Acta Psychiatr Scand* 100:17-26.
- III. Isohanni I, Jones P.B, Järvelin M-R, Nieminen P, Rantakallio P, Jokelainen J, Croudace T & Isohanni M (2001) Educational consequences of mental disorders treated in hospital. A 31-year follow-up of the Northern Finland 1966 Birth Cohort. *Psychol Med* (in press).
- IV. Isohanni I, Järvelin M-R, Rantakallio P, Jokelainen J, Jones P.B, Nieminen P, Croudace T & Isohanni M. Juvenile and early adulthood smoking and adult educational achievements. A 31-year follow-up of the Northern Finland 1966 Birth Cohort. *Scan J Pub H* (in press).

Original articles are referred to in the text by the Roman numerals I-IV.

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## 1 Introduction

In the current information-based society, a life-long education for the acquirement of knowledge, skills, and attitudes has become more important. Education plays an important role in either promoting or obstructing the degree of a person's ability and their possibilities to manage in a changing society (Tuijnman 1989, Uusitalo 1999). Mental disorders during young adulthood may be a serious threat to a person's educational capacity and *vice versa*: problems in educational development and adverse lifestyle may be associated with the health of a young person. Educational underachievement is increasingly important in the global, net- and team-working work-life and society with high technology and major demands on social skills, where mental disorders and educational failures may have major adverse consequences on the individual and on society.

It is known that failures in scholastic attainments may predict severe mental disorders in adulthood. Deterioration in school achievement or other intellectual functioning has been known to be a prodromal sign in schizophrenia since Bleuler published his landmark descriptions from the beginning of this century, as is true in other mental illnesses (Yung & McGorry 1996). Gifted, educationally successful and privileged persons may, however, also develop mental disorders (Jamison 1993).

A number of studies have demonstrated that schizophrenia, somatization and antisocial personality disorders, and neurotic disorders are more common among persons with less education (Goldberg & Lecrubier 1995). Such associations in affective disorders are less clear (Aro *et al.* 1995a). Non-psychotic disorders are significant predictors of failure in educational transitions (Kessler *et al.* 1995).

Several earlier studies have demonstrated that smoking can be seen as a very strong factor dividing adolescents into those who follow favourable educational tracts and into those who will eventually remain at the lower levels of educational attainment or even totally without further educational qualifications (Aarø *et al.* 1986, Koivusilta 2000). Smoking was therefore chosen as a marker of risk behaviour in this study. Smoking is an increasing public health problem in many European countries, particularly among adolescent girls. Education has also been described as the best single socio-demographic predictor of smoking (U.S. Surgeon General 1989). Although the prevalence of smoking dimin-

ishes with increasing education, the reasons for this are largely unknown (Rahkonen *et al.* 1994, Koivusilta *et al.* 1998).

The individual's failure to fulfil his educational potential has consequences in his later social and occupational life. Education is the first and obligatory step on the pathway to individual socio-economic status (SES). In the terms of current sociological theory, truncated education may affect an individual's ability to participate as a citizen in adult life, by reducing social capital - "the ability to secure benefits through membership in networks and other social structures" (Portes 1998). Persons with psychiatric disorders may pay substantial personal costs in terms of educational as well as in later social achievements.

Thirty-four years ago professor Paula Rantakallio (1969) started the prospective Northern Finland 1966 Birth Cohort Study (hereafter the Cohort). The aim was to investigate biological, social and environmental factors concerning the mother, child and family, and the morbidity and mortality of the child. The Cohort (12058 live-born children) provides prospective, extensive developmental data from pregnancy, birth, childhood, adolescence and adulthood in a large general population sample. Education and smoking have been two important areas of research in the Cohort from the early 1980's to the age of 31 (Rantakallio 1988, Sorri & Järvelin 1998). The psychiatric sub-project analysing cases with severe psychiatric disorders began to study risk factors and the consequences of severe mental disorders in 1994 (Isohanni *et al.* 2000a).

The purpose of the present study was to extend the research project of the Cohort described above by investigating educational predictors and consequences of mental disorders treated in hospitals between the ages of 16-31, as well as the associations between smoking and adult educational achievements.

## 2 Review of the literature

### 2.1 Education

#### *2.1.1 Definition and importance of education*

*“Man can only become man through education. He is nothing other than what education makes of him. Its noticeable that man is only educated by a man - that is, by men who have themselves been educated.” (Kant 1923/1992)*

Education is the main focus in this thesis. The concept of education is described in some detail in the following. Not only in everyday language, but also in pedagogical texts, the word “education” is used to mean different things. Brezinka (1994) proposed that the term “education” be used in the following sense: the term by education is understood as the action through which people attempt to improve one or more person’s psychic dispositional structures in some respect, preserve the components viewed as valuable or prevent the development of dispositions judged to be bad.

The shortest formulation of the conceptual content of education is the following statement: education is designated as an action through which people attempt to further the personalities of other persons in some respect (Brezinka 1994).

It is suggested that the aim of education is to aid an individual in his development as a member of society, and more broadly, to preserve and/or develop the framework of society (Shafritz 1988, Sinclair *et al.* 1993). In the present study “education” is defined as the system of the formal education which takes place in schools and other educational institutions.

Why is education so important? Education contains classic outputs (knowledge, grades, qualifications) as well as other, both positive and negative individual outcomes. They are usually associated with self-esteem, self-concept and other personality features, as well as familiar and social relations. Both society and the individual suffer if somebody misses his or her educational possibilities. Education both opens and closes the

gates for the future life span (Kivinen *et al.* 1989). From an individual perspective, poor education is a critical determinant of many lost later-life opportunities, such as career constraints and unsatisfactory life (Pietilä 1994, Lu 1995), low personal and professional identity (Järvelä 1991, Ross & Nisbett 1991), poor occupational achievement (Hills 1982, Viljanen 1979, Tuijnman 1989), financial insecurity and low income (Tuijnman 1989, Uusitalo 1999), as well as problematic lifestyle and other behaviour which may influence health (Doornbos & Kromhout 1990, Elo & Preston 1996, Koivusilta *et al.* 1998).

### ***2.1.2 Education as a major determinant of socio-economic status***

In our current information-based society, education may be seen as the first, obligatory step on the pathway to individual socio-economic status (SES). Truncated education, as studied in original publications III and IV, may affect an individual's ability to participate as a citizen in adult life by reducing social capital (Portes 1998).

SES can be characterised by education, profession, occupation, income, or by some combination of these. The process by which people attain a high SES in modern societies is a complex one. In their life course, individuals can move up and down in this SES system as a consequence of either forced or voluntary changes in their social position. This movement during an individual's life course is called intragenerational vertical mobility. Education is one of the building blocks for SES (Behrman & Taubman 1997), as is discussed in detail in section 7.3.3, in original publication III and as is also described in Figure 3.

In earlier eras skills learned in the family or at work were useful capital on the labour market, while in modern times, especially during the second half of the twentieth century, highly specialised occupational life employment and advancement in one's career are strongly dependent on educational qualifications (Howe 1992, Behrman & Taubman 1997). In the highly educated population of Finland, an individual's SES and social appreciation are more obviously related to his education than in many other societies (Keltikangas-Järvinen 1992). Up until recent times, a positive association between the amount of education and income, and a negative association between the amount of education and the probability of unemployment has prevailed (Haven 1999). For employers, attained education acts as a sign of an individual's abilities and suitability. Those who have acquired a long schooling are generally presumed to be ambitious, to have self-discipline, a desire to develop themselves, and the ability to obtain satisfaction from persistent endeavours (Silvennoinen 1992).

There seems to be a growing polarisation into two strata in Western societies – the highly educated elite and the less educated, marginalized people, deprived in many fields of life. Poor scholastic performance or health may expose a person to the latter group as is seen in this thesis (III). Members of the former stratum get jobs with higher wages, more rewarding tasks, more favourable work conditions, a higher degree of occupational safety, more secure employment and better chances for advancement and mobility between regions and enterprises. The latter stratum is left with the jobs with low wages, poor working conditions and poor occupational safety, a greater probability of unem-

ployment, and minor requirements as to professional skills and formal education (Silvenoinen 1992).

Failure in educational attainments thus places a person at risk for a lifetime of personal and career problems, as well as creating problems for society at large. They not only reduce the probability of finding full-time employment, but also increase the risk of becoming an added burden to tax-payers in terms of lost tax revenue and costs associated with unemployment, health care and other social services (Persaud & Madak 1992). An unemployed person with no vocational education has scarce changes of participation and a weak sense of being related to society (Ritakallio 1991).

Typical features of young people who are at risk of becoming marginalized from the society are difficulties in comprehensive school and a low educational level, being unskilled, having experiences in short episodes of employment or unemployment and, in some cases, an unhealthy or criminal way of life. The growing requirements in working life, unstable economic situations, marginalization of parents, learning difficulties and certain learned ways of thinking are examples of the various possible factors making up the life career of a young, disadvantaged person (Nurmi *et al.* 1992).

### ***2.1.3 Formal education system in Finland***

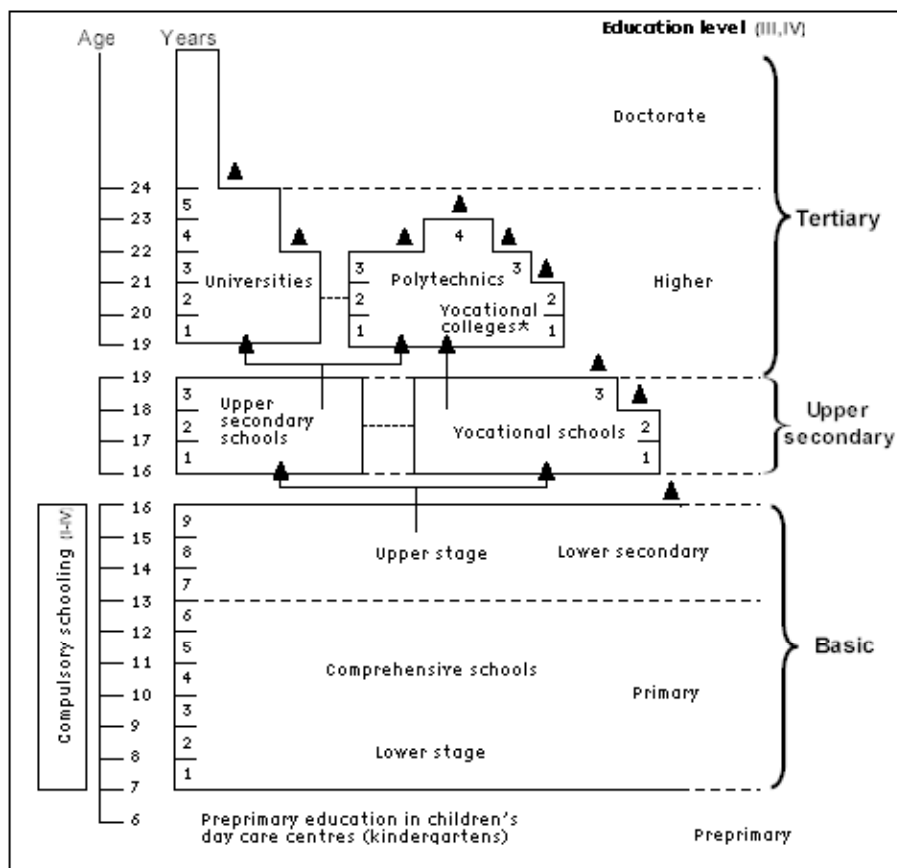
The performance of the subjects in formal education (not in other educational systems, e.g. home, peers and media) was under examination in this study. In this chapter the formal education system in Finland is described.

Potentials for education depend on the resources provided by society (Peltonen 1979, Viljanen 1979, Lampinen 1998). According to the statues governing compulsory education in Finland since 1921, children must attend a comprehensive school from the age of 7 years. The Finnish school system has been based on nationalistic, humanistic, Christian and economic purposes from the 18th-century to the 1960's. After the 1960's both the purposes as well as the structures of formal education have been changed. These school reforms have been influenced by both a tendency towards economic growth and the increase of social equality. Both aims maintain social integrity in a rapidly changing society. Lifetime learning has been the general aim of these innovations (Lampinen 1998). The educational level began to rise rapidly in Finland in the 1960's. These educational reforms influence the educational trajectories from the 1970's within the Northern Finland 1966 Birth Cohort.

*Educational levels and institutions.* The basic structure of the Finnish education system is shown in Figure 1. The formal educational system comprises compulsory (basic) and postcompulsory (upper secondary and tertiary) schooling. Other educational institutions are i.e. night schools, adult education centres, physical education centres and military vocational institutes and academies. The summer universities provide education at a university level regardless of previous education. This also shows approximately how the education provided by the various institutions corresponds to the levels in the revised UNESCO International Standard Classification of Education 1997 (ISCED 1999).



In this study (III-IV) educational levels were combined into three categories: 1. basic education; 2. upper secondary education; 3. tertiary education. These are also described in Figure 1.



**Fig. 1. The formal education system in Finland in 1998 and educational categories (basic, upper secondary, tertiary education) used in this study (I-IV). Modified from Education in Finland (Haven 1999).**

*Pre-school education.* Participation in pre-school education is voluntary, and it is provided for six-year-olds, who will start their compulsory education in the following year, in day care centres and in pre-school classes operating in connection with comprehensive schools. Over half of Finland's six-year-olds attend.

*Comprehensive school.* In Finland as in most Nordic countries, a nine-year school system provides for the education of all children of compulsory school age. Every Finnish citizen is required to complete this basic education as were all members of the Northern Finland 1966 Birth Cohort studied in this thesis. The age at which school is begun is seven in all Nordic countries, as well as in most other countries of the European

Union. In Finland the lower stage of the comprehensive school (primary education) consists of grades 1-6 and the upper stage of grades 7-9 (lower secondary education). Pupils can also participate in a voluntary tenth grade. After their compulsory education, students are selected for postcompulsory education - upper secondary schools and vocational schools - in a joint nationwide selection procedure.

*Upper secondary schools.* Upper secondary schools offer a 2-4 -year general education curriculum, at the end of which the pupil takes the national matriculation examination evaluated by the Matriculation Examination Board (appointed by the Ministry of Education), which is the general eligibility criterion for higher degree education. The matriculation examination consists of four compulsory subjects and one or more optional ones. The compulsory tests are in the native language (either Finnish or Swedish, depending on the language of instruction at the school), the second official language, a foreign language, and either mathematics or general studies. In the latter examination, the student answers questions in one of several subject groups, which are: religion and ethics; psychology and philosophy; history and civics; physics, chemistry, biology and geography. There are two levels of examinations in mathematics, in the second official language and in foreign languages. The more demanding level must be chosen in at least one of the compulsory examinations. Upper secondary school has traditionally constituted the main channel to university education.

Both comprehensive school and general upper secondary school have a broadly based system of counselling which underpins the development of the pupil, and provides guidance in studying, career planning and the choice of further studies. The task of counselling is to ensure that every young person leaving school is aware of what choices for further education are open to him and what working in the adult world entails, and that he has a clear plan for his own future.

Low achievers may have to *repeat a grade*, or they may have to take a test during the summer in a subject that they failed. The percentages of the students who have to repeat a grade are 0.5 in comprehensive schools and about 4 in class-form upper-secondary schools. More boys repeat in both categories.

*Vocational schools* provide post-comprehensive vocational education. Obtaining a vocational diploma generally takes 2-3 years. In the early years of the 1990's the vocational schools and colleges began to group together to form multi-field institutions. Meanwhile primary ownership of these institutions has gradually shifted over to the municipal sector. The apprenticeship scheme has been developed and education is in other ways being more closely integrated with working life. The vocational education provided at the institutions includes work placements lasting for a minimum of six months.

*Polytechnics.* The total number of polytechnics is 29 (in 2000). They are mostly multi-field and regional institutions of higher education, emphasising working life contacts in their operations. Compared with universities, polytechnic studies are more practically oriented. Polytechnics educate experts for positions in working life and its development. In addition to their educational duties, polytechnics conduct research and development work which serves instruction and supports working life. Polytechnic studies for a polytechnic degree take 3.5 to 4.5 years after the matriculation examination or equivalent qualification. The vocational college system is gradually being phased out as part of the polytechnic reform.

*Universities.* In Finland all 20 universities (in 1999) are state-run and engage in both education and research. Ten universities are multifaculty institutions and ten specialised institutions. Of the specialist institutions three are universities of technology, three are schools of economics and business administration, and the remaining four are art academies. In addition, university-level education is provided at one military academy under the Ministry of Defence. Most of the students selected for the universities are admitted for courses leading to a higher university degree. The higher university degree is designed to take 5-6 years to complete after the matriculation examination. If they wish students may also work for a lower degree taking 3-4 years to obtain. Students who have completed a higher degree may go on to complete a Doctorate-level degree. In most fields, students can also take an optional Licentiate's degree before going on to a doctorate. The Finnish university degrees correspond to the degrees of Bachelor, Master and Doctor known internationally. In universities the median age for first-year students is 21, and the master's degree is achieved, on average, at the age of 27 (Haven 1999).

*Adult education.* Adult education has expanded rapidly in the past few years. Continuous changes in work, the ageing of the labour force, and trends in unemployment all underscore the importance of adult education. Efforts have been made to integrate this education into the system according to the principle of continuing education. Vocational adult education is given by all vocational institutions and, specifically, by vocational adult education centres. Adult education at universities and in polytechnics comprises further education and open-university courses. Each university has a centre for continuing education. Annually more than 1.6 million adults (total population 5.0 million) in 1995 were being educated (Haven 1999).

*Special education.* Compulsory education also applies to disabled children. Education is given in special classes, or it is offered as part-time tutoring. Special schools (municipal, state-run or private) exist for the severely handicapped e.g. the intellectually disabled, otherwise educationally or physically handicapped, for those with sensory (hearing, vision) defects and those with behavioural problems. They follow the objectives of comprehensive school with some adaptations. Special arrangements and facilities also exist to help disabled students who attend upper-secondary schools and institutions of higher education. The objective of this education is for those students to attain the same vocational qualifications as do other students.

*Finances.* Finland invests more (6.6 per cent in 1995) in education as a percentage of gross domestic product (GDP) than do other OECD countries on average (5.6 per cent) (Haven 1999). Finland's regular education system is financed almost entirely out of public funds. Schooling leading to a qualification in Finland is free of charge. Students receive free tuition, free teaching materials, school meals and - if necessary - accommodation and school transport at primary and secondary schools. Some of the social costs of education are paid for by the students themselves at the higher levels of education but the government has, by means of student grants, tried to assure equal access to education for all. Since 1969, the state has offered financial support for students in post-compulsory education. This comprises a non-repayable grant and a government guaranteed loan.

