OUTI SAARENPÄÄ-HEIKKILÄ

Sleeping Habits, Sleep Disorders and Daytime Sleepiness in Schoolchildren

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University of Tampere
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To Pauli, Ulla and Elsa

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LIST OF ORIGINAL PUBLICATIONS

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I Saarenpää-Heikkilä OA, Rintahaka PJ, Laippala PJ, Koivikko MJ (1995): Sleep habits and disorders in Finnish schoolchildren.
Journal of Sleep Research 4:173-182.

II Saarenpää-Heikkilä OA, Rintahaka PJ, Laippala PJ, Koivikko MJ (2000): Subjective daytime sleepiness and related predictors in Finnish schoolchildren.
Sleep and Hypnosis 2:139-146.

III Saarenpää-Heikkilä O, Laippala P, Koivikko M (2000): Subjective daytime sleepiness in schoolchildren.
Family Practice 17:129-133.

IV Saarenpää-Heikkilä O, Laippala P, Koivikko M (2001): Subjective daytime sleepiness and its predictors in Finnish adolescents in an interview study.
Acta Paediatrica 90:552-557.

ABBREVIATIONS

AG	average grade at school
DSPS	delayed sleep phase syndrome
EDS	excessive daytime sleepiness
ESS	Epworth Sleepiness Scale
HBSC Study	Health Behavior of School Aged Children - A WHO Cross-National Survey
MSLT	multiple sleep latency test
OR	odds ratio
OSAS	obstructive sleep apnea syndrome
SAD	seasonal affective disorder
SDS	subjective daytime sleepiness
SSS	Stanford Sleepiness Scale
SWAI	Sleep-Wake Activity Inventory
WHO	World Health Organisation

INTRODUCTION

In recent decades great changes have taken place in Finnish society, both socially and economically, affecting our daily rhythms. In everyday life the amount of TV programs has increased and their on-air times have become later, videos and computers have become more common (thus making it possible to watch TV and play games all night), many other leisure activities take place in the evening and shops and restaurants are open later than before. On the other hand, pressures for success in society are growing while part of the population is suffering from unemployment and poverty.

These factors are perhaps reasons for the recent phenomena of sleep and alertness: irregular sleeping habits with late bedtimes, short sleeping times during the week and a compensational long sleep at weekends (Tynjälä et al. 1997), poor sleep quality with insomnia and night waking problems (Hyyppä et al. 1997), and, as a consequence, ever growing daytime sleepiness (Rimpelä 1999; Tynjälä et al. 1999).

Schoolchildren are in many ways vulnerable to these problems. The need for sleep is about 9 to 10 hours during preadolescence, and though sleeping time shortens during pubertal growth there is no evidence of a biological reason for the phenomenon. In fact, there is some evidence that adolescents should perhaps sleep more than prepubertal children (Carskadon et al. 1983). A shortened sleeping time is a consequence of delayed bedtime, which, on the other hand, seems to have some biological basis (Carskadon et al. 1998). The combination of a biological tendency to stay up late and various opportunities to spend the night awake results in very late bedtimes. However, school schedules prefer an early starting time, thus

shortening sleeping time at the other end (Carskadon et al. 1998). The lengthening of school journeys in some parts of Finland has a similar effect on sleeping time. Sleep lack is usually compensated at weekends when late wake-up times are very common. This irregularity may at worst resemble 5 hour "jet lag" once a week (Dahl 1998).

Sleep initiation and continuity disorders are relatively common among schoolchildren (Tynjälä and Kannas 1993). There is also some evidence that they are increasing (Rimpelä et al. 1982; Morrison et al. 1992; Rahkonen et al. 1992; Vignau et al. 1997). The use of various stimulants as well as psychic disorders play a certain role as a cause of these problems (Vignau et al. 1997; Dahl 1998).

Daytime sleepiness is a natural consequence of all this. It has an effect on schoolchildren's learning ability, cognitive functions and emotional behaviour (Dahl 1996). The proneness to accidents increases among tired children and adolescents (Carskadon 1989; Pless et al. 1995). Thus education in sleep behaviour problems is an important goal in the future.

The purpose of this study is to find out how various sleeping habits develop during school age, and what their prevalence and variation in Finnish school-children is. The prevalence of sleep disorders is also evaluated. The main interest is in daytime sleepiness, its prevalence and evolution and its predictors. These are followed throughout the study.

REVIEW OF THE LITERATURE

Sleeping habits in schoolchildren and adolescents

History

The first epidemiological studies on sleeping habits in children and adolescents were made in the early 20th century. Among the first evaluations was a study in California (Terman and Hocking 1913). Terman and Hocking studied the schedules of 2692 children and youngsters between 6 and 20 years of age. Average duration of sleep over 11 hours in the agegroup 6 to 7 years was found, which decreased steadily to 9.5 hours towards the agegroup 13 to 14 years. In the oldest agegroup it was less than 8 hours.

Alice Ravenhill's study from the same period obtained different result (Ravenhill 1910 cited by Terman and Hocking). She studied 6180 English children from 6 to 14 years of age, and found an average sleeping time of 10.5 hours in the agegroup of 7 years, and 8.5 hours in 13-year old boys, but only 7.5 hours in girls of the same age. On the other hand, there were 6-year old children who slept only 7 hours, and 12-year old children sleeping less than 6 hours. Terman and Hocking assessed the difference between Ravenhill's and their own studies and found three reasons: better climate, higher standard of living and later school beginning time in California as compared to the U.K.

The sleeping habits of Finnish schoolchildren were studied by Koskenniemi (Koskenniemi 1980) in three studies in the years 1938, 1954 and 1975, and Koivikko & Lamppu in 1967 (Koivikko and Lamppu 1967). The studies in 1938,

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1954 and 1967 reported that children (age from 7 to 12 years) slept about 10 hours. In Koskenniemi's study there was a small but significant decrease in sleeping time according to age, Koivikko and Lamppu did not find any difference here. Clear shortening of sleeping time (about an hour) had occurred according to the survey in 1975 (10 years of age). The shortening was mostly caused by later bedtimes, which had become more apparent with time during the surveys. Koivikko and Lamppu also evaluated sleeping habits at weekends and found later bedtime on Saturdays, especially among the older children.

Evolution of sleeping habits in recent decades

In the studies of the last thirty decades, shortening of sleeping time according to age has been found repeatedly, especially during pubertal years, related mainly to later bedtime (Karacan et al. 1975; Anders et al. 1978; Klackenberg 1982a; Lugaresi et al. 1983; Rimpelä and Rimpelä 1983; Rugg-Gunn et al. 1984; Clarkson et al. 1986; Levy et al. 1986; Strauch and Meier 1988; Fisher et al. 1989; Szymczak et al. 1993; Tynjälä et al. 1993; Yarcheski and Mahon 1994; Gau and Soong 1995; Tynjälä and Liinamo 1995; Liu et al. 2000b; Laberge et al. 2001). Karacan et al. in their sleep laboratory study monitored a pubertal group for four years and found a clear shortening of total sleep time year by year (8 hours to 7.5 hours). Two other longitudinal studies gave the same result (Klackenberg 1982a; Strauch and Meier 1988), the first in the agegroup from 4 to 16 years (12 hours to 9.5 hours) and the second from 10-14 years old (10 hours) to 20-24 years old (8 hours). In the study by Klackenberg shortening was also observed before puberty, which in fact was already found in the Californian study (Terman and Hocking 1913). The other cross-sectional studies mentioned above reported similar results.