### ***2.1.4 Factors associated with educational performance***

In this thesis, educational performance (school performance) was considered as an exposure variable (I, II) and educational achievements as outcome variables in relation to mental disorders (I-III) or to smoking (IV). These relations may be confounded by other factors, which are shortly described in the following.

*Personal and social factors.* Good educational performance is associated with female gender (Nummenmaa 1992, Koivusilta 2000) and good general ability (Spilerman 1977, Wiersma *et al.* 1983, Lairio 1988). Also both perceived health and health-related lifestyle are possibly related to good education (Koivusilta 2000). Urban residence (Luukkonen & Isohanni 1979, Sinisalo 1986) may also be associated with good education.

*Familial background.* The significance of the home background becomes more pronounced at the highest levels of education (Kuusinen 1986, Nummenmaa *et al.* 1987, Isoaho *et al.* 1990, Haven 1999). An influential factor in this association is the interest of the parents in their offspring's development of personal traits, which are central to the process of education. These are motivation, self-direction, perseverance and flexibility and models of self-presentation, such as manner of speech, dress and peer identification (Kuusinen 1986, Isoaho *et al.* 1990). Parents who are financially more well off may offer more material resources e.g. facilities and opportunities for learning. They can also afford hobbies, which will develop skills useful at school (Koivusilta 2000). The family type is also a dividing factor. Living in a divorced or a one-parent family has been found to be associated with performance deficits at school (Aro & Palosaari 1992, Koivusilta 2000,) as well as with a low attained educational level in the Cohort (Riala *et al.* 2000). A low number of siblings may also be related to good education (Blake 1986, Isoaho *et al.* 1990).

### ***2.1.5 Previous studies of determinants of education in the Northern Finland 1966 and the 1985/1986 Birth Cohorts***

Scholastic performance has been one major factor studied within the Northern Finland 1966 Birth Cohort and within another Northern Finland 1985/86 Birth Cohort gathered in the same geographical area. Earlier studies on education in these two cohorts are reviewed in the following. The present thesis extends these earlier studies by having a longer follow-up and new outcomes while the educational variables are in part the same. In these earlier studies, educational performance was operationalised using type of school, mean school marks, class level (grade) at the age of 14 and an attained educational level as in this study. Enrolment for further education courses at the age of 16 and employment up to the age of 25 years were also used. The main content of these studies is condensed in Table 1.

*Table 1. Summary of the studies on educational attainment and their determinants in the Northern Finland 1966 and 1985-1986 Birth Cohorts.*

Authors (year)	Explanatory variable(s)	Measures of outcome	Main results
Rantakallio & von Wendt (1985)	524 low-birthweight (under 2500 g) infants	Type of school and class level at the age of 14 years	Poor school performance was more common among children with a low birthweight (<2500g).
Rantakallio, von Wendt & Mäkinen (1985)	Psychomotor development during the first year of life (standing, walking, urinating, speaking)	Educational capacity at the age of 14 years.	There was a significant difference in subsequent school performance between early and late learners, 24.4 per 1000 of the former and 47.7 per 1000 of the latter having educational problems.
Rantakallio & von Wendt (1986)	IQ level	Type of school attended at the age of 14 years	2.2% of the children did not attend a regular school, and 3.8% were at a regular school but in a lower class than appropriate for their age. Of the children who were at a regular school but in a lower class, the IQ was over 85 for 66.1% of those tested. The children at school for mentally subnormal students included 88.8% of those with an IQ below 86.
Moilanen & Rantakallio (1989)	289 twins, 11 623 singletons	Educational performance at the age of 14 years and admission to further education at the age of 19 years	The twins did not differ from the singletons during their compulsory and secondary schooling. The twins had applied for admission to further education courses less often than the singletons or their controls matched only by maternal factors, but not when matched by perinatal morbidity.
Järvelin, Läärä, Rantakallio, Moilanen & Isohanni (1994)	School performance, educational level and school placement	Delinquency among males between 15-22 years	Poor school performance was seen as one predictor of delinquency. As for intermediate education, the highest risk to delinquency was seen among those who were not accepted or did not graduate and the lowest among those who graduated from upper secondary school. Those attending special schools had a higher incidence of delinquency.
Olsén, Myhrman & Rantakallio (1994)	Low birth weight (LBW)	Participation in further education after compulsory schooling and completion of further education	The success of the LBW children in their post compulsory education was satisfactory except for the disabled LBW children, especially the girls.
Rantakallio, Myhrman & Koironen (1995)	School performance	Juvenile offenders up the age of 25 years	Poor school performance was associated with an increased incidence of delinquency. Above-average attainment was also predictive of a lower incidence.
Myhrman, Olsén, Rantakallio & Läärä (1995)	Wantedness of the pregnancy	Educational attainment up the age of 24 years	25% of the men born following an unwanted pregnancy failed to attain any education other than the compulsory schooling, compared with 18% of those born as a result of a mistimed pregnancy and 14% from a wanted one. The comparable proportions for women in the cohort were 19%, 13% and 9%, respectively.

*Table 1. continued.*

Authors (year)	Explanatory variable(s)	Measure of outcome	Main results
Järvelin, Mäki-Torkko, Sorri & Rantakallio (1997)	Hearing impairment	Educational outcomes	The more severe the hearing impairment, the poorer was compulsory school performance. Those with normal hearing and those with a slightly abnormal were equally often accepted for intermediate education (88%), while those with a clinically significant loss had the lowest acceptance figures (64%).
Olsen (1997)	Pre- and neonatal and socio-demographic factors	Placement in special school/deferment from school	Maternal epilepsy was the strongest determinant of placement in special school/deferment from school when pre- and neonatal and socio-demographic factors were considered. Maternal education was the most important risk factor of learning difficulties, a low "dose-response" effect could even be observed.

*Educational performance by birth weight.* In the first study on educational issues, Rantakallio & von Wendt (1985) investigated school performance at 14 years of age by birth weight. A total of 524 low-birth weight infants were established. School performance was judged by the type of school and class with or without handicap, the children with normal school performance but with one or more neurological handicaps, and the normal children. The number of children with educational problems with or without a neurological handicap (lower than normal class at school or no school) was 6% (n=702) of the total series with a higher prevalence among low-birth weight infants. 1.5 percent (n=179) had a handicap but normal school performance. Some degree of poor school performance was at least four times as frequent in the lowest weight class than in the highest class. Per live births only 10% of the boys and 30.6% of the girls in the lowest birth weight class were normal in terms of school performance. The total number of children with an IQ below 86 was 326 (202 boys, 124 girls). 0.7% (n=85) of the total had no school or was in a school for the mentally retarded. 14 children went to a school for the deaf, but none of the blind persons (n=4) to a school for the blind, as one had died and the other three were intellectually disabled.

*Psychomotor development and later educational problems.* Rantakallio *et al.* (1985) found a clear correlation between late psychomotor development during the first year and later educational problems. The fast learners in psychomotor development during their first year of life were superior to the others in their educational capacity at the age of 14 years. There was a significant difference in subsequent school performance between the early and late learners, with 24.4 per 1000 of the former and 47.7. per 1000 of the latter having educational problems.

*Type of school attended and IQ.* Rantakallio & von Wendt (1986) found that 2.2% of children in the cohort did not attend a regular school, while 3.8% were at a regular school but in a lower class than appropriate for their age at the age of 14. An intelligence test was administered to only a few children with normal school performance and to 51.9% of the children at a regular school who were in a lower class. Of the 253 children who were unable to attend an ordinary school, only 3 had no intelligence test scores. Of the children who were at a regular school but in a lower class, IQ was over 85 for 66.1% of those tested, so that only 17.6% of the total group was known to have an IQ below 86. The children at school for mentally subnormal students included 88.8% of those with an IQ below 86, whereas all those not at school or at a school for disabled students who were tested were in this category.

*School performance of twins.* Moilanen & Rantakallio (1989) investigated the growth, development and vocation of 289 twins who were followed up to the age of 19 years. Twins were compared with 11 623 singletons and two sets of controls matched either by maternal factors only or by these and perinatal morbidity, all from the same cohort. The twins were more often pre-term and small for their gestational age, and had more often suffered from perinatal asphyxia, neonatal hyperbilirubinemia and hypoglycemia. They had learned to walk without support later than the singletons and the controls matched only by maternal factors, but this difference did not exist between the twins and the controls, who were also matched by perinatal morbidity. Similar result was also found when studying the number of words spoken at the age of one year and physical growth at the ages of 1 and 14 years. The twins did not differ significantly from the singletons during their compulsory nine years of primary and secondary schooling. The twins had applied

for admission to further education courses less often than the singletons or their controls matched only by maternal factors, but not when compared with the controls also matched by perinatal morbidity. Logistic regression analysis revealed numerous perinatal or environmental factors having an adverse effect on educational achievements, but the twin situation itself was not shown to have adverse effects. About half of the same-sex twin pairs and one seventh of the opposite-sex pairs had chosen the same vocation, compared with a just over 10% similarity between the twins and their controls.

*Education and delinquency.* Järvelin *et al.* (1994) examined the association of education with delinquency among males. Those attending special schools had a higher incidence of delinquency. Poor school performance, and especially an inability to pass through elementary school in a class appropriate for one's age, was seen as a predictor of later social problems and delinquency. As for intermediate education, the highest risk was seen among those who were not accepted or did not graduate and the lowest among those who graduated from upper secondary school.

*Birth weight and education.* Olsen *et al.* (1994) examined participation in further education after compulsory schooling and the completion of further education. The study was performed for 377 LBW (low birth weight, < 2500 g) and 10 614 NBW (normal birth weight or  $\geq$  2500 g) children. There was no difference in enrolment for further education, the percentage for non-enrolment was 8.5% for LBW and 7.0% for NBW children. Enrolment among the disabled LBW children, however, was significantly poorer than among the disabled NBW children, 57.1% and 36.8%, respectively failing to enrol. The disabled LBW girls in particular enrolled poorly, 76.9% of them failing to do so. Completing further studies up to the age of 24 was more uncommon among the LBW children than among the NBW children, 17.6% of them failing to graduate compared to 13.8% of the NBW children. If the disabled children were excluded, however, the healthy LBW children were as successful in their education as the healthy NBW children. The LBW girls, especially the disabled ones, graduated least often. When excluding disabled children and controlling confounding variables by stratification, low birth weight did not affect non-enrolment or non-graduation. Altogether, the success of the LBW children in their post-compulsory education was satisfactory except for disabled LBW children, especially girls.

*Social and demographic backgrounds of offenders.* Rantakallio *et al.* (1995) studied the association between social and demographic background variables and male and female juvenile offenders together with the distribution of offences by type and number between the sexes. Up to the age of 25 years, 532 males (8.9%) and 60 females (1.0%) had committed at least one crime leading to a criminal record. An intelligence quotient (IQ) of 50-84, but not below 50, was most closely associated with delinquency, as was school performance, in that not only was poor attainment associated with an increased incidence of delinquency, but above-average attainment was also predictive of a lower incidence. This was not interpreted as a causal association but rather an indication of similarity between the demands of the educational system and demands regarding socially desirable behaviour. The demographic, social, educational and health factors predictive of delinquency were very similar for males and females, and the reasons for the difference in the incidence of delinquency between the sexes must be looked for among the general differences in cultural demands and biological factors.



*Unwanted pregnancy and educational attainment.* Myhrman *et al.* (1995) found in their analysis of educational attainment until the age 25 that 25% of young men born following an unwanted pregnancy failed to attain any education further than the nine years of compulsory schooling, compared with 18% of those born as a result of a mistimed pregnancy and 14% from a wanted one. The comparable proportions for women in the cohort were 19%, 13% and 9%, respectively. Interaction between large family size and unwantedness showed an increased risk for low educational attainment among young men; neither large family size nor other family background variables could explain the association between unwantedness at birth and comparatively little schooling among women.

*Effect of hearing impairment on educational outcomes.* Järvelin *et al.* (1997) studied the association between hearing impairment in adolescence and school performance, and the outcome of education until the age 25. They found that the more severe the hearing impairment, the poorer was the child's performance at elementary school. Those with normal hearing and those with a slightly abnormal or 4 kHz loss were equally often accepted for intermediate education (88%), while those with a clinically significant loss had the lowest acceptance figures (64%). When adjusting for neurological and social confounders, excluding mental disability, the risk of not qualifying from intermediate or higher education at all was twice as high among those with a clinically significant loss as among the controls (OR 2.1, 95% CI 1.1-3.8), and was still elevated after adjustment had been made for the relevant perinatal, neurological and social factors (OR 1.9, 95% CI 1.0-3.6). Fourteen percent of those with a clinically significant hearing loss, 9% of the subjects with a 4 kHz loss and 7% of those with normal hearing were unemployed at the age of 25 years. Hearing impairments appears to have effects on both the outcome of education and on employment status.

*Risk factors for educational performance in the 1985-86 cohort.* In addition to the 1966 Cohort, the determinants of educational performance have been analysed in the Northern Finland 1985-86 Birth Cohort (n=9298). Olsen (1997) found that maternal epilepsy was the strongest determinant of placement in special school/deferment from school when pre- and neonatal and socio-demographic factors were considered. The other significant risk factors were congenital malformations, male gender, maternal low education, maternal pre-eclampsia and being small for gestational age at birth, in that order. With respect to learning difficulties at normal school, maternal education emerged as the most important risk factor, and "a dose-response" effect could even be observed. Male gender also increased the risk, and to a smaller extent both maternal smoking during pregnancy and being second or later in birth order.

## 2.2 Mental disorders

Severe hospital-treated mental disorders have been treated as outcome (school performance as an exposure variable; I, II) or exposure variables (educational achievement as an outcome variable; III) in this study. They are therefore described in greater detail in the following.

### ***2.2.1 Diagnostics of mental disorders***

Which individual can be defined as "case" in psychiatric epidemiology? In the absence of specific biological and pathological markers, the current definitions of mental illnesses are syndromal and are based on a convergence of signs, symptoms, outcome, and patterns of familial aggregation. Psychiatric diagnoses in general and also as used in this thesis are based on agreed criteria. Most modern diagnostic systems are atheoretical and do not make any statement as to the etiology or severity of a disorder. In 1985 The American Psychiatric Association published (Spitzer & Williams 1987) the revised third edition of the Diagnostic and Statistical Manual of Mental Disorders (DSM-III-R). This is a diagnostic system with rules for specifiable inclusions and exclusions of symptoms for diagnoses. In the DSM system every diagnostic category as well as every single diagnosis has a code. For instance schizophrenia, is listed under the code "295" and paranoid schizophrenia "295.30". The DSM-III-R diagnoses for mental disorders and adult psychiatric morbidity were used in this study.

### ***2.2.2 Development of mental disorders***

As many somatic diseases in adulthood may have their origin in childhood, even during pregnancy (Barker 1994), why not mental disorders? The origins of many adult mental disorders, especially psychoses, may be detected in some cases by observing developmental, social and cognitive processes in childhood and young age (Van Os *et al.* 1997, Isohanni *et al.* 2000b). It has long been acknowledged that adult psychological illness may arise more commonly in individuals with certain personality traits and that these may have been continuous with childhood characteristics (Rutter 1984).

Of the psychoses, schizophrenia has been linked to pre-morbid personality abnormalities such as social awkwardness and withdrawal, as well as with varying degrees of developmental, motor or cognitive impairment long before the onset of psychotic symptoms (Kraepelin 1971, Weinberger 1987, Lewis & Murray 1987, Goldberg *et al.* 1993, Jones *et al.* 1994a). Previous studies on the early predictors of schizophrenia in this Cohort have been reviewed by Isohanni *et al.* (2000a).

The specificity of these predictors and abnormalities is not clear. Affective psychosis may also have some links to development during childhood (Van Os *et al.* 1997) and adolescence (Sands & Harrow 1995). On the other hand, early social and cognitive dysfunctions may lead to different outcomes in adult life, not only to schizophrenia and affective psychosis. The developmental abnormalities, however, are quite distinct from the hallucinations, delusions, and thought disorders which characterise adult psychosis, although there is some evidence of a continuity of negative symptoms e.g. social withdrawal, emotional blunting, underactivity and apathy (Foerster *et al.* 1991). Encountering the difficulty in providing a convincing model to fit the data that are available, we are still far from a useful description of the childhood and adolescent characteristics which predict psychosis (Jones & Done 1997).

Demonstrating associations between early events and a disorder with onset most commonly in the third or fourth decade of life is not easy. Retrospective study designs are

prone to selection, information, recall and referral biases and spurious associations. It is accepted that a proportion of individuals are different or behave oddly prior to psychosis, but details and true proportions are difficult to define, e.g. the less obvious departures from normality will not be remembered (Jones & Done 1997).

The development of explanatory models that include remote events has added a new level of complexity to our understanding of several diseases, along with new opportunities to uncover their causes. The mechanisms proposed include a straightforward continuity of symptoms and personality characteristics between childhood and adulthood, leading to behaviour which places individuals at risk for mental illness (Rutter 1984).

### ***2.2.3 School precursors of schizophrenia***

In this chapter the main studies on the association between premorbid school performance and later schizophrenia will be described. This is done to establish the background facts on the existing knowledge on the subjects examined in the original publications I and II. A summary of the main studies reviewed here is presented in detail in Table 2.