A clear difference in sleeping habits between weekdays and weekends or holidays is the major finding of the studies from the end of the 20th century (Anders

et al. 1978; Partinen 1982; Rugg-Gunn et al. 1984; Lack 1986; Strauch and Meier 1988; Hawkins and Shaw 1992; Andrade et al. 1993; Szymczak et al. 1993; Gau and Soong 1995; Tynjälä and Liinamo 1995; Wolfson and Carskadon 1998; Järventie 1999; Lee et al. 1999; Mantz et al. 2000; Laberge et al. 2001). Bedtimes and wake-up times are later at weekends and holidays (1 to 3 hours) (Anders et al. 1978; Partinen 1982; Lack 1986; Strauch and Meier 1988; Andrade et al. 1993; Szymczak et al. 1993; Wolfson and Carskadon 1998; Lee et al. 1999; Mantz et al. 2000; Laberge et al. 2001). On the other hand, sleeping time is also longer (1 to 2 hours), perhaps indicating the recovery from the sleep lack accumulating during the week (Anders et al. 1978; Strauch and Meier 1988; Hawkins and Shaw 1992; Andrade et al. 1993; Szymczak et al. 1993; Gau and Soong 1995; Wolfson and Carskadon 1998; Mantz et al. 2000; Laberge et al. 2001). The difference is clear, especially during puberty. It is remarkable that during vacations no difference in sleep patterns has been found during the week (Szymczak et al. 1993).

Shortening of the sleeping time in all agegroups, especially during the 1990s, is a popular statement in study finding of the 20th century (Terman and Hocking 1913; Miettinen and Wahlroos 1981; Klackenberg 1982a; Partinen et al. 1983a; Rimpelä and Rimpelä 1983; Tynjälä et al. 1993; Tynjälä and Liinamo 1995; Järventie 1999). However, historical comparison is complicated because in the studies in different countries sleeping time varied significantly although data was gathered in the same years (Anders et al. 1978; Klackenberg 1982a; Lugaresi et al. 1983; Tynjälä et al. 1993). The best example of this is a WHO co-ordinated study (the HBSC Study) (Tynjälä et al. 1993) where the health and life-style of school children in 10 European countries were compared using the same questionnaire and the same agegroups. In that survey from the years 1983-84, sleeping time in agegroups 11, 13 and 15 years of age was the second shortest in Finland (9.3, 8.9 and 8.7 hours respectively), it was shortest in Israel (9.0, 8.6 and 8.3 hours) and longest in Switzerland (10.0, 9.6 and 9.2 hours). In that study the difference did not depend only on bedtime, because the order of the countries was different in the

answers concerning bedtime. The latest bedtimes were found in Spain (about 22.30), Finland was in the middle (22.00) and Switzerland and Hungary had the earliest bedtimes (about 21.30). On the other hand, the most convincing evidence about historical shortening of the sleeping time was obtained from the same study series when comparing data from years the 1983-84 and 1994 (Tynjälä et al. 1993; Tynjälä and Liinamo 1995). The reduction was about 20 minutes in every agegroup in the latter study.

Sleeping habits and related factors

Biological changes in sleep with age. Shortening of sleep duration with age is possibly related to some biological background. It is easy to speculate that long sleeping time is essential for the development of a child. Development of sleep cycles was evaluated in an American study made in a sleep laboratory with agegroups from 4 to 96 (Feinberg 1974). The main findings are related to the distribution of sleep stages in every cycle. A significant difference was found between children and adults in the amount of slow wave sleep. This was evident particularly in the first cycle of the night. In another sleep laboratory study a four year follow-up was made, starting with the onset of puberty (Karacan et al. 1975). There was a constant decline of sleeping time, but slow wave sleep was found to rise in the second year and decline after that, being lowest in the fourth year.

In several studies by the Carskadon group evolution of sleep has been investigated thoroughly (Carskadon et al. 1980, 1983, 1993b, 1997). In the first two studies the real sleep need of adolescents was evaluated in a follow up study carried out during three consecutive summers in a sleep laboratory. Pubertal development was evaluated by Tanner stages (Tanner 1962). Sleeping time and daily routines were kept constant throughout the follow up. The sleep need was evaluated by daily multiple sleep latency test (MSLT). If MSLT scores declined under the normal, i.e.

falling asleep occurred earlier than expected, it was assumed that the duration of sleep during the night had been too short. It was found that during puberty MSLT scores declined in spite of the constant sleep duration. The conclusion was that the shortening of sleeping time during puberty is not a biological phenomenon but the sleeping time should be, on the contrary, longer during puberty.

The two latter studies (Carskadon et al. 1993b, 1997) investigated whether the delayed bedtime in puberty is a consequence of biological or social changes. The social effect was evaluated by questionnaires for morningness/eveningness and pubertal status (Carskadon et al. 1993b). There was a significant delay in sleep habits according to pubertal status but no connection to psychosocial factors. In fact, a similar conclusion was drawn in a study following sleep onset times at three timepoints at 6-month intervals during puberty (Andrade et al. 1993).

The most recent study by the Carskadon group was carried out in the sleep laboratory (Carskadon et al. 1997). The study revealed an association between melatonin secretion and age and Tanner stage: melatonin was triggered later in higher Tanner stages and older adolescents. Melatonin secretion was found to change considerably during childhood (Waldhauser and Steger 1986). In infants it was very low and rose until the age of 1-3 years. Then it dropped until early adulthood. Melatonin levels thus decreased when gonadotropin levels increased. Ishihara and Miyake found a delay in the circadian temperature acrophase according to age (Ishihara and Miyake 1998). Delayed sleep phase during adolescence and young adulthood was indirectly shown in a Japanese study where age trends of early awakening and related mood changes were evaluated (Abe and Suzuki 1985). The incidence of early awakenings was the lowest in the agegroup 13 to 21 years but in later life it rose again sharply.

The finding of earlier onset of puberty between the years 1979 and 1997 may also have some implications for the evolution in sleeping habits (Rimpelä et al. 1997). If pubertal development triggers the delay in sleep onset, it may partly

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explain the mean value of bedtime, which is later during adolescence. A recent Canadian study gives support to this hypothesis (Laberge et al. 2001).

Gender. Differences in sleeping habits between the sexes are not clear. There are studies finding no differences (Karacan et al. 1975; Anders et al. 1978; Rimpelä and Rimpelä 1983; Rugg-Gunn et al. 1984; Strauch and Meier 1988; Hawkins and Shaw 1992). On the other hand, studies reporting differences have obtained controversial results. In the studies concerning late adolescence and adulthood both longer and shorter sleeping time of women has been reported (Partinen and Rimpelä 1982; Partinen et al. 1983a; Lack 1986). Levy et al. found a longer sleeping time in girls aged 12 to 13 but the difference almost disappeared in the agegroup 16-17 years (Levy et al. 1986). Tynjälä and Liinamo reported more sleep in 11-year-old girls than boys (Tynjälä and Liinamo 1995), but adolescent boys sleeping more than girls has also been reported (Niemi and Pääkkönen 1992; Yarcheski and Mahon 1994; Gau and Soong 1995).

A similar discrepancy has been found in bedtimes: girls have been found to go to bed both earlier (Rugg-Gunn et al. 1984; Macgregor and Balding 1988a; Tynjälä 1992; Tynjälä and Liinamo 1995) and later (Gau and Soong 1995). On the other hand, girls waking up earlier than boys is a universal finding (Carskadon 1989; Tynjälä 1992; Gau and Soong 1995; Tynjälä and Liinamo 1995; Wolfson and Carskadon 1998; Lee et al. 1999). Irregularity in sleeping habits has been found more often in boys than in girls (Tynjälä and Kannas 1993). In a recent study girls were found to have longer sleeping time and later wake-up time at weekends than boys (Laberge et al. 2001). The findings were similar when prepubertal and pubertal participants were compared.