*Table 2. Summary of studies on the association between scholastic and intellectual performance and later mental disorders, especially schizophrenia.*

Authors (year)	Study design	Study population	Main results
Barthell & Holmes (1968)	Case-control, hospital-based	20 schizophrenics and 20 psychoneurotics. Controls were normal high school graduates, USA	Pupils who later became schizophrenics or psycho-neurotics had participated in fewer activities than the controls and were socially withdrawn and introverted during adolescence.
Watt, Stolorow, Lubensky & McClelland (1970)	Case-control, hospital-based	162 patients and 90 controls, matched with sex, race, father's occupational level and education, USA	Preschizophrenic boys showed unsocialized aggression and overinhibition in public school. Preschizophrenic girls were overinhibited and introverted. IQ did not differ significantly from their controls.
Offord (1974)	Case-control, hospital-based	51 male and 65 female schizophrenics, their siblings and age mates, matched with the same race, sex and social class of origin, USA	The male probands but not the female probands performed significantly more poorly in school than their age mates. The within-family results indicated that the pre-schizophrenic differed consistently in school performance from both his siblings and age mates only when the schizophrenic-to-be was a boy who belonged to a low-IQ sibship.
Aylward, Walker & Bettes (1984)	Meta-analysis		Although a mean premorbid IQ for schizophrenic patients was well within the normal range, the intellectual performance of these patients is lower than would be predicted from family and environmental variables.
Keith, Regier & Rae (1991)	Population-based	Epidemiologic Catchment Area (ECA), 18 000 subjects, USA	Failure to finish school was a risk factor for schizophrenia.
Done, Crow, Johnsons & Sacker (1994)	Birth cohort	National Child Development Study (NCDS), 15398 subjects from the 1958 British birth cohort	At the ages of 7, 11 and 16 children who later develop schizophrenia performed more poorly than the population controls in a wide range of tasks which included verbal and performance IQ, reading, mathematics, general knowledge, oral ability and quality of speech. Children who developed an affective psychosis showed only a minor cognitive deficit. Children who developed anxiety and/or depressive disorders manifested marked deficits in verbal and performance IQ, reading and math.
Jones, Rodgers, Murray & Marmot (1994)	Birth cohort	National Survey of Health and Development (NSHD). Stratified sample of 5362 subjects from the 1946 British birth cohort	Children destined to develop schizophrenia walked and talked later than their peers. The lower the score in the IQ or educational tests were, the more likely the children were to develop schizophrenia as adult.
Malmberg, Lewis, David & Allebeck (1998)	National, male cohort	The Swedish Conscript Study, 500540 men. 195 persons with schizophrenia and 193 with another psychosis at age 18.	A linear relationship was shown between low IQ and risk of schizophrenia. Dislike of other pupils at school and of colleagues and the feeling of being disliked by others were striking among preschizophrenics.
Cannon, Jones, Huttunen, Tanskanen, Huttunen, Rabe-Hesketh, Murray (1999)	Nested case-control within a population-based birth cohort	400 children with schizophrenia in adulthood and 408 controls born in Helsinki, Finland 1951-60	There were no differences between the groups in academic or behavioral factors. Cases performed significantly worse than controls only on the nonacademic factors (sports and handicrafts). Cases were significantly less likely than controls to progress to high school.

Deterioration in school as a predictor of schizophrenia has been presented as a pre-morbid or prodromal sign in schizophrenia since Bleuler (1950) in his personal comment of 1911: "It is certain that many a schizophrenia can be traced back into the early years of the patient's life, and many manifest illnesses are simply intensifications of an already existing character. All ten of my own school comrades who later became schizophrenics were quite different from the other boys."

School is an effective and versatile screening for adolescents, and there may be different types of school precursors of mental disorders, mostly schizophrenia (Jones & Done 1997). Four main categories of these school predictors have been presented: 1) repeating a grade, 2) difficulties in completing the final level of schooling (Offord 1974, Keith *et al.* 1991), 3) low childhood educational tests or I.Q. or marks (Offord 1974, Jones *et al.* 1994a, Jones *et al.* 1994b, Cannon *et al.* 1999) and 4) the teachers's ratings (Mednick *et al.* 1987, Olin *et al.* 1995) indicating emotional lability, social anxiety and withdrawal, passivity, poor peer relations, and disruptive or aggressive behaviour.

Teachers's assessments have been shown to be powerful predictors of adult mental breakdown (Watt *et al.* 1970, Watt 1978, Lewine *et al.* 1980, Goldberg & Seidman 1991, Done *et al.* 1994, Jones *et al.* 1994b, Crow *et al.* 1995, Scheffer *et al.* 1995, Olin & Mednick 1996, Yung & McGorry 1996). In the Copenhagen High Risk Study (Mednick *et al.* 1987), teachers' reports predicted up to 35% of schizophrenic cases.

Less is known of the school precursors of mental disorders other than schizophrenia. The DSM-III-R diagnosis of an antisocial personality disorder requires symptoms in childhood or adolescence. Dysfunctional school performance has been linked to schizotypal (Torgersen 1985), antisocial (Yule & Rutter 1968, Keith *et al.* 1991) and narcissistic (Kernberg 1989) personality disorders, alcoholism (Keith *et al.* 1991), substance abuse (Dawes *et al.* 1997), depressive illnesses (Keller 1994), somatization (Keith *et al.* 1991) and conversion disorders (Binzer *et al.* 1997), as well as social phobia (Davidson *et al.* 1993). Childhood conduct disorders and adult antisocial personality disorders may include a straightforward continuity of symptoms (Rutter 1987).

### ***2.2.4 Intellectual performance and schizophrenia***

Mental and educational performance, and intelligence are interrelated. Thus intelligence may confound this association and explain part of the relation between educational performance and schizophrenia.

*Low IQ.* It is well recognised that patients with schizophrenia as a group, have global intellectual impairments and that these pre-date the onset of psychotic symptoms by many years. Researchers have mainly used two approaches: retrospective and high risk studies. In a review and meta-analysis, Aylward *et al.* (1984) found that preschizophrenic children, adolescents, and young adults performed below their matched controls in a variety of standardised measures of intelligence. Adult schizophrenics seen previously at the Maudsley Children's Department had a low IQ as children (Jones *et al.* 1994b). An extensive study of 50 000 Swedish conscripts showed that the poorer the performance on a test covering IQ plus mechanical and general knowledge, the greater was the risk for schizophrenia (David *et al.* 1997). These results were replicated in a similar design using the

Israeli Draft Board Registry (Davidson *et al.* 1999). These two studies replicated a population trend in risk first noted by Jones *et al.* (1994a). As a summary, most twin and sibling studies as well as those performed on conscripts have shown that probands who develop schizophrenia have a lower IQ (Aylward *et al.* 1984, David 1999).

*High performance.* The link between high intellectual capacity, even genius and madness is one of the most compelling and enduring myths in common thinking but has been minimally studied in empirical psychiatric research as was done in a population sample in original publication II. Ecological case-control and family studies have been attempted, most notably by Karlsson (1983), who showed that psychotic patients were more likely than the remaining population of Iceland to graduate from college, or have a first-degree relative listed in Who's Who. Wrede (1984) found in Finland that children of non-chronically ill schizophrenic mothers with paranoid symptoms were persistently rated superior to controls in social adjustment at school. The literature reports on gifted and able persons who develop schizophrenia as well as other mental disorders, especially bipolar disorders and alcoholism (Jamison 1993, David 1999). With strong support (Russell *et al.* 1997, Karlsson 1983, David *et al.* 1997) we can say that it is at least possible for people with a high IQ, giftedness and creativity to go on to develop an even severe mental disorder. This association, if true at the population level, is theoretically interesting and relevant both to the preservation of mental disorders in the population, and to the mechanisms of development for these disorders.

### ***2.2.5 Educational attainments, socio-economic status and mental disorders***

SES can be characterised by education, profession, or occupation, as is described in detail in section 7.3.3 and in Figure 3. In this study (III, IV) education criterion for SES have been used. A relation between low SES and various types of psychopathology has been confirmed in numerous studies (Dohrenwend *et al.* 1992, Jones *et al.* 1993). For schizophrenia, the relation between measures of SES and the illness has usually been strong (Faris & Dunham 1939, Hollingshead & Redlich 1958, Dunham 1965, Kohn 1973, Häfner *et al.* 1999). Many studies have also linked low education with schizophrenia (Salokangas 1977, Lehtinen *et al.* 1991, Keith *et al.* 1991, Aro *et al.* 1995a). No gradient was observed for major affective disorders. However, bipolar disorder was most common in the highest educational category (Aro *et al.* 1995a). Non-psychotic disorders are significant predictors of failures in educational transitions (Keith *et al.* 1991, Kessler *et al.* 1995). Neurotic disorders seem to be more common at the lower than at the higher educational levels (Goldberg & Lecrubier 1995, Lehtinen *et al.* 1991).

Thus, a number of studies have shown that persons with mental disorders, especially schizophrenia may have substantial personal costs in terms of educational as well as later social achievements. These associations may depend on the population, study design, diagnostic and educational criteria. It has proven difficult to establish the strength of association for different conditions, consistency of findings as well as the direction of causal pathways (Varma *et al.* 1980, Dohrenwend *et al.* 1992, Kessler *et al.* 1994, Aro *et*

*al.* 1995a). In addition many factors, such as parental SES and education, and individual ability may affect transitions through the educational sequence of the pathway to SES.

A summary of studies that examine the association between mental disorders and educational attainment is presented in Table 3.

*Table 3. Summary of studies on the association between mental disorders and educational attainment.*

Authors (year)	Study design	Study population	Findings
Noreik & Ödegård (1966)	National, longitudinal (35-45 years)	Two populations graduated from high school: 117 (N= 5010), and 352 (N=12 843) cases with psychiatric hospital-admission for psychosis in Norway.	Number of psychiatric hospital admissions among males who graduated high school was lower than in a control group representative of the average population, while in women the admission rate was 22 per cent above average, mainly due to manic-depressive psychoses.
Salokangas (1985)	Hospital- and regional-based	75 patients with schizophrenia in Finland	Basic education of schizophrenic patients did not differ much from the general population; their occupational status was lower than that of the general population and of their siblings.
Lehtinen, Joukamaa, Jyrkinen, Lahtela, Raitasalo, Maatela & Aromaa (1991)	Population-based, cross-sectional	Mini-Finland Health Survey. 8000 individuals aged 30 or over	A higher prevalence of neurotic and personality disorders among those with lower educational qualifications.
Keith, Regier & Rae (1991)	Population-based, regional cohort	Epidemiologic Catchment Area (ECA). N=18 000, USA	Schizophrenia was more common among persons with less education.
Coryell, Endicott & Keller (1992)	Population-based, 6 years follow-up	965 subjects; 528 females and 437 males	Female subjects with any college education were significantly more likely to develop depression than female subjects with no college education. However for both sexes, the risk of depression was low at the lowest educational level.
Jones, Bebbington, Foester, Lewis, Murray, Russell, Sham, Toone & Wilkins (1993)	Hospital-based cohort	195 subjects with schizophrenia, UK	The premorbid social underachievement was seen frequently in schizophreniform disorder but not in affective psychosis; the schizophrenic patients who failed to achieve their fathers' social status had poorer educational qualifications.
Crum, Helzer & Anthony (1993)	Population-based regional cohort, prospective one year follow-up	3000 adult household residents at each of the five Epidemiologic Catchment Area Program Survey sites (ECA), USA	Individuals who had dropped out of high school were 6.34 times more likely to develop alcohol abuse or dependence than were individuals with a college degree. For those who had entered college but failed to achieve a degree, the estimated relative risk was 3.01.
Aro, Aro & Keskimäki (1995a)	Population-based, record linkage	68 254 discharges from mental hospitals, in Finland	Discharge rates, first-time admission rates and hospitalization risk were 2- to 4-fold higher in the low educational group compared with the highly educated population. The socioeconomic gradient was steepest for schizophrenia. No gradient was observed for major affective disorders.



*Table 3. continued.*

Authors (year)	Study design	Study population	Findings
Goldberg & Lecrubier (1995)	Multinational, regional-based 12 months follow-up	1500 patients per 25 sites. The WHO Collaborative Study on Psychological Problems in General Health Care	Higher prevalence of mental disorders, especially depression and anxiety disorders among those with lower educational qualifications in primary health care. It is likely that educational level acts as a proxy variable for social advantage.
Häfner, Nowotny, Löffler, an der Heiden & Maurer (1995)	Case-control study, follow-up	232 first episode of schizophrenia in Germany	Nearly all schizophrenic and control probands concluded their school education without significant differences between groups. Only in terms of advanced-level education, the schizophrenic men fell off distinctly reaching only 27% compared with 53% of the male controls.
Kessler, Foster, Saunders & Stang (1995)	Non-institutionalized population-based	The National Comorbidity Survey (NCS) in USA. Persons ages 15 to 54 (N=8 098). Diagnoses of DSM-III-R: anxiety disorders, mood disorders, substance use disorders, and conducts disorders.	Early-onset psychiatric disorders are present in more than 3.5 million people who did not complete high school and close to 4.3 million who did not complete college. The proportion of school dropouts with psychiatric disorders has increased in recent cohorts, and persons with psychiatric disorders currently account for 14.2% of high school dropouts and 4.7% of college dropouts. Early-onset psychiatric disorders probably have a variety of adverse consequences, one of them was truncated educational attainment.

## 2.3 Smoking

The motivation to investigate the association between smoking and educational performance here (IV) was to continue and extend previous studies of the Cohort as well as the consideration of smoking as a major health problem. Smoking of the mothers and cohort members has been one main research focus (Rantakallio 1988, Rantakallio *et al.* 1992, Rantakallio *et al.* 1995, Isohanni *et al.* 1991, 1993, 1995) (see 2.3.3). It is an increasing public health problem in many European countries, particularly among adolescent girls. A 1985-86 WHO survey of smoking among 15 to 16-year-old school-children in European countries showed the prevalence of daily smoking among boys to vary from 6% to 29%, and among girls from 5% to 20% (Aarø *et al.* 1986, Aarø & Wold 1987). In the beginning of the 1990s 22 % of boys and 21 % of girls at the ages of 15-19 in Finland smoked daily (Rahkonen *et al.* 1994), and in 1997 30% of men and 23% of women smoked (Uutela *et al.* 1997).

### 2.3.1 Smoking as a marker of risk behaviour

In this study (IV) smoking was chosen as a marker of risk behaviour based on the facts described earlier and previous research tradition of the Cohort.

Of behavioural traits, smoking is a very strong dividing factor of adolescents into those who follow favourable educational tracks and into those who will eventually remain at the lower levels of education or totally without further educational qualifications (Aarø *et al.* 1986, Koivusilta 2000). Smoking has been said to represent a broader lifestyle where education is not valued. Smoking is typical of children and adolescents who do not see education as the source of a good life, and who thus are exposed to the danger of eventually achieving a low level of education or remaining outside further education after the compulsory phase (Stronegger *et al.* 1997). Interest is directed towards other spheres of life, such as leisure and peer groups (Donovan *et al.* 1991). Related phenomena are the rejection of an achievement ideology, rebelliousness, and the adoption of non-conventional values in society.

Cigarettes may be often taken up in order to relieve stress and anxiety (Hurrelmann & Maggs 1995) The association between smoking and mental health problems, such as depression (Patton *et al.* 1988) point to one explanation of why young people in unfavourable educational tracks smoke more than those in favourable educational tracks. Bad feelings and a lack of success in school and life may make a person search for immediate relief or escape through the use of tobacco (Wills 1986).

### 2.3.2 Education and smoking

Education is described as the best single socio-demographic predictor of smoking. The prevalence of smoking mostly diminishes with increasing education (Kandel *et al.* 1986, U.S. Surgeon General 1989, Wagenknecht *et al.* 1990, Rahkonen *et al.* 1994, Hardy *et al.*

1997, Karvonen & Rimpelä 1997, Koivusilta *et al.* 1998), but the reasons are largely unknown (U. S. Surgeon General 1989, Rahkonen *et al.* 1994, Koivusilta *et al.* 1998).

In 1990-1992, nearly half of the 20-29 year old, lowly educated (under 12 years of education) Finnish population smoked regularly. Only about one third of men and one fifth of women with 12 or more years of education (Rahkonen *et al.* 1994) smoked. This kind of social gradient seems to be typical in northern societies and in the USA. In some countries, Italy for instance, smoking during the 1980's was much common among more educated women, being three times more frequent among those with a university degree than among the least educated (La Vecchia *et al.* 1986).

It seems that the same background factors known to be behind educational success or educational failure also lie behind the adoption of risk behaviour such as smoking. The main background factor likely to influence an association between juvenile smoking and academic achievements is parental low education (Chassin *et al.* 1992). In this Cohort parental smoking increased the probability of offspring's smoking (Rantakallio 1983b, Isohanni *et al.* 1991 & 1995), and this relation has also been found in other studies (Chassin *et al.* 1992, Power & Matthews 1997).

### ***2.3.3 Previous studies on smoking and education in the Northern Finland 1966 Birth Cohort***

In the following, earlier studies on the associations between educational performance and smoking in the Northern Finland 1966 Birth Cohort are reviewed. Both maternal smoking and the offspring's smoking have been investigated. Original publication IV extends these studies.

*Maternal smoking during pregnancy.* Rantakallio (1983a) studied the children of mothers who smoked during pregnancy. Offsprings of smoking mothers were more prone to respiratory diseases, they were shorter and their mean ability at school at the age of 14 years was poorer than among offsprings of non-smokers. The differences remained significant after adjusting for the height and age of the mothers, social class as determined by the father's occupation, number of older and younger children in the family, and the sex of the child. The smoking mothers were found to differ from non-smokers in each social class, in contrast to the situation at the time of pregnancy, having on average poorer health, being more often unemployed and having more often left their families. Maternal smoking was seen to have an effect on the children's physical and mental development, even when these factors were also taken into consideration in the regression analysis, although maternal smoking was less important than many other socio-biological factors, and maternal smoking was not more important than paternal smoking.

Isohanni *et al.* (1995) investigated the current and future factors associated with smoking habits during pregnancy. The following background factors were independently associated with the mother's smoking and/or continuing smoking during pregnancy: mother's age under 23, parity two or more, low social class, urban dwelling, unmarried status, gainful employment and heavy smoking before pregnancy. The follow-up responses of the non-smoking mothers and those who quit smoking during pregnancy were mostly

more favourable than those who continued smoking: stable family structure, child's smoking and drinking habits and application for intermediate education.

*Determinants of juvenile smoking.* In her study of smoking habits at the age of 14, Rantakallio (1983b) found that 6.5 % of children smoked every day and 59.5% were non-smokers. Of the family background variables, parental smoking, one-parent family, and a large number of children in the family displayed the strongest association with juvenile smoking. Family background variables explained only 6.5% of the total variance in smoking among girls and 3.5% among boys, but when the characteristics of the children themselves were also introduced into the analysis, 57.7% and 42.7% of the variance respectively could be explained. Juvenile smoking had the strongest association with an excessive drinking of alcohol, poor school performance, less frequent participation in sports and greater body height.

Teenage smoking was studied in terms of its social and family determinants, especially in "non-standard" families (with one or more of the parents absent for at least part of the child's upbringing) by Isohanni *et al.* (1991). The prevalence of experimental or daily smoking was 67.4%, the rate being 65.5% in the standard, and 75.5% in the non-standard families. The overall prevalence of daily smoking was 6.4%, while it was 5.1% in standard families and 12.1% in non-standard families. An elevated risk of smoking existed among adolescents who had experienced death of their father or divorce of their parents and among girls who had experienced death of their mother. Maternal smoking during pregnancy and maternal age less than 20 years at the time of delivery increased the risk, while being the first-born child reduced it. Among family factors existing in 1980, paternal smoking increased the risk for both sexes, while more than three siblings, mother's unemployment or gainful employment (i.e. not a housewife) were associated with smoking by the boys as was urban living, and for the girls migration by the family to a town. The results suggest that juvenile smoking may be an indicator of possible problems experienced by the parents and/or the adolescents themselves with respect to parenthood and family development.