Individual differences. The observation that sleeping habits may have individual differences from a very early age is well-known. In all studies evaluating sleeping time the variation is quite wide, and it is difficult to estimate how much children

should sleep at different ages (Klackenberg 1982a). Evidence of genetic influence on the individual sleeping habits was obtained in a Finnish twin study where sleep length and quality of monozygotic twins were more similar than in dizygotic twins (Partinen et al. 1983b). In a study evaluating reported sleep need among adolescents the individual differences in sleep need were considerable (Mercer et al. 1998).

The idea of morningness/eveningness, or 'larks' and 'owls' to describe different sleeping manners has been used for decades (Horne and Östberg 1976; Webb and Bonnet 1978; Langinvainio 1984; Ishihara et al. 1987; Park et al. 1997). In a Finnish study, children of 7 years of age could be divided into 'larks' and 'owls' according to parental answers (Langinvainio 1984). The 'larks' were more frequent (30%) than the 'owls' (7%). In an American study college students were investigated, and the 'larks' and the 'owls' were identified (Webb and Bonnet 1978). The differences between these extreme subgroups were evaluated, and more regular sleeping habits, more adequate sleep and better sleep quality were found in the 'larks' than in the 'owls'. Even when the 'owls' shifted their awakening time earlier (as instructed by the researchers) their sleep problems did not diminish. In fact, their sleeping time shortened because their bedtime was only 25 minutes earlier although they woke up an hour earlier than normally. The authors concluded that going to bed early or late is determined by internal cues which can be modified only to some extent by social surroundings.

Similar differences between 'larks' and 'owls' have also been found also in other studies (Ishihara et al. 1987; Park et al. 1997; Taillard et al. 1999), but sleep quality has not differed so clearly. An effect of external cues was seen in the study by Park et al., where young studying and working adults were compared. More 'larks' were found in the group of workers than among the students, which was clearly a consequence of working hours. An interesting finding supporting a biological basis of different sleeping types was made in an British study on young adults (Horne and Östberg 1976). In this study significantly different timing of peak temperature of the body was found in 'larks' and 'owls'.

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Sleep disturbances and depression. Problems in falling and staying asleep are obvious causes for sleep pattern changes. Sleep continuity problems have usually been included in the concept of sleep quality and they have often been regarded as a sign of psychic problems. The association between poor sleep quality and shortened sleep time, late bedtime and/or early wake-up time in adolescents and young adults has been shown in several studies (Lugaresi et al. 1983; Partinen et al. 1983a; Kirmil-Gray et al. 1984; Levy et al. 1986; Zammit 1988; Ferber 1990; Vignau et al. 1997; Järventie 1999; Laberge et al. 2001). On the other hand, the association between sleep quality and sleep quantity has been evaluated to be vague (Pilcher et al. 1997). Sometimes lengthened sleep time has also been found to be a sign of psychic problems, usually depression (Hawkins et al. 1985; Beersma 1986; Ford and Kamerow 1989).

Late bedtime causing shortened sleep time is not always a sign of poor sleep quality. It may be related to delayed sleep phase syndrome (DSPS) which has been described particularly in adolescents and young adults (Weitzman et al. 1981; Lack 1986; Thorpy et al. 1988; Regestein and Monk 1995). In this syndrome bedtime and wake-up time tend to be delayed, especially when strict schedules are lacking as is the case for example in university life, but the sleep itself is of good quality. An adolescent suffering from the syndrome has great social problems. The prevalence of the syndrome is not frequent, about 7% to 10% of insomniac patients are estimated to have it (Regestein and Monk 1995).

Somatic sleep disorders. There are some somatic diseases causing either shortening or lengthening of sleep duration. A fairly rare idiopathic hypersomnia may occur in all agegroups (Billiard et al. 1998). In this syndrome sleeping time is lengthened and daytime sleepiness occurs. The syndrome has a strong familial component. Sometimes poor sleep quality causing shortened sleep may be a sign of obstructive sleep apnea syndrome (OSAS) (Owens et al. 1998).

Seasonal variation. Variation of sleeping habits during the year has seldom been evaluated, although most epidemiological studies have been made on the high latitudes with a wide variation in temperature and light. Perhaps the findings of seasonal variation in sleeping time have been most often made in studies of seasonal affective disorder (SAD). In this syndrome, the lengthening of sleeping time in autumn and winter is one of the major findings. Depression, fatigue and behavioural problems are other symptoms. The syndrome has been first described among adults (Rosenthal et al. 1984), but it has also been found in children and adolescents (Rosenthal et al. 1986; Carskadon and Acebo 1993; Sourander et al. 1999). Prevalence was estimated at 4.2%, (Carskadon and Acebo 1993) although much higher figure, 24%, was found for a single symptom: lengthening of sleeping time during winter. Both Carskadon and Acebo and Sourander et al. compared adolescents in the various latitudes, and found that the symptoms were more pronounced in the northern areas.

In other than depression studies the seasonal variation of sleep pattern is only occasionally mentioned. In a Finnish interview study made in Lapland among Skolt Lappish and Finnish families, clear delay in bedtime and wake-up time was found during the summer when the sun is almost constantly above the horizon (Forsius 1973). In another Finnish study of the use of time in the Finnish population, no difference was found in sleeping time during the year (Niemi and Pääkkönen 1992). On the other hand, an Australian study among young adults found a shorter sleeping time during the summer (Johns et al. 1971).

The most detailed follow-up study on sleep patterns through the year is from Poland (Szymczak et al. 1993). In this study, annual and weekly changes in the sleep of schoolchildren were followed by sleep diaries. A shortening of sleeping time was found during the spring months caused by earlier wake-up time. Sleeping time was longest during vacations, i.e. in the summer and in December. It is obvious that the evaluation of the sole effect of latitude or school schedules on sleep patterns is difficult.

Social background. In Finland, a clear association between living area and sleeping habits has been established in several studies. Children and adolescents in rural areas slept more and had earlier bedtime than in urban areas (Partinen and Rimpelä 1982; Tynjälä and Kannas 1993). The same finding was also made in a study of adult Finns (over 15 years of age) (Partinen and Rimpelä 1982). The finding especially concerned farmers' families (Tynjälä and Kannas 1993). In a British study late bedtime was associated with lower social class (Rugg-Gunn et al. 1984). Another English study reported later bedtime and shorter sleeping time in adolescents from families with four or more children (Macgregor and Balding 1988a).

School schedules and requirements. The effect of school schedules on sleeping habits is obvious. The Polish study (Szymczak et al. 1993) showed that during the week in term time sleep rhythm differed significantly from that of weekends and vacations. In two recent studies the effect of various school schedules on sleeping time was compared (Carskadon et al. 1998; Epstein et al. 1998). In the study by Carskadon et al., adolescents' sleeping time was evaluated at two points: at the end of the 9th grade when the school starting time was at 8.25 and at the beginning of 10th grade when it was at 7.20. Significant shortening of sleeping time was found. The finding was the same in a study conducted in Israel, where schoolchildren of 10-12 years of age were compared according to their school start time which was either 7.10 at least two times a week or 8.00 during a whole week (Epstein et al. 1998).

The effect of school demands was evaluated in Taipei, Taiwan (Gau and Soong 1995). Adolescents from two different kinds of schools were compared. These junior high schools differed from each other in requirements, one being much less stressful than the other. The adolescents slept less in the higher grades, and they also slept less in the school with tougher requirements. Homework or studying was

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the reason for late bedtime in the demanding school more often than in the other school.

Free-time activities. It has been postulated that increasing leisure time during the last forty years has had an impact on living habits. A remarkable change in the Western countries occurred when Saturday became a holiday. At the same time television came to every home, and during the 1990's videos and computers became popular. This phenomenon was evaluated in a Finnish study mentioned already (Koskenniemi 1980). It was found that at the same time as of sleeping time diminished from the 1950's to the 1970's, the time spent on TV/radio increased almost as much. A study from the 1980s in USA did not report an association between TV and sleep duration (Weisbluth et al. 1981) but a Finnish study with data from the 1980s in many European countries made the opposite finding (Tynjälä et al. 1993). In a Taiwanese study from the 1990's over 20 % of those having bedtime after 11.00 p.m. reported the reason to be TV (Gau and Soong 1995). A clear association between diminished sleep duration and TV was also found in a recent American study (Owens et al., 1999)

Sleeping time was found to be shorter in adolescents spending a lot of time with friends (Tynjälä et al. 1993) or having many activities outside school work (Carskadon 1989). Working after school was found to have an especially remarkable effect on sleeping time in the study by Carskadon.

The effect of stimulants on sleeping habits has been evaluated in many studies. Smoking has been connected with late bedtime and short sleeping time in studies concerning adolescents and young adults (Palmer et al. 1980; Macgregor and Balding 1988b; Townsend et al. 1991; Hallman et al. 1992; Tynjälä et al. 1993; Phillips and Danner 1995). Alcohol has been found to have the same effects and also to increase irregularity of sleeping habits (Palmer et al. 1980; Levy et al. 1986; Carskadon 1989; Townsend et al. 1991; Hallman et al. 1992; Rahkonen et al. 1992; Tynjälä et al. 1993; Phillips and Danner 1995). It is not always easy to separate the

effects of these two because their use is strongly associated with each other. Use of drugs has not yet been widely evaluated. Only in few studies (Levy et al. 1986; Carskadon 1989) was marijuana use reported to be more common in the short sleepers group than in the others.

An explanation for one universal phenomenon - that girls wake up earlier than boys - could be found in a Finnish investigation about Finns' use of time during the year 1987-88 (Niemi and Pääkkönen 1992). In that study it was found that girls, especially in the age of puberty, spent more time on washing and dressing.

Sleep disorders in schoolchildren and adolescents

Disturbances of initiation and continuity of sleep

Insomnia usually refers to a difficulty to initiate sleep but night waking and premature awakenings are also sometimes included in it. Occasionally it has been regarded as a separate phenomenon depending only on subjective evaluation. The prevalence of insomnia varies in different agegroups.

Several studies on adults also include the agegroups of late adolescence (over 15 years). In Finnish studies the prevalence has been 5% to 8% in adults (>17 years) (Partinen 1982; Partinen and Rimpelä 1982). In studies from other countries difficulty in falling asleep has varied from 8% to 18% (Bixler et al. 1979; Karacan et al. 1983; Smirne et al. 1983; Welstein et al. 1983; Lack 1986; Andrews and Davis 1988; Ford and Kamerow 1989). Difficulty in staying asleep has been reported to vary from 9% to 17% (Bixler et al. 1979; Karacan et al. 1983; Smirne et al. 1983; Welstein et al. 1983; Lack 1986; Andrews and Davis 1988; Ford and Kamerow 1989), and early awakenings from 2% to 16% (Bixler et al. 1979; Karacan et al. 1983; Smirne et al. 1983; Welstein et al. 1983; Lack 1986; Ford and Kamerow 1989). All studies reported that these three problems were more common

in women. Welstein et al. also reported that the problems were clearly more common in the agegroup of children and adolescents (the exact figures for different agegroups were not given) while Smirne et al. made the opposite finding. When asking directly whether respondents had insomnia the total prevalence was only 4% (Welstein et al. 1983; Lack 1986) and higher in the older agegroups (Welstein et al. 1983).

Clearly different results were reported about difficulty in falling asleep and night waking in a study from Scotland (McGhie and Russell 1962), where both symptoms were less than 5% among the agegroup 15 to 25 years. A Japanese study reported early awakenings in all agegroups and found the lowest occurrence in 13 to 18-year-olds (Abe and Suzuki 1985). Contrary to other studies males had the symptom more frequently than females.

Studies concerning sleep problems in schoolchildren and adolescents are numerous. In Finland a study among 7-year-old children found a low prevalence of 1% for night waking (Langinvainio 1984) while another Finnish study with data gathered ten years later found significantly higher prevalence of night waking (7%) in 8 to 9 year-old children (Paavonen et al. 2000). In this study sleep onset problems were found in 11% and early awakening in 2% of participants.

A Finnish study which was part of the WHO's HBSC Study reported, in the data gathered 1983-84, a prevalence of 30% in inability to fall asleep. However, the data from the year 1990 included only 10% of adolescents who could not fall asleep in 30 minutes (Tynjälä 1992; Tynjälä et al. 1993). The discrepancy may be due to varying questions used in the studies. In the same study series in 1994 night waking varied form 6% to 11% in the 11,13 and 15 agegroups (Tynjälä et al. 1999).

A study reporting health habits among Finnish young people 12 to 18 years of age found stable prevalence in difficulties in falling or staying asleep in the years 1979 and 1981, 10% for girls and 6 to 7% for boys (Rimpelä et al. 1982; Rimpelä and Rimpelä 1983). Similar prevalence and sex difference have been reported in a study of Finnish adolescents 14 to 16 years of age (Aro et al. 1987). Higher

prevalences were found in a study in 1987 of health habits (Rahkonen et al. 1992). Difficulty in falling or staying asleep occurred in 19% of respondents.

Studies on schoolchildren and adolescents from other countries include both longitudinal and cross-sectional settings. In Switzerland and Sweden longitudinal studies of sleep behaviour have been carried out (Bühler and Largo 1981; Klackenberg 1982a) followed children before school age to late adolescence. The Swiss study reported difficulty in falling asleep every night in 11-17% of the agegroup 6 to 18 years. The prevalence of frequent night waking was found to be 9% in 6-year-old children, and it diminished to 1% at 12 years of age. Similar frequencies of night waking were found in the Swedish study. No sex differences were reported.

In cross-section studies among preadolescents the prevalence of difficulty in falling asleep and night waking have varied between 5 and 15 % (Fisher et al. 1989; Kahn et al. 1989; Blader et al. 1997). No sex differences were found. However, the prevalence of night waking in girls decreased with age in a Canadian study (Fisher et al. 1989). In a preadolescent group a strong correlation between difficulty in falling asleep and night waking has been reported (Bühler and Largo 1981; Blader et al. 1997). In the study by Blader et al. it is striking that altogether 21% of the children between ages 5 to 12 years tried to fall asleep more than one hour.

In adolescent studies difficulty in falling asleep varied from 10% to 16% (Yang et al. 1987; Morrison et al. 1992; Liu et al. 2000b; Mantz et al. 2000) to a clearly higher prevalence between 20% to 27% (Bearpark and Michie 1987; Gau and Soong 1995; Phillips and Danner 1995; Vignau et al. 1997). Night waking was also more frequent in the latter studies (14% to 39%) than in the studies by Morrison et al. and Liu et al. (2% to 6%). The prevalence of early awakenings has usually been reported to be only a few percent in spite of the 22% in a Taiwanese study (Gau and Soong 1995). An overall finding is that girls have more night wakings than boys.