## **2.4 Summary of the literature review: what is known and what should be studied?**

On the basis of the facts presented by the literature as reviewed earlier, some central theoretical and practical facts emerged related to this study and are presented in this chapter.

*Scholastic performance and schizophrenia (for original paper I).* One of the main focuses of this thesis is scholastic performance. Different types of deterioration in school have been presented as a pre-morbid or prodromal sign in schizophrenia. Some categories of school predictors especially for schizophrenia have been presented e.g. difficulties in completing the final level of schooling, or showing impaired performance on tests of general intellectual functioning. The origins of schizophrenia can in some cases be traced by observing adverse social and cognitive development processes during young age at school. Developmental delays or problems may be widespread in the case group (among the persons with mental disorders), however, the majority being hidden within the wide normal range, on a continuum with normality (Jones 1999). Less is known about the school precursors of other mental disorders.

Few investigations have attempted to systematically study the school records and school class level of persons with mental disorders as is reviewed above and in the original publication I. To my best knowledge, a longitudinal, prospective one-year birth cohort design and a follow-up of nearly three decades has never been applied.

*Giftedness and later psychopathology (for original paper II).* Clinical case histories, some epidemiological studies with methodological limitations or biographies suggest that some highly gifted and creative persons may develop schizophrenia or other severe mental disorders, but there is no epidemiologically sound data on this subject.

*Mental disorders and educational career (for original paper III).* A number of studies have shown that persons with schizophrenia pay substantial personal costs in terms of educational as well as later social achievements. These associations have mainly been studied in cross-sectional and retrospective designs. Causality is difficult to establish in these circumstances, particularly as the onset of the disorder or emergence of associated confounding factors can be difficult to define, either conceptually or in practice, and where the origins of adult educational failure may lie in early life but independent from illness. Associations in other mental disorders are less clear.

Longitudinal, prospective studies provide most unbiased data on factors impacting on both education and mental illness and enable the description of transitions through education, to occupation and eventual adult SES, as has been done in the original publication III. This may improve our understanding of the sequentiality and causality between mental disorders, education and SES.

*Smoking and education (for original paper IV).* Smoking seems to be a very strong dividing factor of adolescents into those who follow favourable educational tracts and those who will eventually remain at the lower levels of education or totally without further educational qualifications. Smoking seems to be an indicator of a variety of adverse personal, social and familial properties, lifestyles, and attitudes towards society, which is why it was independently explored in more detail in this study.

As far as I know there is no prospective, follow-up study of the association between cigarette smoking (with longitudinal smoking habits in adolescence and early adulthood), and adult educational attainment.

*In summary,* the relation between scholastic performance and later mental disorders should be examined, as well as the manner in which serious mental disorders and smoking may predict later educational underachievement. It is important to study which predictors are indicative of the fact that all young people do not process equal capabilities or aspirations to take advantage of the educational opportunities available, at least in

principle, for all citizens in a welfare state. The aims in section 4 were set in an attempt to respond these kinds of issues.

### 3 Main theoretical frames of the study

In the following, the main theoretical frames of this study are presented. The theoretical discussion is extended in section 7.3.

*Cognitive model.* The main cognitive functions are memory, learning, thinking and expressive functions. For almost a century cognitive impairment has often been studied as a mechanism responsible for the disintegration observed in individuals with schizophrenia, and there is an increasing trend to define schizophrenia based on a cognitive disturbance rather than on phenomenology (Andreasen 1999). Motor skills, language and visual perception may also be deficient. In addition, overall intellectual functioning will be reduced in most patients (Jones *et al.* 1994b).

*Neurodevelopmental model.* The neurodevelopmental model of schizophrenia is one major theoretical explanation for these early precursors of mental disorders as well as for adult clinical symptomatology. The model suggests that schizophrenia results from the effects of abnormalities in early brain development that is attenuated by further brain maturation. Neurodevelopmental dysfunction may precede the onset of serious mental disorders by many years (DeLisi 1997). There is increasing evidence that psychoses, especially schizophrenia, are not conditions, which appear suddenly in early adulthood (Weinberger 1995, Isohanni *et al.* 2000a,b). Childhood precursors of schizophrenia have revealed cognitive, socio-emotional, and neuromotor abnormalities (Walker 1994). It seems to be clear that some young adults destined to develop schizophrenia show deficits in cognitive, scholastic and social performance long before they display any psychotic symptoms.

*Life course model.* The theoretical main frame of this thesis is a life course model, which includes biological, physiological and social factors (Eriksson 1963, Bronfenbrenner 1979, Dunderfelt 1997, Alanen 1997). This model is discussed in detail in the discussion section (7.3.5.) and is also demonstrated in Figure 4. In this study (I-IV) the individual is seen as a part of the entire system, where social context (Erikson 1963), continuities and discontinuities (Pulkkinen 1983), have key life transitions (Jung 1982) as well as risk and protective factors. These include genetic mechanisms, the non-genetic biological substrate, shaping of the environment, cognitive and social skills, habits, cognitive sets and coping styles and links between experiences (Rutter 1989).

Some long-term physical diseases of adult life (Barker 1994), as well as adult mental disorders (Jones 1997, Cannon & Murray 1998) may have their origin in childhood, even during pregnancy. The most important period in life in terms of educational achievements can be placed between 15-30 years of age, when the educational capacity develops and educational attainments are taken up. It coincides with the period of the maximum risks for the onset of schizophrenia and some other serious mental disorders (Häfner *et al.* 1995).

Many decisions are made in adolescence, which chart the direction of the future life trajectory. Among the most important decisions are those related to education (III), risk behaviour and life style (IV). Education is known to be strongly connected with an individual's competitive position on the labour market, with its related economic and cultural rewards. As today's labour market, demands highly specialised skills and flexibility, the significance of education is likely to be emphasised.



## 4 The aims of the study

The purpose of the present research was to determine the school predictors for mental disorders treated in hospital (I, II), how severe mental disorders affect adult educational attainments (III), and how smoking is related to educational attainments in adulthood (IV).

The specific research questions were:

- a) What are the associations between compulsory school performance and later onset hospital-treated psychiatric morbidity (I, II)?
- b) How do hospital-treated mental disorders at the ages of 16-28 predict the educational level attained by 31 years of age? Do people with mental disorders treated in hospital achieve the same educational level as their age-mates without mental disorders treated in hospital (III)?
- c) What are the associations between smoking in adolescence and in early adulthood, and the educational level attained by 31 years of age (IV)?

## **5 Study design, population, variables and methods**

### **5.1 Study design**

The present epidemiological study represents a longitudinal and prospective, geographically defined, one-year birth cohort design. The study contains many follow-up measurements between 1966-1997 on each subject.

### **5.2 Study population and data collection between 1966-1997**

The study population and data collection procedure for the four original papers is presented in Figure 2.

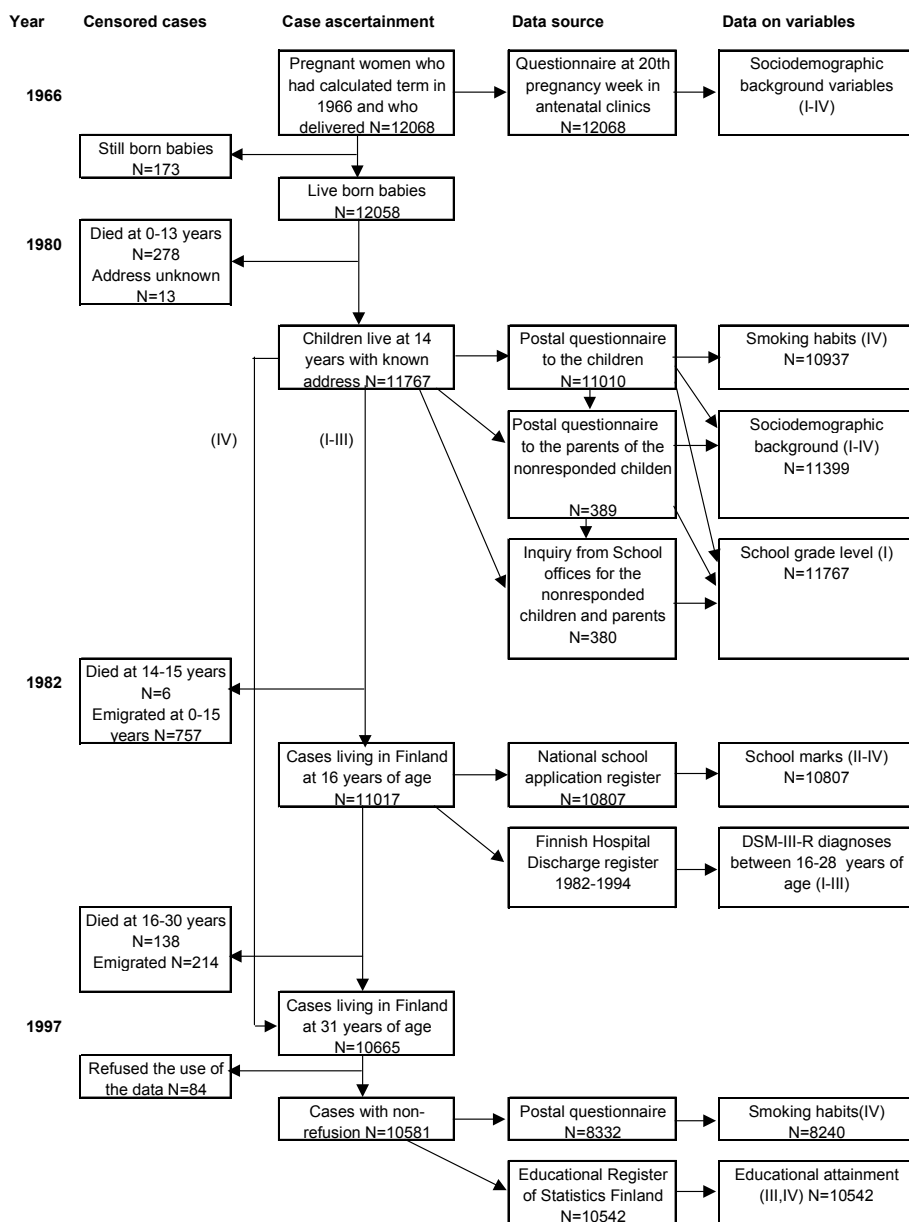


Fig. 2. Study population and data collection between 1966-1997.

This investigation is a part of the Northern Finland 1966 Birth Cohort Study. Rantakallio (1969) assembled a one-year birth cohort of women living in the provinces Oulu and Lapland with expected dates of delivery between Jan 1, 1966 and Dec 31, 1966. The original purpose was, among other things, to study the social and biological characteristics of mothers whose babies had a low birth weight, were premature or suffered perinatal death. There were 12 068 mothers who gave birth to 12 231 children, of whom 12 058 were born live. All pregnant women fulfilling the above criteria were eligible. The eligible subjects were recruited when they visited their municipal maternity health centre during the seventh or eighth month of pregnancy. Information was obtained concerning background factors such as the educational level of mother and father, social status and smoking by the mother (Rantakallio 1988). The data represents 96.3% of all children born in Northern Finland in 1966.

*Multiple follow-ups.* There have been many follow-up to date. One of the most important follow-ups was at the age of 14 years, which data were used in this study (I-IV). A psychiatric follow-up (Isohanni *et al.* 1997, Isohanni *et al.* 2000a) begun in 1994 and was utilised in the present study in papers I-III, and carried out when the subjects were 28 years of age. This study, especially original publication IV, is one part of the 31-year follow-up study carried out in 1997-1998, and referred to as the Northern Finland Health and Well-being Study (Sorri & Järvelin 1998) with many subprojects and domestic and international collaborators.

*Study sample in original publications I-III.* The study sample of psychiatric morbidity arising in adult life concerned 11017 individuals alive and living in Finland at the age of 16 years excluding those who died (n=138) between 16-28 years (see in details in Figure 2).

*Study sample in original publication IV.* The baseline data are the survey data collected in 1980 and in 1997-8. In the first follow-up, 11 780 persons of the cohort were alive at the age of 14, and the completed data set consisted of 11 010 persons (93.5%). In the second follow-up at age 31, data were collected through a postal questionnaire from 10 665 cohort members living in Finland. Data on their highest completed level of education of 10 542 cohort members was drawn from the Educational Registry, which is maintained by Statistics Finland. This data was then linked with the questionnaire data from 1980 and 1997-8.

*Data on the socio-demographic background (I-IV)* was collected in 1966 and in 1980-1981. In 1966 data was collected from the antenatal clinics by a structured questionnaire developed specifically for the study. Data was gathered in 1980-1981 by a postal questionnaire was sent to the families, the school and the health authorities and school nurses, when the children were 14 (Rantakallio 1983a) inquiring as to school performance, school class level, hobbies, social and family status. This data was used in all the original papers. As 278 of these children had died by the age of 14, the number alive at this time was 11780, of whom 82.9% were still living in northern Finland, 10.7% had moved to southern Finland and 6.5% to other countries. Only 13 children had been lost to follow-up by that age. Variables used in this study are described in more detail in 5.3.5. and in Table 7.

*Data on the developmental milestones (III)* of the children (ability to stand) in 1967 at the age of 1 were collected at the routine child welfare clinic visit by the structured questionnaire, when the children were one-year-old.

*Data on psychiatric morbidity (I-III)* between 1982-1994 were collected using the nation-wide Finnish Hospital Discharge Register (FHDR) resulting in 387 psychiatric cases.

*Data on school marks (I-IV)* at the age of 16 were from registers of the national application system for the secondary education after compulsory schooling. School grades were not available for 241 of whom 39 had not attended school at all, 73 were in a special school, 48 had failed at least one grade and 81 were not in a class appropriate for their age. All adolescents are advised to take part in the national application system for upper secondary education including vocational schools and upper secondary schools. All applications and preferences for upper secondary education are stored in national registers, as are data on school marks. All data (n=10776, 97.8%) were extracted for 1980-1985, when the children of the Cohort were 14-19 years old.

*Data on the highest completed educational level (III-IV)* until the age of 31 were gathered from the National Educational Registry of Statistics Finland in 1997. The classification of Education Statistics is designed to describe the system of regular school and university education, which is usually pursued on a full-time basis and with a view to attaining a certificate, diploma, degree, or qualification for an occupation. The classification principle is essentially consistent with the Unesco International Standard of Classification of Education (ISCED 1997, 1999) (Figure 1).

*Data on smoking (IV)* at the age of 14 (in 1980-81) and at the age of 31 (in 1997-98) were gathered by postal questionnaire as described above.

## 5.3 Study variables

### 5.3.1 School performance (I-IV)

After compulsory basic education all adolescents are advised to take part in the national application system for upper secondary education including vocational schools and upper secondary schools. All applications and preferences for upper secondary education are stored in national registers, as are data on school marks.

Depending on the school, 12-14 theoretical school subjects and 6-7 practical subjects are graded in Finland. The theoretical subjects are: native language, reading; native language, literal; second, third, fourth and fifth language; mathematics; chemistry; physics; history; biology; geography; religion and civics. The practical subjects are: physical education, music, drawing, craft, domestic science, commercial subjects, typewriting, and agriculture. School marks in Finland range from 4 to 10. Each set of marks is defined in the following way: 4 is rejected, 5-6 are poor, 7-8 are satisfactory and 9-10 are excellent. In this study school performance was characterised and operationalised in two ways:

First, the categorical description of school grade (class) at age 14 was defined: 1) Not in normal grade: below age-appropriate level or special school. 2) In normal grade: appropriate for age level or above.

Second, school performance at the age of 16 was analysed by school marks. The mean scores of theoretical and all subjects were calculated from the school reports at the end of compulsory primary school and categorised in the following two ways: low or below 7.0, moderate or 7.1-8.0 and good or over 8.1 (I, III, IV); and  $\geq 9$  vs. less (II)

### **5.3.2 Mental disorders (I-III)**

The nation-wide Finnish Hospital Discharge Register (FHDR) founded in 1967 covers all mental and general hospitals. Psychiatric diagnoses were coded routinely between 1969-1986 using ICD-8, between 1987-1995 according to ICD-9 with DSM-III-R criteria, and since 1996 with ICD-10. All case records were scrutinised and diagnoses were validated for the DSM-III-R criteria until the end of 1994. Inter-rater reliability was good, with kappa values from 0.6 to 0.9 (Isohanni *et al.* 1997).

A hierarchical principle was used: only one, i.e. the most pervasive diagnosis was settled on, based on an agreed hierarchical system (Isohanni *et al.* 1997). Multiple diagnoses were not applied in this study. In practice this reduces the amount of diagnoses in non-psychotic disorders. These difficult, hospital-treated cases often have different syndromes occurring together in one episode of illness. The main focus in this thesis lies in psychoses, as case ascertainment was based on the Finnish Hospital Discharge Register (FHDR), i.e. cases treated in a psychiatric hospital. In Finland, nearly every young person with acute psychosis is treated in a hospital, but only one fifth of non-psychotic cases, as is discussed in detail in original paper I.

The official DSM-III-R diagnoses used in this study (I-III) are presented in Table 4. Three diagnostic main categories were used (I-III): DSM-III-R schizophrenia, other psychoses, and non-psychotic disorders (Table 4). Cohort members with no psychiatric hospital treatment or adulthood psychiatric diagnosis after the diagnostic validation were used as a single comparison category.

Table 4. The official DSM-III-R codes, diagnostic categories, and DSM-III-R diagnoses used in original papers I-III, as well as the number of cases.