Sleep quality and related factors

As a study object sleep quality has been treated quite heterogenously: in some studies a special question about it has been used, in other studies a group of questions constituted a basis for sleep quality. The questions mostly concerned initiation and continuity of sleep, but sometimes questions of parasomnia are included, especially in studies of preadolescents when the term 'sleep disturbance' is used in place of 'sleep quality'. The different studies are, thus, not easily comparable. Two studies concerning preadolescents in the 1970's reported quite similar prevalences (24%) of sleep disturbances on opposite sides of the world (Finland and New Zealand) (Forsius 1973; Clarkson et al. 1986).

In adolescent studies the prevalence of poor sleep quality has been consistently at the level of 10% to 15% (Price et al. 1978; Kirmil-Gray et al. 1984; Levy et al. 1986; Tynjälä and Liinamo 1995; Patten et al. 2000). In a study using a direct question about poor sleep quality the prevalence was lower (very bad quality 1-2% and satisfactory quality 5-10%) (Tynjälä et al. 1999). Girls had poorer sleep quality in some of the studies (Price et al. 1978; Kirmil-Gray et al. 1984; Levy et al. 1986; Patten et al. 2000), while others reported no sex difference (Tynjälä and Liinamo 1995; Tynjälä et al. 1999).

Studies including the age range from childhood to adults have evaluated sleep quality with a special question, and some studies have also regarded the use of sleeping pills as a sign of poor sleep quality (Karacan et al. 1976; Partinen and Rimpelä 1982; Lugaresi et al. 1983; Partinen et al. 1983a; Ohayon 1996). In the studies from the 1970's and 1980's the prevalence has been quite low (2% to 6%) but the study carried out in the 1990's among the French population reported a much higher rate (15% for females and 10% for males) (Ohayon 1996). In these studies an overall observation was also that sleep quality is poorer in females than in males.

As to many of the contributing factors described below, it is difficult to interpret whether they are causes or consequences of poor sleep. The factors regarded as consequences are included in the effects of daytime sleepiness dealt with later.

Genetic factors. Sleep initiation, maintenance and quality have been shown to have a genetic component. The most convincing proof has been obtained from the Finnish Twin Cohort study (Partinen et al. 1983b), which found more similar sleep quality in monozygotic than in dizygotic twins. In other epidemiological studies the genetic influence has rarely been evaluated. However, in an American study on adolescents and a Belgian study on preadolescents the parental sleep disturbances were also studied (Price et al. 1978; Kahn et al. 1989). Chronic poor sleepers had more sleeping problems in the family than good sleepers in the American study. In the Belgian study poorly sleeping boys were found more frequently to have insomniac fathers than boys with good sleep quality.

Sleep disorders in general. Some sleep disorders seem to disturb sleep quality. Mostly there has been an association between poor sleep and nightmares or frequent dreaming (McGhie and Russell 1962; Price et al. 1978; Rimpelä and Rimpelä 1983; Kahn et al. 1989; Tynjälä 1992; Tynjälä and Liinamo 1995; Philip and Guilleminault 1996; Blader et al. 1997; Ohayon et al. 1997b). Such parasomnias as somnambulism, somniloquy and night terrors (Kahn et al. 1989) or symptoms of restless legs syndrome or nocturnal myoclonus (Kirmil-Gray et al. 1984) have been reported. However, an opposite finding has been reported in a study comparing insomniac and well sleeping children (Dixon et al. 1981). A Chinese study mentions enuresis in connection with sleep problems (Liu et al. 2000a).

Some studies have addressed the evolution of insomnia. It has been shown that children having sleep onset problems in school age have had this problem and frequent night waking since the first year of life (Salzarulo and Chevalier 1983;

Blader et al. 1997). These children needed the parents' presence while falling asleep more often than the children without sleep onset problems (Blader et al. 1997). A study investigating adults suffering from psychophysiological insomnia reported that people who had insomnia already in childhood had had significantly longer sleep latencies, more fear of the dark and more frequent nightmares than those whose insomnia had its onset later in life (Philip and Guilleminault 1996). The association between sleep onset problems and delayed sleep phase syndrome was discussed in the previous section.

Sometimes poor sleep quality is associated with snoring (Delasnerie-Laupretre et al. 1993) or narcolepsy (Challamel et al. 1994).

Somatic disorders. Physical complaints have been widely reported in association to poor sleep. Children and adolescents suffered both from psychosomatic problems (Rimpelä et al. 1982; Rimpelä and Rimpelä 1983; Zammit 1988; Tynjälä et al. 1993; Paavonen et al. 2000) and actual somatic diseases (Bixler et al. 1979; Klackenberg 1982a; Rimpelä et al. 1982; Kirmil-Gray et al. 1984; Simonds and Parraga 1984; Gau and Soong 1995; Bartlet et al. 1997; Blader et al. 1997; Vignau et al. 1997; Rona et al. 1998; Liu et al. 2000a, b; Mantz et al. 2000; Paavonen et al. 2000) more often when the sleep quality was poor. Adolescents have mentioned aches and pains as a cause of poor sleep (Tynjälä and Liinamo 1995; Bruni et al. 1997; Mantz et al. 2000; Paavonen et al. 2000) and girls have reported menstruation and aches during the period to cause poor sleep (Rimpelä et al. 1982). Head injury has been found to precede sleep disturbances (Kaufman et al. 2000). Subjectively perceived poor health status in adolescents has also been found to cause poor sleep (Rimpelä et al. 1982; Rimpelä and Rimpelä 1983; Mahon 1995; Pilcher et al. 1997; Tynjälä et al. 1999).

Stress and psychic disorders. In several studies the most frequent reason for poor sleep quality has been some kind of psychological factor. Occasional stress

connected to a difficult life situation has been reported especially in adolescents (Price et al. 1978; Bixler et al. 1979; Lugaresi et al. 1983; Partinen et al. 1983a; Aro 1988; Tynjälä 1992; Gau and Soong 1995; Tynjälä and Liinamo 1995; Vignau et al. 1997; Liu et al. 2000b), but the effect of the situation at school as a single occasional stress has not been reported very often. However, in some studies there is clear evidence of heavy school demands affecting sleep quality (Price et al. 1978; Gau and Soong 1995; Tynjälä and Liinamo 1995).

Various kinds of behavioural problems - overactivity, aggressiveness, irritability, learning and developmental disability - commonly seen in children and adolescents have been connected to sleep quality problems (Marks and Monroe 1976; Monroe and Marks 1977; Simonds and Parraga 1984; Clarkson et al. 1986; Seitamo 1988; Morrison et al. 1992; Blader et al. 1997; Liu et al. 2000a; Paavonen et al. 2000). Antisocial behaviour has also been associated with poor sleep quality in adolescents (Vignau et al. 1997). Fear of the dark (Dollinger 1982; Simonds and Parraga 1984; Philip and Guilleminault 1996; Blader et al. 1997), poor self-confidence (Price et al. 1978; Tynjälä et al. 1999) or a tendency to worry at onset of sleep (McGhie and Russell 1962; Price et al. 1978; Bixler et al. 1979; Karacan et al. 1983; Partinen et al. 1983a; Kirmil-Gray et al. 1984; Zammit 1988; Waters et al. 1993; Gau and Soong 1995; Tynjälä and Liinamo 1995; Pilcher et al. 1997; Mantz et al. 2000) are traits of character seen in poorly sleeping adolescents. Loneliness has also been found in association with disturbed sleep (Mahon 1994).

Poor sleep quality has been reported to be a symptom of actual psychic disorders (Bixler et al. 1979; Dixon et al. 1981; Dollinger 1982; Lugaresi et al. 1983; Partinen et al. 1983a; Simonds and Parraga 1984; Clarkson et al. 1986; Seitamo 1988; Zammit 1988; Ford and Kamerow 1989; Morrison et al. 1992; Blader et al. 1997; Ohayon et al. 1997b; Pilcher et al. 1997; Vignau et al. 1997; Paavonen et al. 2000; Patten et al. 2000). Anxiety, depression, eating disorders and psychotic disorders have a major effect on sleep onset, maintenance and early awakenings.