DSM-III-R code	Diagnostic categories and axis I or II DSM-III-R diagnosis	Number of cases (males) <sup>1)</sup>
	<i>Schizophrenia</i>	89 (58)
295.10	Schizophrenia, disorganized	10 (7)
295.30	Schizophrenia, paranoid type	20 (15)
295.90	Schizophrenia, undifferentiated	59 (36)
	<i>Other psychoses</i>	55 (30)
295.40	Schizophreniform disorder	13 (5)
295.70	Schizoaffective disorder	3 (1)
291.00	Alcohol withdrawal delirium	3 (3)
291.30	Alcohol hallucinosis	9 (7)
293.00	Delirium	1
296.24	Major depression, single episode, with psychotic features	1
296.34	Major depression, recurrent, with psychotic features	4 (3)
296.44	Bipolar disorder, manic, with psychotic features	2 (1)
296.70	Bipolar disorder NOS (not otherwise specified) <sup>2)</sup>	3 (1)
297.10	Delusional (paranoid) disorder	4 (1)
298.80	Brief reactive psychosis	1 (1)
298.90	Psychotic disorder NOS (not otherwise specified)	7 (5)
299.00, 299.80	Pervasive developmental disorders <sup>2)</sup>	3 (2)
301.22	Schizotypal personality disorders	1 (1)
	<i>Non-psychotic disorders</i>	243 (173)
301.10, 301.50, 301.70, 301.81, 301.83, 301.90	Personality disorders	87 (69)
303.90, 304.90, 305.00	Psychoactive substance use disorders: alcohol dependence, polysubstance dependence, alcohol abuse	36 (24)
296.22, 296.23, 296.31, 296.33, 300.40, 309.00, 309.28, 311.00	Depressive disorders	53 (30)
300.00, 300.01, 300.02, 300.15, 300.23, 300.29, 300.30, 309.24	Anxiety disorders	40 (33)
294.80, 300.90, 307.10, 307.40, 307.42, 307.60, 307.70, 309.40, 309.82, 310.10, 312.00, 312.20, 312.31, 313.81, 316.00	Other non-psychotic disorders	27 (15)
	All cases treated in hospital	387 (261)

<sup>1)</sup>The differences of the total number of cases in original papers (I-III) due to different amount of missing data on education, as is described in detail in each original publication.

<sup>2)</sup>In principle these diagnoses do not necessarily belong to psychotic disorders, but cases in this study were severe hospital-treated cases.

Diagnoses of outpatient care or diagnoses from the population who had not undergone any care were not available in this study, except for 2 schizophrenic subjects treated solely on an out-patient basis (Isohanni *et al.* 1997).

### 5.3.3 Educational attainment (III, IV)

In this study (III, IV) eight education level categories (ISCED) (Haven 1999) were combined into three as follows (Table 5):

*Table 5. Educational level categories used by International Standard Classification of Education (ISCED) and in this study (III, IV).*

International Standard Classification of Education (ISCED) (years)	Educational level categories used in study (III, IV) (years)
1. primary education (less than 9)	Basic ( $\leq 9$ )
2. lower secondary education (9)	
3. lower level of upper secondary education (10-11)	Upper secondary (10-12)
4. upper level of upper secondary education (12)	
5. lowest level of tertiary education (13-14)	Tertiary ( $\geq 13$ )
6. lower-degree level of tertiary education (15)	
7. higher-degree level of tertiary education (16)	
8. doctorate or equivalent level of tertiary education	

### 5.3.4 Smoking habits (IV)

Adolescent smoking habits at the age 14 were assessed with one question *Do you smoke?* with 8 alternatives to answer as below. Smoking was classified into three categories: non-smokers, occasional smokers and regular smokers in this study (Table 6).

*Table 6. Questions of smoking habits at the age 14 and smoking categories used in this study (IV).*

Do you smoke?	Smoking categories used in this study (IV)
Never	Non-smokers
I have tried once	
I have tried twice or more	
I smoke occasionally	Occasional smokers
I smoke about twice a week	
I smoke 1-5 cigarettes a day	Regular smokers
I smoke 6-10 cigarettes a day	
I smoke more than 10 cigarettes a day	

At the age of 31 subjects were asked about their smoking habits using two questions, *Have you ever smoked in your life?* If the answer was "yes" they were questioned *Do you*



*smoke at present?* with 5 alternatives to answers as follows. The answers were classified into three smoking categories: non-smokers, occasional smokers and regular smokers in this study (Table 7).

*Table 7. Questions of smoking habits at the age 31 and smoking categories used in this study (IV).*

Have you ever smoked in your life?	Smoking categories used in this study (IV)
No, and do not smoke at present.	Non-smokers
If yes; do you smoke at present?	
Occasionally	Occasional smokers
On 1 day a week	
On 2-4 days a week	Regular smokers
On 5-6 days a week	
On 7 days a week	

Finally a measure of longitudinal smoking habits was formulated at ages 14 and 31. The following five final smoking categories were constructed (Table 8):

*Table 8. Smoking categories of longitudinal smoking habits (IV).*

Longitudinal smoking habits at ages 14 and 31	Final smoking categories in this study (IV)
Combined categories non-smokers and occasional smokers at ages 14 and 31	Infrequent (including non-smokers)
Regular smokers at the age of 14 but non-smokers at the age of 31 (combined categories non-smokers and occasional)	Ex-smokers
Combined categories non-smokers and occasional smokers at the age of 14 but regular smokers at the age of 31	Adult smokers
Regular smokers at ages of 14 and 31	Prolonged smokers
No information on smoking at the age of 14 or 31 years	Incomplete information on smoking

### ***5.3.5 Variable definition by their exposure, confounding and outcome status (I-IV)***

In this thesis the same variable may be both exposure, confounding and outcome variable depending on the paper. Variables by their status by paper are described in Table 9, and more detailed information is given in the original papers.

*Table 9. Exposure, confounding and outcome variables used in the original papers (I-IV).*

Variables and their categorization	Exposure variable	Confounding variable	Outcome variable
Educational attainment: basic, upper secondary, tertiary level	-	-	III,IV
Psychiatric diagnosis until the ages of 28: schizophrenia, other psychoses, non-psychotic disorders	III	-	I, II
School class (grade) level at the age of 14: in normal class, not in normal class	I	-	-
Mean score of all school subjects at the age of 16: fairly good or over 8.1, moderate or 7.1-8.0, low or below 7.0	I,II	III,IV	-
Mean score of all subjects at the age of 16: over $\geq 9$ , under 9	II	-	-
Smoking habits at ages 14 and 31: non-smokers, ex-smokers, adult smokers, prolonged smokers, incomplete information on smoking	IV	-	-
Gender: male, female	-	I-IV	-
Family's place of residence at the child's age of 14: rural, urban	-	I-IV	-
Social class based on father's occupation (mother's if single) at the child's age of 14: III-V or low; I-II or high	-	I-IV	-
Family structure at the child's age of 14: single parent family, two-parent family	-	I,III,IV	-
Age at onset: over $\geq 23$ years, under 23 years	-	II	-
Maternal education at child's age of 14: $\leq 8$ , 9-11, $\geq 12$ years	-	III	-
Perinatal risk: no, yes (low birth weight $>2500$ g, short gestation $>37$ weeks, or perinatal brain damage)	-	III	-
Maternal smoking during pregnancy at the child's age of 14: no, yes	-	IV	-
Paternal smoking at child's age of 14: non-smoker, smoker, child does not know	-	IV	-
Mental disorder of first degree relatives: schizophrenia, other psychosis, alcoholism, any mental disorder	-	II	-
Birth order: first-born, other	-	II	-
Number of children in family: mean	-	II	-
Age at onset: mean	-	II	-
Days in hospital after diagnosis: median	-	II	-
Proportion of time spent in hospital after diagnosis: median	-	II	-
Level of function (Strauss-Carpenter): mean	-	II	-
Clinical course: chronic, intermediate, favourable	-	II	-

## 5.4 Statistical methods

The data were analysed using a conventional cohort approach. Association between exposure and outcome variables were analysed using cross-tabulations and regression models adjusted for confounding. The statistical significance of associations in the frequency tables was analysed using the  $\chi^2$ -test or by Fisher's exact probability test when appropriate.

*Original paper I.* The proportion of pupils who were not in a normal grade was compared with the children in normal grade in each diagnostic category. Unadjusted odds ratios were calculated to estimate the increased risk of developing an adulthood psychiatric disorder among children not in their normal grade. The mean scores for all school subjects pooled together were calculated in each diagnostic category, stratified by gender. The statistical significance of differences between these means (each diagnostic category vs. the comparison category "no psychiatric hospital treatment") adjusted for confounding factors was calculated using analysis of variance (ANOVA). Logistic regression models were fitted to demonstrate the association of each diagnostic category with grade level, school marks, sex, parental social class, place of residence and family type. Regression models were reported using adjusted odds ratios (OR) and their 95% confidence intervals (95% CI).

*Original paper II.* The total scores of all school subjects were calculated for each diagnostic category, stratified by gender. The statistical comparison of the means of the total scores of all school subjects (each diagnostic category vs. persons without psychiatric hospital treatment) were analysed by analysis of variance (ANOVA), adjusted for social class and place of residence. The  $\chi^2$ -test and Fisher's exact test for independence were used when appropriate for categorical variables. Odds ratios (OR) for schizophrenia with 95% confidence intervals (95% CI) were calculated by logistic regression.

*Original papers III and IV.* The continuation ratio model of a polytomous logistic regression (Agresti 1990) was applied. This provides a method to estimate the adjusted odds ratios for the level of education by each diagnostic category and makes an ordinal (ordered categories) assumption on the outcome; i.e. educational level. The continuation ratio model partitioned the analysis of the original outcome variable (the level of education) into two different logit models (logistic regression models for dichotomous response): basic education vs. the others, and upper secondary education vs. tertiary education. These two models were reported using adjusted odds ratios (OR) and their 95 % confidence intervals (95 % CI).

Data management and analysis were performed using either SAS (I-II) or SPSS (I-IV) statistical software (Norusis 1994).

## 5.5 Ethical considerations

This study design was under review by the Ethics Committee of the Faculty of Medicine, University of Oulu on September 22, 1997 and on October 14, 1997 by the Postgraduate Research Committee of the Faculty of Medicine, University of Oulu.

Permission for gathering register data for the entire Cohort was obtained from the Ministry of Social Welfare and Health Affairs in 1993. The research plan for the 31-year follow-up study design of the Cohort named the Northern Finland Health and Well-being Study (Sorri & Järvelin 1998) was under review by the Ethics Committee of the Faculty of Medicine, University of Oulu (IV) on June 17, 1996. After complete description of the study, the subjects had an opportunity to refuse to participate in the study. A total of 84 participants did not consent to the use of their data and were excluded from the study (III,IV).

## **5.6 Personal involvement**

I have participated since 1994 as a researcher in the Northern Finland 1966 Birth Cohort (managed by professor Paula Rantakallio) and Northern Finland Health and Well-being Study (managed by professor Marjo-Riitta Järvelin) and its psychiatric sub-project (managed by professor Matti Isohanni). I selected the topic of education and mental disorders mostly due to my professional background and education. I have worked between 1973-78 in a psychiatric hospital as a graduated psychiatric nurse with the most severe patients, and as a teacher in psychiatric nursing in the Nursing College between 1980-1987. I achieved a degree as a Master of Education in the University of Oulu in 1994. Since 1996 I have been working in the Polytechnic as a director of studies and student affairs, and I am one of those responsible for developing the curriculum of social and health care studies there.

## 6 Results

### 6.1 Compulsory school performance and psychiatric morbidity at ages 16-28 (I)

The majority of 14-year-olds in a group without any need for hospital treatment due to mental disorders (93.2% boys, 96.6% girls) were in their normal grade (Table 10; I: Table 1). Not being in a normal grade was associated with future schizophrenia up to 28 years of age and, independently, with male gender (I: Table 2). The association between not being in a normal grade and the diagnostic category "other psychoses" was even stronger. Those not in their normal grade at the age of 14 had a 2 to 8 times higher risk than in comparison group (with no psychiatric hospitalisation) to develop some mental disorders treated in hospital (Table 10; I: Table 1).

*Table 10. The association of school class level with diagnosis in the Northern Finland 1966 Birth Cohort at the age of 14.*

School class level	Schizophrenia <sup>*</sup>				Other psychoses <sup>*</sup>				Non-psychotic disorders <sup>*</sup>				No hospital treatment	
	N	%	OR <sup>†</sup>	95%CI	N	%	OR <sup>†</sup>	95%CI	N	%	OR <sup>†</sup>	95%CI	N	%
<b>Boys</b>														
Not in normal class <sup>‡</sup>	10	17.2	2.8	1.4-5.7	5	16.1	2.5	1.0-6.6	24	13.9	2.2	1.4-3.4	365	6.8
In normal class <sup>§</sup>	48	82.8	1.0	(ref.)	26	83.9	1.0	(ref.)	149	86.1	1.0	(ref.)	4986	93.2
Total	58	100			31	100			173	100			5351	100
<b>Girls</b>														
Not in normal class <sup>‡</sup>	3	9.7	3.0	0.9-10.0	5	22.7	8.0	2.9-21.8	10	14.7	4.9	2.5-9.7	179	3.4
In normal class <sup>§</sup>	28	90.3	1.0	(ref.)	17	77.3	1.0	(ref.)	58	85.3	1.0	(ref.)	5065	96.6
Total	31	100			22	100			68	100			5244	100

<sup>\*</sup> Category 'no hospital treatment' as a comparison group.

<sup>†</sup> Crude odds ratio (OR).

<sup>‡</sup> Class below age-appropriate level or special school.

<sup>§</sup> Appropriate for age level or above.

The means in school marks of all subjects for boys were about 0.6 unit lower (I: Fig 2) than that for the girls in the population reference category (7.3 vs. 7.9). This population gender difference was also noted ( $p < 0.05$ ) in all diagnostic categories. Among adolescents who later developed non-psychotic disorders, the mean school grades were lower ( $p < 0.05$ , adjusted for social class and place of residence) than in a group without any need for hospital treatment due to mental disorders. The boys who later developed personality disorders (means of all subjects 6.5) and substance use disorder (6.3) had particularly low mean marks in all subjects. Lower marks were not found in schizophrenia or other psychosis categories.

## **6.2 Excellent school performance and schizophrenia in adulthood (II)**

A total of 11% of pre-schizophrenic boys (6/54) had excellent mean scores of school marks (over 9) compared with only 3% (166/5245) among the comparison group (with no psychiatric hospitalisation) ( $p = 0.01$ ). The probability of belonging to the schizophrenia category (boys without hospital-treated psychiatric disorders as a reference) was elevated among boys with excellent mean scores (OR 3.8; 95% CI 1.6-9.1) which did not change after allowing only for social class alone or with other potential confounders, i.e. social class, place of residence or birth order.

Only few gifted cases were found among other diagnostic categories (II: Figure 1). Among pre-schizophrenic girls, only one gifted case was found. There was no any subgroup of gifted premorbid cases in other diagnostic groups, or among girls in all categories. There was a 4-fold excess of gifted girls when compared with boys (12%, 598/5169 vs. 3%, 166/5245) among subjects without hospital-treated psychiatric disorders.

There were no significant differences in socio-demographic factors except the over-representation of first-borns among gifted (Table 11; II: Table 2). Gifted pre-schizophrenic boys were firstborn twice as often as gifted controls (83% vs. 42%,  $p = 0.09$ ), or other pre-schizophrenic boys with normal school performance (83% vs. 32%,  $p = 0.02$ ).

*Table 11. The comparison of family background and some clinical course variables between gifted (mean value of all school marks  $\leq 9$ ) and other pre-schizophrenic boys.*

Variable	Gifted (n=6)	Other (n=48)
Social class in 1980 <sup>1</sup> (%)		
I,II	67	29
III-V	33	71
Mental disorder of first-degree relatives (%)		
Schizophrenia	0	14
Other psychosis	0	14
Alcoholism	33	24
Any mental disorder above	33	52
Urban residence in 1980 (%)	33	39
Firstborn <sup>2</sup> (%)	83	32
Mean number of children (SD) (range)	3 (0.7) (2-4)	4.2 (3.3) (1-14)
Mean age at onset (SD)	22.5 (3.4)	21.4 (3.3)
Median days in hospital after diagnosis	128	188
Proportion of time spent in hospital after diagnosis (%)	17	20
Mean level of function (SD) (Strauss-Carpenter <sup>3</sup> )	19 (8.5)	14 (6.8)
Clinical course (%)		
Chronic	68	60
Intermediate	16	24
Favourable	16	16
Committed suicide (%)	16	7

<sup>1)</sup>  $p=0.09$  (I-II versus III-V) ( $\chi^2$ -test).

<sup>2)</sup>  $p=0.02$  (Fisher's exact test).

<sup>3)</sup> Poor function is 0, excellent function is 36.

Five cases had begun their academic studies but only one was able to finish his university studies. Others had to discontinue studies due to psychosis. Only one case seemed to have a favourable clinical course in the follow-up.

### **6.3 Psychiatric morbidity treated in hospital ages 16-28 and educational attainment by 31 years of age (III)**

Twelve percent of the individuals without any mental disorders treated at hospital completed only basic education. Almost two thirds (62%) passed upper secondary, and a quarter (26%) of them tertiary education. People with early onset disorder tended to stagnate at the basic level of education.

In the schizophrenia category with an onset before 22 years, 38% of persons stayed at the basic educational level. None completed tertiary education. In cases with an onset after 23 years, similar proportions achieved basic level (15% vs. 12%) and upper secon-

dary (70% vs. 62%) as in the comparison group without mental disorders treated in hospital, while 15% (vs. 26%) achieved the tertiary level. The distribution of educational levels in other psychoses category with an onset before 22 years was intermediate between the distributions of schizophrenia and the comparison group. A total of 27% had stayed at the basic educational level while a few had (9%) completed tertiary education. In cases with an onset after 23 years, the proportion at the basic level was the same as the comparison group, and 7% achieved the tertiary level. In the non-psychotic disorders category with an onset before 22 years the proportion of those who had stayed at the basic level was high (particularly in personality disorders). Only a few (4%) had completed tertiary education. In the non-psychotic disorders category with an onset after 23 years, 31% of persons stayed at the basic level (especially cases with substance use disorders), but many (18%) had achieved tertiary education (especially those with dysthymia).

Many with early onset schizophrenia completed secondary education, but none completed the tertiary level. There were 5 schizophrenia and 4 other psychoses cases having an onset after 23 years who achieved the tertiary level. Hospitalisation for non-psychotic disorder increased the risk of underachievement in tertiary education for those with an early onset.

Early onset schizophrenia and all non-psychotic cases had 3- to 6-fold adjusted odds for staying at the basic level. The "other psychoses" group with later onset (after 23 years) and non-psychotic disorders with an onset before 22 years predicted an approximately 4- to 5-fold odd for staying at the intermediate upper secondary level, as is presented in Table 12 (III: Table 2).



*Table 12. The association of psychiatric diagnosis (stratified by age at onset) and attained educational level as assessed using two multiple logistic regression models, adjusted for confounding variables. In the first model psychiatric diagnoses are predictors of basic education (vs. all others), and in the second model of upper secondary education (vs. tertiary education).*

Variables	Basic (vs. upper secondary and tertiary) education OR (95% CI) <sup>1</sup>	Upper secondary (vs. tertiary) education OR (95% CI) <sup>1</sup>
Psychiatric diagnosis		
Schizophrenia		
Age at onset ≤ 22 years	5.8 (2.7-12.4)	*
Age at onset ≥ 23 years	0.9 (0.3-2.6)	1.7 (0.6-4.8)
Other psychoses		
Age at onset ≤ 22 years	0.8 (0.2-3.1)	1.4 (0.3-7.3)
Age at onset ≥ 23 years	0.9 (0.3-2.8)	4.7 (1.1-21.4)
Non-psychotic disorders		
Age at onset ≤ 22 years	3.2 (2.1-4.7)	3.7 (1.5-9.3)
Age at onset ≥ 23 years	3.1 (1.9-5.3)	0.9 (0.4-1.8)
No psychiatric diagnosis (reference)	1.0	1.0

\*No cases.

<sup>1</sup> Odds ratios (OR) are adjusted for confounding (gender, length of stay, perinatal risk, learned to stand at the age of 1 year, maternal education, parental social class at the age of 14, family structure at the age of 14, school class level at the age of 14, school performance at the age of 16).

## **6.4 Association between smoking in adolescence and in adulthood, and attained educational level at adult age (IV)**

The more frequent smoking was at ages 14 and 31 and, especially, at both ages, the lower were attained educational levels. A greater proportion of boys (15%) than girls (10%) were found in the lowest educational level, and girls (28%) reached the highest educational level more often than boys (24%). Individuals with low mean score of all school subjects at the age of 16, with parental smoking, with a low social class, with single parent family and with a rural place of residence of the primary family were more likely to be in the lower educational level (IV: Table I).

Regular smoking at ages 14, 31 or at both ages was associated with an approximately 2- to 6- fold, adjusted odds for educational underachievement Table 13 (IV: Table 2). Allowing for school performance at age 16 diminished these associations, and smoking only at age 14 was not associated with remaining at the basic educational level. Regular smoking only at age 14 but non-smoking at age 31 did not increase the risk of not achieving tertiary education when school performance was adjusted.

*Table 13. The association of smoking habits and attained educational level until the age of 31 as assessed using multiple logistic regression models, adjusted for confounding variables<sup>2,3</sup>. In the first model smoking habits at ages 14 and 31 are predictors of basic education (vs. all others), and in the second model of upper secondary education (vs. tertiary education).*

Smoking habits at ages 14 and 31	Basic education (vs. all others)						Upper secondary education (vs. tertiary education)					
	OR <sup>1</sup>	95% CI	OR <sup>2</sup>	95% CI	OR <sup>3</sup>	95% CI	OR <sup>1</sup>	95% CI	OR <sup>2</sup>	95% CI	OR <sup>3</sup>	95% CI
Infrequent (including non-smokers) (reference)	1.0		1.0		1.0		1.0		1.0		1.0	
Ex-smokers: regular smokers at age 14 but non-smokers at age 31	2.0	1.2-3.3	2.0	1.2-3.3	1.3	0.8-2.2	2.4	1.6-3.6	2.2	1.4-3.3	1.2	0.7-1.8
Adult smokers: non-smokers at age 14 but regular smokers at age of 31	2.7	2.3-3.2	2.4	2.1-2.9	1.8	1.5-2.1	2.8	2.5-3.3	2.7	2.3-3.1	2.0	1.7-2.3
Prolonged smokers: regular smokers at ages 14 and 31	6.5	4.9-8.5	5.7	4.3-7.6	3.0	2.3-4.1	3.4	2.3-5.0	3.1	2.1-4.5	1.4	0.9-2.2
Incomplete information on smoking	4.4	3.8-5.1	3.8	3.2-4.4	2.6	2.2-3.1	2.0	1.8-2.3	1.9	1.7-2.2	1.5	1.3-1.8

<sup>1</sup> Unadjusted.

<sup>2</sup> Adjusted for sex, parental smoking in 1980, parental social class in 1980, family structure in 1980 and place of residence of the family in 1980.

<sup>3</sup> Adjusted as above and school performance (mean score of all school subjects at age of 16).

The associations in the three different strata of school performance differed slightly, especially in the category fairly well where there is a major group of prolonged smokers with tertiary education (IV: Figure 1). The proportion of poor performers at school (mean value of all school subjects under 7, or the lowest tertile) staying at the basic level increased linearly with smoking habit and was over two-fold (37%) among prolonged smokers when compared to non-smokers (16%). Among moderate performers (mean between 7.1 to 8.0), and good performers (mean over 8.1) the associations were non-linear (category prolonged smokers).

## 7 Discussion

### 7.1 Discussion of the results (I-IV)

#### *7.1.1 Compulsory school performance and psychiatric morbidity treated in hospital at ages 16-28 (I)*

Of the cohort members without mental disorders treated in a hospital, a total of 6.8% of boys and 3.4% of girls were not in their normal class. In all the diagnosis categories the proportion of those not in their normal class were from 2 to 8 times higher than those without psychiatric treatment. A majority of children not in normal grade and with a psychiatric diagnosis were intellectually subnormal. Of the adolescents who later developed non-psychotic disorders, the means of school marks were lower than in the comparison group. Lower marks were not found in the schizophrenia or other psychosis categories (I).

Thus, some relationship between poor school performance and severe mental disorders in adult life was demonstrated. Children who later developed hospital-treated mental disorders were more likely to have been delayed in achieving the highest grade of compulsory schooling or were in special schools, mainly due to intelligence deficiency. There was a significant difference between the educational levels achieved at the age of 14 by those with schizophrenia compared with the entire population.

These results partly replicate earlier studies where difficulties in completing the final level of schooling (Offord 1974, Keith *et al.* 1991) or low educational test and IQ scores have been demonstrated among children who later develop schizophrenia (Offord 1974, Done *et al.* 1994, Jones *et al.* 1994a). In contrast to the study hypothesis, school marks at the age of 16 in adolescents who later suffered psychotic disorders, i.e. at the end of compulsory schooling, were essentially the same as those of the group without any mental disorders treated in hospital. This result practically concords with Cannon *et al.* (1999) where the mean score in theoretical subjects among pupils in Helsinki in the 1960's did not predict schizophrenia. The association between poor school achievement

and future severe, hospital-treated non-psychotic mental problems was clear, especially in personality disorders or substance use disorders among boys.

There seems to be three types of psychoses and other severe mental disorders in the premorbid phase: a small group of persons with difficulties in staying in the normal educational trajectory, the main group with normal and even higher scholastic achievement - at least in terms of the formal evaluation performed at school using school marks.

School marks in practical subjects did not predict schizophrenia in original publication I. Cannon *et al.* (1999) found lower marks in practical subjects (mainly sports and handicrafts) among persons with schizophrenia than in the comparison group. They compared their own and our results in their discussion but do not discuss this discrepancy. The comments written by our team based on original publication I on these different results were published as a letter to the editor in the leading journal of psychiatry, Archives of General Psychiatry (Isohanni *et al.* 2000c). We debated that it is not clear that scholastic underachievement predicts schizophrenia. Inconsistent findings may be caused by methodological differences (e.g. different case ascertainment or different measures of achievement). Schizophrenia is likely to be a heterogeneous group even in the premorbid phase, with some having difficulties at school because of not staying in an age-appropriate educational mainstream. For most, data registered routinely at school is probably not a sensitive enough instrument to reveal predictors of schizophrenia, compared with standardised tests. On the other hand, they may not have any problems.

### ***7.1.2 Excellent school performance as a predictor of schizophrenia among males (II)***

The main result was that the boys with excellent school performance had nearly four times higher risk of schizophrenia than other boys. Eleven percent of pre-schizophrenic boys (6/54) had excellent mean school marks compared with only 3% of the group without any mental disorder.

This result was not originally hypothesis-based, but was observed when analysing the exposure data in detail, and the association between schizophrenia and high premorbid achievement is only minimally supported by earlier research. It is possible that the results are a statistical artefact and a chance phenomenon: the number of cases was small. Also varying the cut-off point of excellent school performance suggested that the distribution of pre-schizophrenic children in the upper tail might be similar to that in the comparison category. If the sexes had been combined, the association between schizophrenia and excellent school performance would become non-significant. However, a justification exists for the cut-off of excellent school performance and stratification by gender that we used. Also, the small number of cases leading to a type II statistical error limits the conclusions regarding our comparison of gifted and non-gifted children.

If this result can be replicated, there may be some theoretical explanation for a link between giftedness and psychosis. The fecundity disadvantage that may accompany schizophrenia requires a balance in a substantial advantage. The speciation characteristics of language may be one advantage. Crow (1997) proposed the hypothesis that there is a link between human creativity and psychosis. This model argues that language and psychosis have a common evolutionary origin, and psychotic symptoms describe what happens when the process of cerebral hemisphere differentiation fails. Schizophrenia is the price that homo sapiens pays for language. Other potential advantages for carriers of genes predisposing to schizophrenia are reviewed in original publication II.

Excellent school performance did not associate with pathological personality characteristics, bipolar disorders and alcoholism. In this study (II), non-psychotic cases were highly selected in-patients and represented the most difficult minority of all non-psychotic cases with a young age at onset. Also the number of cases was small.

This part of the study (II) presents some new empirical support for the hypothesis that schizophrenia may be linked to positive premorbid features, albeit less commonly than adverse ones. This point is also relevant to the issue of possible positive value for the genotype associated with vulnerability to schizophrenia, its preservation in the population, as well as a link between neurodevelopment (language, lateralisation) in human speciation and schizophrenia. This finding does not necessarily contradict the literature, suggesting a link between premorbid low IQ and later schizophrenia. A deviation from the norm in either direction warrants further study as a risk factor for future schizophrenia. Poor development may be a manifestation of one or a number of early causal factors important in schizophrenia. Being very able, however in terms of the species and individuals within it, may bring its own stresses which may lead independently to schizophrenia, despite having overall evolutionary and fecundity advantages.

The original paper II was commented by David in the editorial of same issue of *Acta Psychiatrica Scandinavica* (1999). He presented some reservations on the result (mainly based on analyses from data where sexes are pooled). He reported that in the Swedish conscript study there was also an excess of gifted preschizophrenic cases.

### ***7.1.3 Associations between mental disorders treated in hospital and educational attainments by 31-years of age (III)***

The main result was that people with an early onset mental disorder tended to stagnate at the basic level. Early onset schizophrenia and all non-psychotic cases had 3- to 6-fold adjusted odds for this outcome. Many with early onset schizophrenia completed secondary education, but none completed the tertiary level. Treated in hospital non-psychotic disorder increased the risk of underachievement in tertiary education for those with early onset. In the group without mental disorders treated in hospital 12% of the cohort members completed basic level education, 62% upper secondary, and 26% tertiary education.

These results suggest that people with schizophrenia diagnosed before 23 are increased risk of stagnating in the basic level of educational outcome, even by age 31 when, in theory, there has been time to catch-up. None completed tertiary education. This is partly explained by the fact that progress from basic education occurs between ages 16-20

years when some of these subjects first become ill. Regardless of the cause, this stagnation is in accordance with previous studies, particularly for people with early onset disorder (Häfner *et al.* 1999). People with schizophrenia have been shown to have a substantial disadvantage in completing education (Salokangas 1977, Keith *et al.* 1991, Lehtinen *et al.* 1991). The present study adds to existing knowledge about this stagnation in that it occurs most markedly for early onset disorder, is not specific for schizophrenia amongst the disorders treated in hospital, and is caused by educational failure at the beginning of the educational career.

In the other psychoses category only cases with an onset after 23 years were more likely to remain in secondary education, rather than to progress. The small numbers of cases limited the analyses. In non-psychotic disorders early onset predicted failure at the secondary/tertiary level and stagnation in the first level. Educational failures were the most prominent in personality disorders and alcoholism. These results are in concordance with earlier studies, where there exists a downward trend of prevalence of substance use disorders with higher levels of education (Helzer *et al.* 1991, Keith *et al.* 1991, Crum *et al.* 1993). In the National Comorbidity Survey (Kessler *et al.* 1995), non-psychotic disorders were related to educational disadvantage, with odds ratios ranging between 1.3 and 2.9. The associations found in our study were greater, probably because our subjects had more severe disorders requiring hospital treatment.

Performance at compulsory school of the persons with substance abuse and personality disorders was also low in this sample (I) and educational under-achievements seemed to start there. In the ECA (Epidemiological Catchment Area) failure to complete education was also associated with antisocial personality disorders. This is a disorder with unusually early onset and origins, making it questionable that a lower rate of completing schooling was a cause rather than a consequence of these disorders (Robins *et al.* 1991).

Only a small fraction of psychiatric cases, particularly those with onset before 22 years, completed the tertiary educational level, probably due to the severity and progress of the disease. However, we found that quite a number of persons with schizophrenia (15%) and other psychoses (8%) achieved the highest educational level. Most of them did not have any indicators of severe neurodevelopmental delays. This is in accord with the recent Finnish study (Salokangas *et al.* 2000) as well as, preliminary result presented by MacCabe *et al.* (2000) that schizophrenia in people with high academic achievement is not associated with neurodevelopmental damage.

Some persons suffering from severe non-psychotic disorders (10%) achieved the tertiary level, especially those with dysthymia. This may be one explanation why neurotic mental disorders are common in selected, educationally privileged populations, for instance, among university students, where the prevalence in Finland varied between 23% and 29% (Vauhkonen *et al.* 1971). There may even be some link between giftedness and psychopathology (Noreik & Ödegård 1966, Karlsson 1983), especially in affective disorders (Jamison 1993) but also, perhaps, in schizophrenia (David 1999), as was also demonstrated in original publication II.

Although the effect of severe mental disorders was damaging to education, 60% of subjects with mental disorders achieved upper secondary education, and 8% tertiary education. This may be related to the heterogeneity of mental disorders. This finding may also be connected with the supportive Finnish educational system. The main objective of the Finnish education policy is to offer all citizens equal educational opportunities, re-

ardless of age, domicile, economic situation, sex or mother tongue. Schooling leading to a qualification has traditionally been free of charge. Students have received free tuition and free teaching materials as well as health care, school meals and if necessary accommodation and school transport at the primary and secondary schools. At the higher levels some of the social costs of education have been paid for by the students themselves, but the government has, by means of student grants, tried to assure equal access to education for all (Haven 1999). This may be particularly important for the young adults with psychological or behavioural vulnerability, and is why practically all (including psychiatric cases) achieve at least basic education in Finland.

One determinant of a lower level of education was gender: in a multivariate analysis boys had an increased probability to progress to the tertiary level. Even in a country like Finland with a long egalitarian tradition between genders, familial duties and style may hinder education and affect women's careers. Adverse social factors such as low maternal education, low parental social class, and one-parent family background had some association with low educational performance, but a school grade below age-appropriate level (reflecting low intelligence) and poor school performance (indicating intelligence and motivation) had a major effect.

#### ***7.1.4 Associations between smoking and educational level attained by 31 years of age (IV)***

Smoking was studied as an indicator of a variety of adverse personal, social and familial properties, lifestyles, and attitudes towards society. The main finding in original paper IV was that adult smoking (at age 31) and prolonged smoking (at ages 14 and 31) were associated with an approximately 2- to 6- fold, adjusted odds for educational underachievement. Smoking only at age 14 showed none of these associations.

Poor school performance and juvenile smoking have been linked in many studies. This study extended this finding to regular and prolonged smoking, as opposed to experimental smoking (perhaps time limited) during adolescence, and to adult educational achievements up to age 31.

In contrast with Kandel *et al.* (1986), who found that adolescent and early adulthood cigarette smoking added little to the variance in educational achievements, a greater impact of prolonged smoking was found in this study. Like Kandel *et al.* (1986), school performance at the age of 16 was found to be strongly associated with later educational achievements in this study. School performance at basic level modified the relationship between permanent smoking and later tertiary education.

The associations between smoking and education are unlikely to be causal. In this study good school performance - reflecting higher intelligence and perhaps a different personality and lifestyle - was linked to a higher ultimate educational attainment and probably also cessation of smoking. It is possible that the more education a person receives, the more likely they are to give-up smoking before age 31.

The periods of exposure to smoking habit and the cumulative effect of education with age in young adulthood are captured only very coarsely by two assessments at age 14 and 31. A more regular data collection would have allowed a more fine-grained and dynamic



exploration of these important relationships. This is not easy, even impossible in large general population samples. However, it is possible that lower or unsuccessful education may be more of a causal factor for smoking behaviour than *vice versa*.

## 7.2 Methodological considerations

### 7.2.1 Study design

The present study represents a birth cohort design, which began with a single, geographically defined cohort. It was heterogenous with respect to exposure history, but genetically and geographically homogenous. Comparisons of disease experience were performed within the cohort across subgroups defined by exposures or outcomes. The limitations imposed by ethics and cost restrict epidemiological research to non-experimental designs in most circumstances. While it is unethical for an investigator to expose a person to a potential cause of disease simply to learn about etiology, people often willingly or unwillingly expose themselves to many potentially harmful factors, e.g. poor school performance, adverse mental health or lifestyle.

Longitudinal cohort studies offer opportunities to study associations between scholastic performance, risk behaviour and diverse outcome measures, whether with overall psychosocial functioning or with specific factors e.g. mental disorders, and educational attainment. In this regard cohort studies are particularly useful for testing, rather than generating hypotheses e.g. of risk factors.

### 7.2.2 Representativeness of the study population

The criterion representativeness or external validity refers to the generalisability of findings to the population from which the data have been taken. For a given data set, one should assess the degree to which data are representative of the target population under study (Friis & Sellers 1999).

*Schizophrenia.* The inclusion of hospital-treated psychiatric cases only introduces the possibility of a selection bias to the study. Outpatients were not identified (except 2 persons with schizophrenia) in this phase of study. Schizophrenias in this study sample are representative. The cumulative incidence (0.81%) of DSM-III-R schizophrenia (n=89) by the end of the 28th year, estimated at between 0.67% and 0.97%, is quite high, but in line with previous epidemiological studies in Finland (Lehtinen *et al.* 1990, 1991).

*Non-schizophrenic psychoses.* It is not easy to estimate the life-time rate of non-schizophrenic psychoses in a population under 30 years. The incidence of bipolar disorders is in some studies half the incidence of schizophrenia (Keith *et al.* 1991). The incidence of bipolar disorders may be exceptionally low in Finland in this age period (Räsänen *et al.* 1998). However, the selection bias cannot be very significant regarding other psychoses, which are included in the FHDR and this study, the cumulative inci-

dence being about 0.5%. In general, acute psychoses (especially schizophreniform or schizo-affective) in young age are treated in a mental hospital, as is recommended in the academic Finnish textbook of psychiatry (Isohanni *et al.* 1999). It is probable, however, that a considerable part of brief reactive psychosis with a short duration and mild symptomatology were not included in the study sample, especially in the 1990s, when deinstitutionalisation progressed rapidly in Finland.