Social background. An association between low socioeconomic status of the family and poor sleep quality has been found in several studies (Simonds and Parraga 1982; Kahn et al. 1989; Tynjälä 1992). Ethnic origin has also been associated with disturbed sleep (Rona et al. 1998). In that study children of Indian origin had more disturbed sleep than Caucasian children.

Family problems have been mentioned as a reason for poor sleep quality in several studies (Price et al. 1978; Klackenberg 1982a; Lugaresi et al. 1983; Clarkson et al. 1986; Seitamo 1988; Kahn et al. 1989; Gau and Soong 1995; Vignau et al. 1997; Järventie 1999; Tynjälä et al. 1999; Liu et al. 2000a; Paavonen et al. 2000). Poorly sleeping children had more often divorced parents (Seitamo 1988; Kahn et al. 1989; Vignau et al. 1997) or a so-called stepfamily (Paavonen et al. 2000), and their parents had more somatic and psychic illnesses than in families with children sleeping well (Klackenberg 1982a; Clarkson et al. 1986; Seitamo 1988; Vignau et al. 1997; Paavonen et al. 2000). A parental punitive, authoritarian control (Seitamo 1988) or parental neglect (Järventie 1999) were also more common in association with a child's poor sleep quality.

Noisy and lighted sleeping environment has been mentioned in some studies as a cause of poor sleep (Kirmil-Gray et al. 1984; Kahn et al. 1989; Gau and Soong 1995; Tynjälä and Liinamo 1995; Mantz et al. 2000) as well as crowded homes (Liu et al. 2000a). Adolescents living without their parents in a community home or alone had poorer sleep quality, too (Vignau et al. 1997).

Free-time habits and activities. Use of stimulants has an obvious impact on sleep quality, as also on sleep quantity. However, some contradictions exist between different studies. Poor sleep quality has been found in smoking adolescents more frequently than in non-smokers (Rimpelä et al. 1982; Rimpelä and Rimpelä 1983; Phillips and Danner 1995; Vignau et al. 1997; Patten et al. 2000) but an opposite finding has also been reported (Palmer et al. 1980; Hallman et al. 1992). A negative effect of alcohol on sleep quality has been reported almost unanimously (Price et al.

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1978; Rimpelä et al. 1982; Rimpelä and Rimpelä 1983; Ford and Kamerow 1989; Hallman et al. 1992; Rahkonen et al. 1992; Vignau et al. 1997; Lee et al. 1999; Tynjälä et al. 1999). Only one disagreement has been reported (Palmer et al. 1980). Poor sleepers have also been reported to drink more caffeinated beverages (Kirmil-Gray et al. 1984).

A positive impact of physical activities in leisure time has been reported in a Finnish study, where it was found in adolescent girls (Tynjälä et al. 1999), though the opposite also exists (Rimpelä et al. 1982). A negative effect of not getting enough exercise has been found (Price et al. 1978; Gau and Soong 1995; Liu et al. 2000b). Other leisure time activities are rarely mentioned in sleep quality studies, but excessive television-viewing has been found to be associated closely with sleep disturbance in children (Owens et al. 1999).

Use of medication and drugs for poor sleep quality. Use of various kinds of medication and other hypnotic substances as an aid to falling and staying asleep has been evaluated in many studies. These studies concern mostly adult population, and often include the late adolescent agegroup. In these studies the use of hypnotics, tranquillisers, alcohol and drugs has been associated with sleep onset and maintenance difficulties (Karacan et al. 1983; Lugaresi et al. 1983; Partinen et al. 1983a; Smirne et al. 1983; Welstein et al. 1983; Ohayon 1996; Johnson et al. 1998; Liu et al. 2000b). The frequency of use has been quite low in the agegroup of late adolescence from 2% (Partinen et al. 1983a; Liu et al. 2000b) to a few percent more (McGhie and Russell 1962; Karacan et al. 1976, 1983; Lugaresi et al. 1983).

The use has been estimated to have increased, as in a recent American study 18% of the general population aged 18 to 45 years used medication, 13% used alcohol and 5% used both as sleep aids (Johnson et al. 1998). There were more female users of medication than males, but the difference is not as clear as it is later in life (McGhie and Russell 1962; Karacan et al. 1976, 1983; Partinen et al. 1983a; Welstein et al. 1983; Johnson et al. 1998). Alcohol use was not related to sex

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(Johnson et al. 1998). Smoking marijuana was reported in an American study (Welstein et al. 1983).

Studies in adolescent population have reported similar prevalences, though studies concerning this item are few and the results are controversial. An occurrence of only a few percent even in an occasional use of alcohol or medication has been mentioned (Kirmil-Gray et al. 1984; Vignau et al. 1997), while 18% occasional use and 7% regular use has been found in a Canadian study (Levy et al. 1986) and use of 6% in boys and 13% in girls in a French study (Ledoux et al. 1994). The latter thus reported a sex difference, as has been shown in the adult studies. In the Canadian study, regular alcohol use as a sleep aid has been reported in 9% of adolescents, and marijuana was also mentioned. It is remarkable that in this study poor sleepers and good sleepers did not differ from each other in regard of these habits, while in the study by Vignau et al. the use of medication was three times more common in poor sleepers than in good sleepers. Regular use of sedatives in preadolescents has been reported in 4% in a Belgian study (Kahn et al. 1989). No reports among Finnish young people are available.

Parasomnias

Snoring. The natural history of snoring has not been evaluated in longitudinal studies. However, obstructive sleep apnea syndrome (OSAS) which is occasionally encountered in snoring people has been found to have the highest prevalence during childhood between years 2 to 5 (Guilleminault et al. 1981). This has been related to the developmental maximum of lymphoid hyperplasia of Waldeyer's ring. Later on this lymphoid tissue becomes smaller and OSAS prevalence decreases. However, during puberty the prevalence rises again, thus leading to bimodal age distribution of OSAS (Owens 1998).

The prevalence of habitual snoring before school age is estimated to be 7-10% (Ali et al. 1993). A similar percentage of snoring has also been found in the agegroup 6 to 13 years (Corbo et al. 1989) and 5 to 18 years (Simonds and Parraga 1982). A lower prevalence of snoring during preadolescence cannot be found in these studies because the age distribution also includes adolescents.

In two studies concerning only adolescents (Gau and Soong 1995; Lee et al. 1999) higher prevalence of snoring has been reported: 18% and 26% respectively. However, the authors have not reported the exact number of adolescents who were classified as snorers. Even higher prevalence was found in a French study at 15 to 20 years of age (Delasnerie-Laupretre et al. 1993). Here, the prevalence of habitual snoring in boys was 39% and in girls 28%. The male preponderance was also clear in the study by Simons and Parraga (Simonds and Parraga 1982), but not in a study concerning a younger agegroup (6-13 years) (Corbo et al. 1989). This finding is in line with the results obtained from adult population (Schmidt-Nowara et al. 1990), where habitual snoring was found more often in males than females. In a Finnish study concerning young recruits (age range 17 to 29 years) (Partinen 1982) the prevalence of frequent snoring was only 9%. In the French and Finnish studies the same alternatives (never, sometimes, often, always/every night) were used, so they should be comparable.