*Non-psychotic disorders.* For most non-psychotic cases, a comparison between population-based incidence would be irrelevant, as only a small proportion of these patients are treated as inpatients. In this study non-psychotic cases are highly selected. The study sample represents the most severe fifth of all non-psychotic cases in population, based on estimates from the Mini-Finland Study where one tenth of the population (9.0% of males and 10.2% of females) had a non-psychotic disorder at the age of 30 (Aromaa *et al.* 1990, Lehtinen *et al.* 1991). Acknowledging this selection bias, it remains of interest that non-psychotic groups proved to be similar, or even worse than psychotic subjects in some of the characteristics studied (e.g. premorbid school performance (I) and adulthood educational achievements (III)).

*Combined diagnostic categories.* The pooled categories “other psychoses” and “non-psychotic disorders” are heterogenous compared with the schizophrenia category as is described in section 5.3. “study variables” (Table 4), where the official DSM-III-R diagnoses used in original papers I-III are presented. Thus the pooled results of the other psychoses and non-psychotic groups are not as informative, specific and generalisable as in the schizophrenia group. In some analyses, however, it was possible to subcategorise these major diagnostic categories (I-III).

*Age at onset.* The birth cohort design and relative young age of study subjects causes limitations in two ways. In general, the incidence and the number of cases with severe mental disorders remains relative low. This is especially true in some diagnostic categories, e.g. major depressions, where the majority of cases i.e. late onset cases, are missing. The subjects were 28 years old at the end of the follow-up, thus only representing the high-risk years for the morbidity of some mental disorders, mainly schizophrenia, but not the entire spectrum of mental disorders. The results are relevant only to cases, disorders or smoking habits with a fairly young age at onset, below 28-32 years.

*Gender.* As in most studies, there were twice as many male as female schizophrenia cases in this study (I-III), giving greater statistical power to males, and excluding the substantial proportion of women who will possibly develop schizophrenia after 28 years (Räsänen *et al.* 1999, 2000). There were also more males than females among the non-psychotic cases (I-III), which is in disagreement with the epidemiological findings from

the general population, according to which females have higher rates of these disorders than males (Lehtinen *et al.* 1991). This discrepancy can be explained by the excess of male cases with serious alcohol problems, as well as males with treatment episodes in military hospitals. An under-representation of females in non-psychotic disorders limits the generalisation of the results.

*Geographical area.* Is it possible to generalise these results to all of Finland? Geographical, social and economic differences are small within Finland. As the study population was an unselected general population sample under the age of 31, the results can most likely be generalised to represent the entire Finnish population of this age, as well as to other Western developed countries. However, the Finnish formal educational system is mostly free of charge and covers all of Finland. Finnish schools were rather supportive in the 1980s as is discussed in detail in 7.1.3. which may be one reason why even potentially psychotic persons in premorbid phase (I) or after onset of illness (III) performed rather well in education.

### 7.2.3 Strengths of the study

The major strength of this study was having a birth cohort of more than 12 000 subjects. The large, unselected, geographically representative, general population sample with small attrition and high rates of follow-up over three decades and the use of record linkage minimised selection, referral, information, and recall biases.

A prospective birth cohort study provides a window on the early development of a representative group of mental disorders drawn from an epidemiological population, free of retrospective observer or period effects. A birth cohort study as a special type of longitudinal cohort studies may be one of the best ways of investigating the precursors of mental disorders and causality. In addition, they can identify the consequences of morbidity and disability and assess continuity or changes of behaviour over time. Problems with studying the association between mental disorders and educational performance include how to establish the chronological order and potential causality between educational achievements and mental disorders (Robins *et al.* 1991).

In the present thesis the extensive follow-up from mid-pregnancy until 28 years of age made the inclusion of many explanatory factors possible. The data-gathering on somatic and psychosocial factors during pregnancy, birth, the perinatal period, or childhood and adolescence years in the Cohort begun at the seventh or eighth month of pregnancy was truly prospective and is still ongoing. A number of potential confounding factors have been collected and considered in the study.

The study population consisted of hospital-treated cases. One of the important main strengths of this thesis was diagnostic accuracy. All psychiatric diagnoses were validated carefully using the DSM-III-R criteria, which provided the possibility to compare the results with the results from other methodologically valid and identical epidemiological studies. Hospital case-notes were scrutinised by a team of three junior and two senior researchers with good reliability (kappa 0.6-0.9). Psychiatric diagnoses can be regarded as reliable. Diagnostic data appeared to be reliably transferred from case records in the

FHDR and thus probably only a few, if any of the psychiatric hospital treated cases were lost, but many non-psychotic cases naturally were (Isohanni *et al.* 1997).

Data collection has been so intensive that the attrition rate is small; the proportion of missing data is in most cases insignificant. Finnish registers are reliable and accurate. The emigration of 757 and the death of 284 individuals before age 16 are unlikely to have introduced any systematic bias. The major results of this study involved standardised childhood data collected prospectively.

Registers are invaluable tools in epidemiology, which are also increasingly being used in Finnish psychiatric research (Isohanni *et al.* 1997, Cannon *et al.* 1999). The use of registers in obtaining data for cohort-study offers several advantages. It is possible to obtain much larger data sets than by any other method with moderate costs and efforts. Registers are also an excellent method for choosing representative samples for studies.

Only a few retrospective investigations (Cannon *et al.* 1999) have attempted to systematically study the school records of preschizophrenic children as is reviewed above. The examination of the school records of individuals who become schizophrenic (or other mental disorders) as adults was the method that has been used to study the development of mental disorders in original publications I-II.

The school record method has the advantage that the research data is collected in adolescence before the subjects suffer any mental disorders, so that neither the providers of the data nor the relatives or the subjects themselves know that they will later come to have mental disorders, and none of them will have been influenced by the epiphenomena of the illness. The school records method has the handicap that one must utilise whatever data is available, rather than designing it to suit the purposes of the research. However, school records are available for the general population, not only for a limited population, such as child guidance clinic patients (Watt *et al.* 1970).

The results of this thesis brought new knowledge and debate to the scientific community. As is discussed in detail in chapters 7.1.1. and 7.1.2.; original paper I was commented by Cannon *et al.* (1999) in their article and this debate was continued by our team (Isohanni *et al.* 2000c). Original paper II was commented by David (1999) in the editorial of same issue of *Acta Psychiatrica Scandinavica*.

#### ***7.2.4 Limitations of the study***

In any large population sample, only part of the potential exposures or confounders can be assessed. Premorbid assessment is difficult, even impossible due to the large amount of potential but symptom-free cases. There are some possible confounding variables which could not be controlled in this study, such as the IQs for all subjects and factors based on observations and ratings on social and behavioural difficulties by the teachers. It was also not possible to investigate the influence of attitudes towards society as well as many familial factors, which may also be related to educational performance. These non-identified unmeasured factors, such as some premorbid symptoms (I,III), rule-breaking in school (IV), low levels of child compliance within the family (IV), low levels of responsibility (IV), non-conventionality (IV) and rebelliousness (IV) may play a causal role and offer a more plausible explanation for the observed associations of mental

disorders, smoking and educational achievements. The list of potential, unobserved and thus residual confounding variables is long, which makes causality explanations difficult.

The limitation of the Cohort is that it was not set up specifically to study educational attainments or mental disorders. Hence the measurements in childhood tended to be rather crude on school issues (e.g. teachers' assessments were missing), and psychosocial factors (e.g. family relations).

The Pre-morbid Adjustment Scale (Foerster *et al.* 1991), an adapted version of the Cannon-Spoor scale (Cannon-Spoor *et al.* 1982) has been developed separately for childhood and adolescence assessment of pre-morbid functioning in schizophrenia items out of five areas: socialability, peer relations, scholastic performance, adaptation to school and interests, social and sexual adjustment have also been included for adolescents. This scale was not applied in this study, but it will be used for a subsample within the 33-year psychiatric follow-up of the Cohort between 2000-2001.

This study gave reasonable statistical power for primary analyses as it was able to exploit the entire Cohort. Severe mental disorders as well as some other exposure or confounding factors are relative rare conditions, which contain the risk of Type II statistical error; large effects are worth considering even when confidence limits include unity. There is therefore also the possibility of Type I errors when multiple comparisons are undertaken as is discussed regarding original publication II (7.1.2.). An alternative here would be case-control study design, utilising a study sample including cases outside a one-year birth cohort. In this design, however, a retrospective data collection may be difficult to execute, as well as controlling some potential confounding variables, e.g. age and period.

### 7.3 Theoretical discussion

This study focuses on school performance (I, II) and educational achievements (III, IV), on mental disorders (I-III) and on risk behaviour such as smoking (IV). It is grounded in many theoretical frames such as biological, psychological, social, educational and psychiatric approaches.

The theoretical models by which I understand the investigated phenomena and results are described in this section. The development of schizophrenia is explained by cognitive model and neurodevelopment model (I, II). It is also possible that these models are applicable to other functional psychoses. The development of socio-economic status in relation to adult educational achievements is described in section 7.3.3. (III). In chapter 7.3.4. it is described how smoking can be seen as a marker of risk behaviour (IV). Finally, a life course model, in chapter 7.3.5. summarises the other theoretical approaches and forms a frame of reference for the entire project (I-IV).

#### 7.3.1 Cognitive model (I- III)

Cognition is the mental process involved in knowing, learning and understanding. It has been hypothesized for almost a century that cognitive impairment is one mechanism re-

sponsible for the disintegration in individuals with schizophrenia and nowadays also in other psychoses. There is an increasing trend to define schizophrenia based on cognitive disturbance rather than phenomenologically (Andreasen 1999). Cognitive impairment affects all domains of cognition, including executive function, attention, vigilance, working memory, recall memory, semantic memory, and fine motor performance (Saykin *et al.* 1994). Although the analysis of premorbid and current impairments in schizophrenia has broadened in recent years to include more direct markers of central nervous system development such as IQ, attention, information processing and developmental milestones, the debate over whether they constitute specific precursors or nonspecific risk factors for schizophrenia continues. Many studies show impairment in general intellectual functioning in children who later developed schizophrenia (Jones *et al.* 1994a, David 1999). In this study (I) scholastic impairment was true among only a minor part of the pupils destined to develop schizophrenia or other severe hospital-treated disorder.

Part of these cognitive defects may exist in the premorbid and prodromal phase so that children who develop schizophrenia exhibit early signs of cognitive impairments (Jones *et al.* 1994b, Crow *et al.* 1995, Green 1998). An interesting new finding suggests that an extensive cognitive test battery applied to a symptomatic adolescent can probably predict vulnerability for schizophrenia. In a study as yet not replicated, draft board tests for healthy male adolescents had a positive predictive value of 42.7% (Davidson *et al.* 1999).

Schizophrenia and other psychoses were seen here as external phenomenon of a basic cognitive disturbance. In original publication I, the finding that an excess of pre-schizophrenic adolescents were not in the normal educational trajectory may be due to cognitive disturbances, probably low IQ, impaired attention, or thought disorders. A new aspect and hypothesis, however, is that excellent school performance, reflecting exceptionally good cognitive capacity at least in a narrow area of psyche, may also predate schizophrenia (II), or that some late onset schizophrenic persons can achieve a high educational level (III).

### ***7.3.2 Neurodevelopmental model (I-III)***

The neurodevelopmental hypothesis of schizophrenia suggests that schizophrenia results from a defect in early brain development and the brain abnormalities are present early in life but do not manifest themselves as psychosis until late adolescence or early adulthood (Weinberger 1995). Cognitive impairment may be one external symptom and element of this defect. A "neurodevelopmental" subtype of schizophrenia (Castle & Murray 1991, Castle *et al.* 1994) is characterised by early onset, poor premorbid sociality and cognitive capacity, and male preponderance. Some studies (Jones 1997) have put forward the view that developmental abnormalities may be more widespread, the majority being hidden

within the wide normal range as was seen in original publication I where school performance among preschizophrenic pupils was mostly normal. Thus, a comprehensive model of schizophrenia must encompass these early manifestations of dysfunction as well as the immediate pre-morbid and post-morbid period (Isohanni *et al.* 2000a), and gender (Räsänen *et al.* 2000). The antecedents which have been found (I) are likely to be manifestations of a neurodevelopmental abnormality already present and which form part of a larger causal constellation. Thus, they may be considered as part of a longitudinal psychotic phenotype, or as manifestations of vulnerability. Investigations with genetic and brain morphological data which will be performed in the future in the Cohort (Isohanni *et al.* 2000a), may suggest which model is more useful.

A gradually accumulating body of literature suggests that neurodevelopmental dysfunction and cerebral pathology may precede the onset of the schizophrenic syndrome by many years (DeLisi 1997) and also lead before and after illness onset to many harmful consequences to educational capacity (I,III). Some schizophrenics show deficits in motor, cognitive, and social performance long before they develop psychotic symptoms. With regard to schizophrenia, only a minor proportion of the preschizophrenic persons demonstrated failures in scholastic performance (I). It is possible that only some persons with schizophrenia have neurodevelopmental deficits in this premorbid phase. What is not clear is whether or not there is a distinct subgroup which is only typified by childhood abnormality as is suggested in original publication I, whether the childhood deficits are an early manifestation of a neurodevelopmental lesion or whether they are independent risk factors for later schizophrenia (Murray *et al.* 1997).

The neurodevelopmental model of schizophrenia may explain part of the cognitive defects in this disorder as detected in original publications I and III. This model suggests that the brains of people who become schizophrenic are not completely normal well before the onset of the illness (Tsuang & Faraone 1999). The main assumption is that the substrate for schizophrenia is formed when neural development goes awry and key neural networks do not develop properly. This model has refined the diathesis-stress or vulnerability model of schizophrenia by proposing that some combination of genetic and non-genetic errors lead to maldevelopment of the brain in childhood.

There are critical periods in development of the central nervous system which have relevance for the acquisition of cognitive and behavioural capacities. In addition, vulnerability to schizophrenia is polymorphic in its behavioural expression, or there are different expressions in their level of functioning among preschizophrenics (Walker 1994). Some of them attain high levels in specific areas (as an excess of clever preschizophrenic boys in the original publication II), some perform as well as comparisons (as did most preschizophrenic pupils regarding means of school marks in original publication I) and some have scholastic failures (an excess part of preschizophrenics in original publication I).

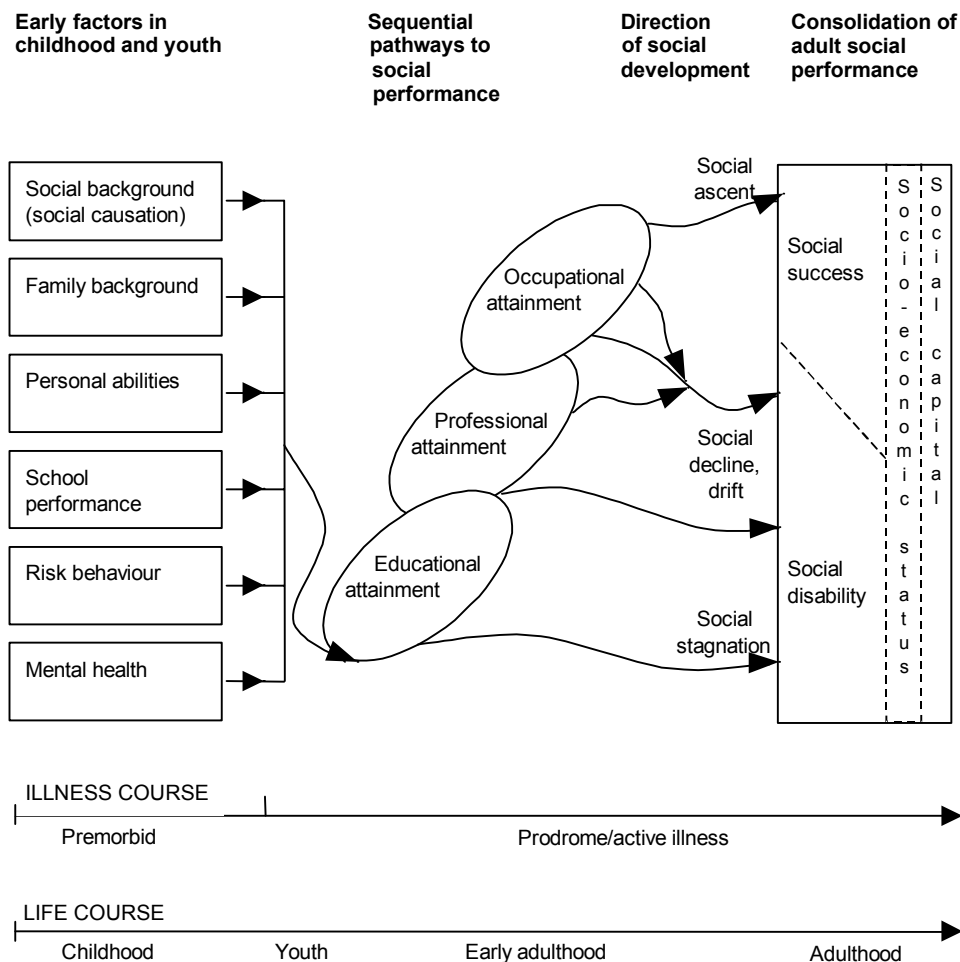
There are some results suggesting that neurodevelopmental delays are not specific for schizophrenia, but also exist in other psychoses (Van Os *et al.* 1997). This was also true in this study: excess amount of other psychosis cases being in a grade below normal (I), or had failures in adult educational performance (III). Correspondingly, among adolescents in the Cohort who later developed non-psychotic disorders, the means of school grades were lower than in the comparison group although social factors may also be causal here (I).

### 7.3.3 Pathways to socio-economic status (III-IV)

The main study subject of this thesis is education. Education often is used to determine one's SES. SES can also be conceptualised in terms of profession, occupation, income, and their combinations. In this study SES was operationalised by using education as an outcome (III). There were three basic reasons in this study (III) for preferring educational attainment to other common markers of SES such as occupation or income. First, educational level can be determined for all individuals, whereas not everyone has an occupation or an income, especially those with a psychiatric inpatient history. Second, educational attainment is essentially established in early adulthood and remains stable thereafter: health impairments can exert an important influence on occupation and level of income. In the current information-based society, the level of educational attainment is the first and obligatory phase of the pathway to consolidated adult SES followed by the profession and occupation. In this study the chronological relationship between these was defined. Educational attainment is essentially established in early adulthood and remains stable thereafter (Elo & Preston 1996). Third, in this Cohort approaching the age of 31, the majority of cohort members have passed only the educational transitions of the pathway of adult SES. For many, especially those who ultimately may achieve higher professional and occupational status, later follow-ups will be needed.