Factors influencing snoring have been evaluated in some studies. The sex difference occurring during puberty has been estimated to be a consequence of testosterone production in males (Sandblom et al. 1983). Individual facial dimensions have been shown to have an effect on snoring (Guilleminault et al. 1989) in addition to lymphoid hyperplasia of the tonsils (Owens 1998). Allergies in the upper airway area have been found more often in snoring children and adolescents than in non-snorers (Simonds and Parraga 1982; McColley et al. 1997). The effect of smoking on snoring has been reported to be transmitted through both passive (Corbo et al. 1989) and active smoking (Delasnerie-Laupretre et al. 1993).

In the latter the dose – effect relationship was also reported; a great deal of snoring in young adults has been interpreted to be attributable to smoking.

Dreaming and nightmares. The prevalence of dreaming and nightmares varies depending on the way the answers are interpreted. A longitudinal Swiss study concerning the agegroup 2 to 18 years found a high prevalence of nightmares (60%) in categories 'often' and 'sometimes' up to the age of 5, after which it decreased to about 25% (Bühler and Largo 1981). In other studies mainly concerning schoolchildren and adolescents, percentages have varied between 17% and 37% when the same categories have been evaluated (Dollinger 1982; Rimpelä et al. 1982; Salzarulo and Chevalier 1983; Fisher and Wilson 1987; Fisher et al. 1989; Kahn et al. 1989; Gau and Soong 1995). Studies also reporting separately the categories 'often' or 'always' however found prevalences in these classes of only 10% or less (Bühler and Largo 1981; Rimpelä et al. 1982; Langinvainio 1984; Fisher and Wilson 1987; Rintahaka and Uusikylä 1987; Fisher et al. 1989; Morrison et al. 1992; Paavonen et al. 2000). Chinese studies report only 9% prevalence in adolescents (Yang et al. 1987) and 12% in preadolescents (Liu et al. 2000a), even when a fairly rarely occurring symptom has been noted .

Sex difference, if it has been found, has been on the side of girls reporting more nightmares (Rimpelä et al. 1982; Yang et al. 1987; Fisher et al. 1989; Liu et al. 2000b; Nielsen et al. 2000). Nielsen et al. found in their study that in the group of 13-year old adolescents, girls had more disturbing dreams than boys and after a three year follow-up the symptom had increased in girls but decreased in boys. A recent Finnish study, however, reports an opposite gender difference (Paavonen et al. 2000).

The prevalence of frequent dreaming has been reported to be 70% in Finnish schoolchildren (Rintahaka and Uusikylä 1987). Dreaming has also been reported to be more common among girls than among boys (Nielsen et al. 2000).

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In adult studies including late adolescence in the age range (more than 18 years), the results of nightmare prevalence 'often' or 'sometimes' have been mostly similar to child studies, i.e. a few percent suffered the symptom often and 14% to 30% had nightmares sometimes, with female preponderance (Karacan et al. 1976; Bixler et al. 1979). An exception was reported in an Australian study where 24% of adolescents reported that they often had nightmares (Andrews and Davis 1988).

As has been mentioned previously, nightmares are associated with insomnia and sometimes are a cause for it (Ohayon et al. 1997b). An association between nightmares, sleepwalking and sleeptalking has been also found (Fisher and Wilson 1987). Children in psychiatric clinics have been found to suffer more from nightmares than a control group (Simonds and Parraga 1984).

Other parasomnias. Other phenomena occurring during sleep have usually been studied together, and attention has been mainly paid to the effect of age and gender. The parasomnias presented here are sleeptalking (somniloquy), teeth grinding (bruxism), sleepwalking (somnambulism), night terrors (pavor nocturnus), bed-wetting (enuresis) and head banging/rocking (jactatio capitis).

Sleeptalking has been mostly reported to occur in 20% up to 50 % in both preadolescent and adolescent studies (Dollinger 1982; Partinen 1982; Salzarulo and Chevalier 1983; Fisher and Wilson 1987; Fisher et al. 1989; Gau and Soong 1995; Lee et al. 1999) but the prevalences have been lower when exact answer categories (number of symptomatic nights during a week) have been used (Reimao and Lefévre 1980; Rintahaka and Uusikylä 1987; Yang et al. 1987; Kahn et al. 1989; Morrison et al. 1992). No sex or age differences have been found (Reimao and Lefévre 1980; Fisher and Wilson 1987; Yang et al. 1987; Lee et al. 1999). However, in an adult study concerning agegroups 18 years or older, sleeptalking was reported to be most common in the youngest agegroup (Bixler et al. 1979); sleeptalking is thus perhaps a symptom occurring more in childhood and youth. It has been reported to occur more often in poorly sleeping preadolescents (Kahn et al.

1989) and in children who have problems in sleep-wake rhythm early in their lives (Salzarulo and Chevalier 1983). As mentioned above, sleeptalking has been found to occur often with sleepwalking and nightmares (Fisher and Wilson 1987).

The prevalence of teeth grinding has been constantly 6-9% (Salzarulo and Chevalier 1983; Fisher et al. 1989; Gau and Soong 1995; Lee et al. 1999), except in a Chinese study, where a much higher occurrence of 22% was reported (Yang et al. 1987). Bruxism has been found to decrease with age (Yang et al. 1987; Fisher et al. 1989). The use of caffeine and hot chocolate has been found to increase bruxism (Lee et al. 1999).

The occurrence of sleepwalking has been evaluated in numerous studies, and the results are quite uniform in spite of different cultural backgrounds of the studies (Bixler et al. 1979; Bühler and Largo 1981; Dollinger 1982; Klackenberg 1982b; Partinen 1982; Fisher and Wilson 1987; Rintahaka and Uusikylä 1987; Yang et al. 1987; Andrews and Davis 1988; Fisher et al. 1989; Kahn et al. 1989; Morrison et al. 1992; Gau and Soong 1995; Blader et al. 1997; Lee et al. 1999; Paavonen et al. 2000). Sleepwalking has been reported to be rare, only a few percent. Decrease of the symptom during pubertal years (Bühler and Largo 1981; Klackenberg 1982b) and familial occurrence (Fisher and Wilson 1987) have been reported. A Swedish longitudinal study found no correlation with other sleep disorders apart from nightmares (Klackenberg 1982b). The author reported more inhibited aggression and a more developed mental reaction against anxiety in sleepwalkers than in other children. An American study reported an association between sleepwalking, sleep initiating and sleep maintenance problems (Blader et al. 1997). Poorly sleeping children were found to sleepwalk more often than good sleepers (Kahn et al. 1989). In another study sleepwalkers drank more caffeine, hot chocolate and alcohol than nonwalkers (Lee et al. 1999).

Night terrors have been found to occur in 1% to 10% of children, the most common frequency being 3-4% (Dollinger 1982; Salzarulo and Chevalier 1983; Fisher et al. 1989; Kahn et al. 1989; Gau and Soong 1995; Paavonen et al. 2000).

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There is one report about decreasing tendency in prevalence with age (Fisher et al. 1989). In another study night terrors included in night fears were found more often in children with poor sleep quality than in the others (Kahn et al. 1989). Night terrors have also been reported more often in children attending psychiatric clinics than in controls (Simonds and Parraga 1984).

The prevalence of enuresis varies from 1% to 17%, clearly depending on the age range of the study (Dollinger 1982; Partinen 1982; Salzarulo and Chevalier 1983; Fisher and Wilson 1987; Yang et al. 1987; Fisher et al. 1989; Kahn et al. 1989; Gau and Soong 1995; Blader et al. 1997; Liu et al. 2000a; Paavonen et al. 2000). In fact, two studies reported significant differences when examining the effect of age on the symptom: the older agegroup had less enuresis than the younger group (Yang et al. 1987; Fisher et al. 1989).