A relationship between low SES and various types of psychopathology has been confirmed in numerous studies (Dohrenwend *et al.* 1992, Jones *et al.* 1993, Mäkikyrö *et al.* 1997). The development of the explanations of the intragenerational vertical social mobility during an individual's life course has proceeded along two main lines: *the causal models* (materialist/structural and cultural/behavioural models) and *selectional models* (natural/social selection models). The former model states that the SES of the parents is associated with the person's own SES. Social selection means that a person fails for some reason (i.e. for mental illness or health behaviour) to attain his expected educational level. The significance of schooling as a selection criterion becomes still more striking in our information-based society and international competition. A third approach is the *social drift model*. In this model a person falls from a higher to a lower level of SES (Dunham 1965, Dohrenwend *et al.* 1992, Aro *et al.* 1995b). This sequential pathway from childhood to early adulthood, adapted to the study population, is described in detail in original publication III and in Figure 3.





**Fig. 3. Model of the developmental pathway over the life-course; illness course from childhood to adult life in the context of social performance.**

About two-thirds of patients fall ill with schizophrenia before the age of 30 years (Häfner *et al.* 1999). This stage of life-course is also the main period of consolidation of one's SES; educational and occupational training, employment status, and personal life situation. The contribution of educational attainments to an individual's continually evolving social capital; the ability of actors to secure benefits by virtue of membership in social networks or other social structures (Portes 1998) remains to be established in this sample. It will be possible to describe the pathways to eventual SES in this Cohort, thereby determining whether later professional or occupational attainments are determined by educational factors, or by mental illness itself.

### ***7.3.4 Smoking as a marker of risk behaviour (IV)***

Smoking may be an indicator of lifestyle and attitudes towards society, which may also be related to educational performance and its impairments, as was determined in original publication IV. Smoking can be seen as one of the best markers of risk behaviour. Previous studies have found that adaptation to school is inversely associated with the use of tobacco (Jackson 1997). Smokers are more likely to hold lower expectations for attaining academic success (Aarø *et al.* 1986, Chassin *et al.* 1992) and anti-school values (Aarø *et al.* 1986, Banks *et al.* 1981). Self-injurious behaviour can be seen as an attempt to communicate, and guidance may therefore be an effective method of communicating their needs to their careers which can reduce the challenging behaviour (Durand 1990).

Adolescents with lower educational aspirations may find positive benefits in smoking which might compensate for their lack of academic success. These adolescents may be less dependent on adults for their future plans, and be thus less willing to accept conventional adult values and authority. On the other hand, intelligent 14 year-olds performing well at school and life in general may give up smoking as a considered decision. Their later high educational achievements may be another, unrelated consequence of their ability; the relationship between giving up smoking and later attainment may be confounded by IQ, rather than there being a causal relationship between changes in smoking habit and attainment.

Low parental control and support - possibly more often seen in families of a lower social class - leads to less effective socialisation of adolescents into conventional behaviour. Thus, adolescents may be at greater risk for problem behaviour such as cigarette smoking and poor education. Such parents may be relatively tolerant of their adolescent smoking. Smoking may also be an indicator of some other disadvantageous familial factors, e.g. poor rearing habits or a less protective parental role, which were not recorded in this study (IV). Adolescents from less educated families are more frequently exposed to parental modelling of cigarette smoking. These exposures were, however, standardised in our study but are not necessarily related to rearing habits, as well as to the ability to protect oneself from tobacco and factors related to it (Jessor & Jessor 1977).

### 7.3.5 *Life course model (I-IV)*

Among many other meanings, a model can be defined as an abstract representation of the relationship between empirical components of the system (Last 1995), e.g. human life course. The present study stresses the importance of the life-course aspects of mental disorders and educational attainments. A life-course perspective helps to understand the longitudinal principles and concepts of both normal development and psychopathology. Many diseases including mental disorders, as well as educational capacity in adulthood may have their origin in childhood, even during the perinatal stage (Jones 1997, Jones *et al.* 1998, Cannon & Murray 1998). The important period in life from about 15-30 years of age, when educational attainments are taken up, coincides with the period of the maximum risk for the onset of schizophrenia (Häfner *et al.* 1995).

*Genetic factors and biological changes.* The risk of schizophrenia is higher among family members of patients than in the general population. Adoption studies have shown that this increased risk is genetic. The inheritance of schizophrenia has largely been studied through the mathematical modelling of pedigrees and twin and adoption data. The exact nature of the genetic transmission is unclear and does not follow a simple recessive or dominant pattern associated with a single gene. Polygenic models of inheritance, which seem most consistent with the data available to date, postulate that an additive effect of several genes confers susceptibility to schizophrenia, and may interact with environmental factors. Various environmental factors have been investigated over the past few decades including viral exposure, nutritional deficiencies, and obstetric complications (Schultz & Andreasen 1999, Isohanni *et al.* 2000a). The human body changes rapidly between birth and early adulthood. These changes are most rapid during the first year of life and puberty. This change is especially pervasive in central nervous system. Brain growth and maturation, including apoptosis, synaptic pruning, and synaptogenesis, continues through life, and is especially active in adolescence and early adulthood (Tsuang 2000). This aspect has been discussed in detail earlier (7.3.2.). Adolescence and early adulthood are the time periods studied in this study and biological growth may relate to the psychiatric morbidity and educational capacity.

*Psychological development.* Psychological development during the period studied is also rapid and complex. The division of the life course into developmental stages may follow fairly clear lines of demarcation: infancy, toddler stage, preschool, juvenile, adolescence, young adult, middle age and old age. The juvenile moves beyond his family into peer groups and school where he gains acceptance and position on the basis of his achievements and his personality gains new coherence through the impact of how others relate to him and help him define himself. As adolescents leave childhood behind, they face the challenges of establishing heterosexual relationships, getting their first job, and making decisions about career choice. In the young adult period the personality undergoes marked modifications through the choice of an occupation (Lidz 1968, Moos 1986).

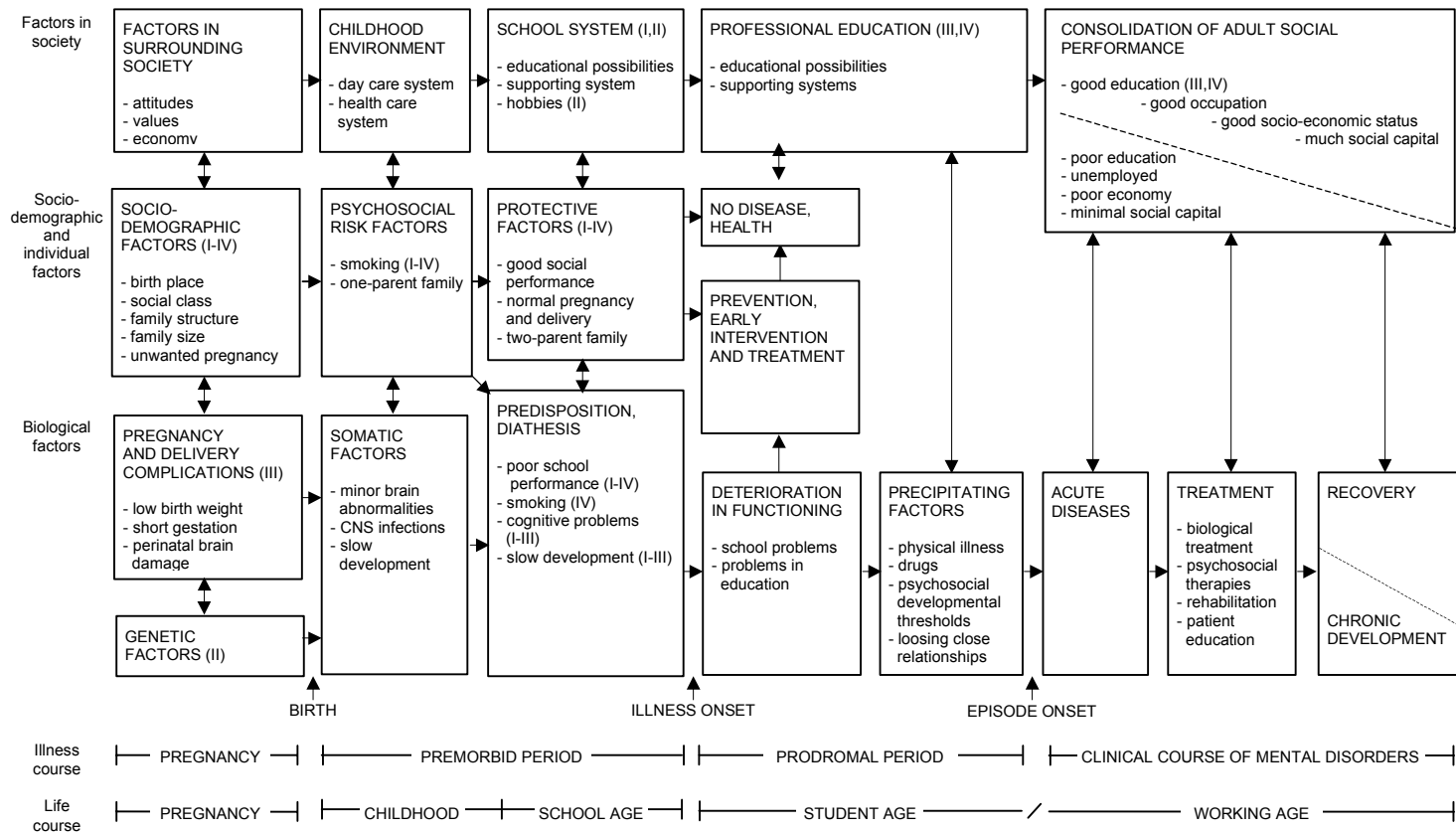
*Psycho-social life stressors.* The association between stressful psycho-social events (i.e. leaving home, loss of job and divorce) and the etiology and course of mental disorders and smoking habits has been much debated and studied. Acute illness or relapse of a pre-existing disorder often follows after extraordinary stress. Others argue that stress plays only a marginal role in the pathogenesis of the disorder or simply triggers schizo-

phrenia in vulnerable persons. The stressor might have triggered the onset of a disorder that would have occurred without the potential stressor. Some of these stressors have been studied in this Cohort; unwanted pregnancy (Myhrman *et al.* 1995) and depression during the antenatal period (Jones *et al.* 1998) were more common among mothers whose children later developed schizophrenia. However, living in a single-parent family did not predict schizophrenia (Mäkikyrö *et al.* 1998), nor did “grand multiparity”; being brought up in a family in which there were six or more children (Kemppainen *et al.* 2000), but did relate to other psychoses, alcoholism and depressive disorder. It is possible that low school performance (I), even high ability behind excellent school performance (II) and low educational achievements (III) as stressors which provoke schizophrenia or other mental disorders.

*Descriptive life-course model.* An increasing trend in science is to link basic neurobiology, epidemiology and clinical research and care, as well as to formulate longitudinal pathways from asymptomatic, subthreshold and threshold stages to clinical disease over the life span (Wittchen 2000). Modelling schizophrenia or other severe mental disorders - mostly after onset - is neither a new idea nor an easy task. There are hardly any causative factors specific to schizophrenia, although unitary models have been proposed (Andreasen 1999). Other models, such as Ciompi’s (1988) stress the importance of the life-span aspects of schizophrenia and present more wider ranging descriptions of the pre-morbid, acute and chronic phases of psychosis. Cullberg’s (1993a & b) model proposes an integrated three-dimensional etiological view integrating genetic, brain damage, and psychosocial elements. These elements (and drug abuse) are also emphasised by Murray and Fearon (1999). Alanen (1997) integrates biological, psychological and familial aspects to etiology and treatment, and Cornblatt *et al.* (1999) aims at the conceptualisation of a recognition and prevention program by modelling the development of schizophrenia.

Determinants of mental disorders are an important focus for research in the Northern Finland 1966 Birth Cohort. The psychiatric research team around the Cohort (and original publications I-IV) was invited to review the scientific activities of the Cohort (publications and work in progress) as well as a descriptive model on the schizophrenia developed (Isohanni *et al.* 2000a). The life course developmental model developed in this review is a basis for the model presented in Figure 4.

In summary, the findings from the Cohort and from elsewhere show that some young adults destined to develop severe mental disorders show deficits in motor, cognitive, scholastic, and social performance long before they have psychotic symptoms; some abnormalities are present in very early life.



**Fig. 4.** A life-course developmental model of education, mental disorders and risk behaviours, mainly applicable to psychoses. The roman numerals indicate the item (and original paper) used in the present study.

A descriptive model based on original publications of this thesis is presented in detail in Figure 4. A comprehensive model on the known etiological, biological and psychosocial factors as well as factors in society, and the components and life course of educational attainment and mental disorders has been formulated. The model includes all the risk factors summarised in this thesis. In addition, there are some hypothetical and speculative ideas on predictive and protective factors, which are not evidence-based.

What is the value of this kind of model? The descriptive model is not intended to be useful to clinical decision-making. Models developed are still far from a useful description of the childhood and adolescent characteristics which predict psychosis (Jones & Done 1997, Jones 1997). The variety of factors embraced in Figure 4 and the range of time periods identified argue for a serious treatment of the longitudinal dimensions to the syndrome that we call psychosis. The model may help young investigators to orient with the topic, with the findings of our Cohort, and relevant literature.

This cohort study began using a single cohort, heterogeneous with respect to exposure history. Longitudinal study such as this offers opportunities to use data on every phase of the life-course thus to build a better overall picture of the different stages of the life-course.

## 8 Main scientific conclusions of the results

The primary aim of the present research was to determine the school predictors for mental disorders treated in hospital; how severe mental disorders affect educational attainments, and the predictors for educational attainments in adulthood. The main results and the main conclusions of the results are as follows:

Not being in the normal class or school at age 14 predicted future hospital-treated disorders, but low school marks at age 16 predicted only non-psychotic disorders. These findings may be an early manifestation of the disorders themselves, or a marker of vulnerability or risk factors. The mechanisms may vary between diagnoses (I).

The boys with excellent school performance had nearly four times higher risk of schizophrenia than other boys. Eleven percent of the pre-schizophrenic boys (6/54) had excellent mean school marks compared with only 3% of the group without mental disorders treated in hospital (OR 3.8; 95% CI 1.6-9.3, adjusted for parental social class, place of residence and birth order). It is a new hypothesis that adult schizophrenia may be linked to excellent school performance. This finding requires replication. This result may be relevant to the preservation of schizophrenia in the population, and to mechanisms of developing schizophrenia. This finding may show epidemiologically some link between genius and madness, which has earlier been mainly speculated on based on single case studies or non-epidemiological samples (II).

Twelve percent of the individuals without any mental disorders treated at a hospital completed only basic education. Almost two thirds (62%) passed upper secondary, and a quarter (26%) of them tertiary education. People with an early onset disorder tended to stagnate at the basic level. Early onset schizophrenia and all non-psychotic cases had 3- to 6-fold adjusted odds for this outcome. Many with early onset schizophrenia completed secondary education, but none completed the tertiary level. A mental disorder treated in hospital truncates education (III).

Adult smoking (at age 31) and prolonged smoking (at ages 14 and 31) were associated with an approximately 2- to 6- fold, adjusted odds for educational underachievement, but not smoking only at age 14. These results are unlikely to be causal, but may be explained by other characteristics associated with smoking such as personality or lifestyle factors, as well as the effect of knowledge related to smoking gained during higher education (IV).

## 9 Practical conclusions and future tasks

*School as a screening instrument.* In principle, school may be an effective screening for mental disorders although the predictive power of school determinants used in this study were not high and not sufficient alone for intervention in the existing school system. Teachers and health care professionals should, however, be aware of the potential current and long-term sequels of difficulties at school. In addition, school and education history is an essential part of the psychiatric interview.

The case remains that no single premorbid factor of schizophrenia (e.g. problems in school) has yet been identified that is specific. No powerful risk or antecedent factor has been identified which is useful for prediction in the general population. The number needed to treat (NNT) for any of the risk factors identified in this review is high, as is the number needed to inconvenience unnecessarily high (Jones & Croudace 2000). However, the immediate prospects may be much better in clinical samples who may already be experiencing features of the prodromal phase. These early detection and intervention clinics are often active research facilities which also have advanced clinical practice capabilities. After having formulated the additional predictors in the Cohort, extensive predictive models should be constructed and tested as part of an early detection and intervention program in schools, as is done in some current and ongoing early intervention programs (McGorry & Jackson 1999).

*Giftedness at school* is undoubtedly a positive phenomenon in general but may be associated with the increased risk of schizophrenia in some cases. Some highly performing pupils may need observation and support. The replication and verification of the novel hypothesis on non-linear association between intellectual performance in adolescence and later schizophrenia needs extensive study populations (also females), as well as more sophisticated measurements of premorbid intellectual and cognitive performance. There is an important scientific question raised by this study (II): are some persons with schizophrenia, or who are predisposed to develop the disorder, more creative, than the average member of the population, especially in the premorbid phase?

*Failure to complete higher education* due to mental illness seems to contribute to social stagnation, to social decline and to low SES through reduced opportunities in later life. Persons with mental disorders (especially late-onset) may still have considerable educational capacity. Life-long learning is necessary for all persons; why not also for



persons suffering from severe mental disorders? Disease *per se* is a special reason for the need to learn how to cope with it, although educational capacity may be reduced. Early intervention models for educational deficits are needed. Over 90% of psychosis sufferers recover after the first episode, and educational activities are possible in this convalescence and recovery phase. A patients's educational capacity is one element of the treatment and rehabilitation plan.

Young age at onset was related (III) to severe educational failure. Delay in the onset of psychosis is one goal of the early intervention programme (McGorry & Jackson 1999) and may decrease the educational dysfunctions connected with the psychoses.

*Adolescent smoking* may be a starting point for the longitudinal development of smoking. For many adult smokers, their habit will have begun during their schooling years. These findings stress the importance of investigating the attitudes and other factors which affect the development of permanent smoking habits, as well as adaptation to school and later education. These are important factors in preventing permanent smoking and the associated educational risks. If the school environment, and young adults' positive orientation toward school can be a barrier to experimentation to tobacco, as well as increasing education, then schools and other educational institutions could offer a valuable context for health promotion.

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