Head banging and rocking has been reported in a few studies (Salzarulo and Chevalier 1983; Fisher et al. 1989; Lee et al. 1999). The prevalence of this symptom has been 5-10%. In one study, higher caffeine and hot chocolate consumption has been found in head bangers than nonbangers (Lee et al. 1999).

Daytime sleepiness

Concept of daytime sleepiness

The definition of daytime sleepiness is not clear. Neither text-books in pediatrics and neuropediatrics nor sleep medicine give contents to daytime sleepiness of children and adolescents. In fact, it is not clearly defined among adults, either. The primary cause of sleepiness is considered to be either quantitative or qualitative lack of sleep. An effort has been made to limit the term 'sleepiness' to describe 'pure' somnolence when a person has a tendency to fall asleep easily during daytime (excessive daytime sleepiness, EDS). However, in questionnaire studies participants

may report daytime sleepiness although they cannot fall asleep during daytime, when the proposed term would be 'subjective daytime sleepiness' (SDS). The term 'fatigue' is also used, but its contents are wider than the concept of 'sleepiness'. Fatigue has been evaluated to be common in individuals with sleep disorders but not to correlate with EDS when the latter was estimated with MSLT (Lichstein et al. 1997).

Evaluation methods of daytime sleepiness in epidemiological studies

Daytime sleepiness is estimated by various questions or question combinations. A simple question about daytime sleepiness/tiredness/drowsiness is common but very often the estimation has been based on difficulty to wake up or tiredness in the morning. In a few studies tiredness at different times of the day has been elicited. The need for more sleep has also been used as a measure of sleepiness. The quantity of sleepiness has been evaluated with a question 'Are you sleepier than your friends?' or with the estimation of daily sleep urge. Questions about napping and dozing during lessons, in vehicles and while watching TV are also used in the evaluation of EDS.

Support for a subjective feeling of sleepiness has been gathered by sleepiness scales developed for clinical use, especially when sleep disorders and illnesses have been selected (Hoddes et al. 1973; Johns 1991; Rosenthal et al. 1993). The Stanford Sleepiness Scale (SSS) includes the statements about sleepiness with seven different items (Hoddes et al. 1973). The Epworth Sleepiness Scale (ESS) elicits the likelihood of dozing in various situations, and a sum score is formed from the answers (Johns 1991). The Sleep-Wake Activity Inventory (SWAI) includes various statements on excessive daytime sleepiness with Likert-type answer alternatives (Rosenthal et al. 1993). A visual analogue scale is also widely used as a measurement of sleepiness in different situations (Herbert et al.

1976). However, these methods have been developed and tested in adult populations.

Prevalence of daytime sleepiness and its correlates

The *v*arying prevalences of daytime sleepiness have depended on the questions used. The variation between studies using the same questions is also great, which obviously depends on the answer categories used to describe the symptom. In studies on prepubertal children the lowest estimation of morning tiredness is about 10% in the agegroup 6 to 11.5 years (Fisher et al. 1989), while 17% is reported in another study on preadolescents (Blader et al. 1997) and as high as 37% in a study on seven-year-olds (Dollinger 1982). In studies on adolescents the prevalence has been between 10 and 20% (Bearpark and Michie 1987; Fisher et al. 1989; Andrade et al. 1993; Gau and Soong 1995) but higher figures have mostly been presented, rising from 25% (Rimpelä and Rimpelä 1983; Tynjälä 1992; Tynjälä et al. 1993, 1997; Vignau et al. 1997) to 80% (Kirmil-Gray et al. 1984).

Adult studies including older adolescents (over 15 years) report morning tiredness in 18% (Partinen and Rimpelä 1982) and 29% (McGhie and Russell 1962) in the youngest agegroup, and a decreasing tendency of the symptom in older agegroups. Studies evaluating agegroups from 11 to 18 years found an increase in the symptom during puberty (Rimpelä and Rimpelä 1983; Tynjälä 1992; Tynjälä et al. 1993, 1997). In an international comparison among adolescents (11 to 16 years) morning tiredness was most common in Finland and Norway among the European countries (Tynjälä et al. 1993). The countries with the lowest prevalence (Hungary and Spain) had a prevalence of less than 10% in all three agegroups (11/12, 13/14 and 15/16 years), while in Finland the figures were 19%, 31% and 36% in each agegroup respectively.

The occurrence of daytime sleepiness has been lower than morning tiredness in studies ascertaining both aspects (Dollinger 1982; Bearpark and Michie 1987). Low prevalences of daytime drowsiness both among preadolescents (5 to 6%) and adolescents (4 to 12%) were found in the beginning of the 1980's (Rimpelä et al. 1982; Simonds and Parraga 1982), except for an adolescent study using the expression 'feel tired/very tired most of the time' where respective prevalences of 40% / 10% were obtained (Price et al. 1978). However, a more recent study reports a prevalence of 18% in preadolescents (Blader et al. 1997), and percentages from 20% to 50% have been commonly reported in studies of adolescents (Kirmil-Gray et al. 1984; Tynjälä 1992; Andrade et al. 1993; Gau and Soong 1995; Tynjälä et al. 1997; Rimpelä 1999). In the agegroup of older adolescents/young adults daytime sleepiness has been found in 11% (McGhie and Russell 1962) and 36% (Partinen 1982). A striking feature in the Finnish follow-up study is the increasing daytime sleepiness at the end of the 1990's from 24% in 1996 to 35% in 1999 (Rimpelä 1999). When older adult groups have been included, the percentages have been lower, 7.6% (Lack 1986) and 5.5% (Ohayon et al. 1997a).

When adolescents have estimated their sleep need, the feeling of insufficient sleep has been very common. Figures have varied between 46% and 75% (Lack 1986; Levy et al. 1986; Strauch and Meier 1988; Gau and Soong 1995; Mercer et al. 1998). In studies using tighter categories, i.e. 'sleep need at least four times per week' (Morrison et al. 1992) or 'not nearly enough sleep' (Lack 1986), the prevalence of the symptom has been lower, 25% and 8%, respectively.

The question 'Are you sleepier than your friends?' has been used in two Finnish adult studies also including late adolescence to indicate a serious sleepiness (Partinen 1982; Partinen and Rimpelä 1982). In both studies there were 10% older adolescents/young adults regarding themselves as seriously sleepy.

Daily sleep urge and dozing in various situations has been reported in only a few percent among preadolescents (Anders et al. 1978; Simonds and Parraga 1982) but recent studies on this agegroup do not include these symptoms. Simonds

and Parraga reported 10% irresistible sleepiness in the adolescent agegroup, which is less than later studies have reported (Levy et al. 1986; Billiard et al. 1987; Mercer et al. 1998; Lee et al. 1999). Studies from the 1980's reported 15% prevalence of the symptom (Levy et al. 1986; Billiard et al. 1987), and at the end of the 1990's the figures have varied between 15% and 30% depending on the dozing situation (Mercer et al. 1998; Lee et al. 1999).

Napping behaviour has been reported from only a few percents up to 8% in studies from the 1980's (Partinen 1982; Partinen and Rimpelä 1982; Lack 1986; Bearpark and Michie 1987), except for one study reporting 37% prevalence of napping (Levy et al. 1986). Adolescent studies conducting in the 1990's report higher prevalences: 12% in a French study (Vignau et al. 1997), 15% in a Taiwanese study (Gau and Soong 1995) and 6-10% at 11 years of age and 20-29% at the age of 15 in a Finnish study (Tynjälä 1992).

The association between various sleepiness symptoms has been evaluated in some studies. The wish for more sleep was associated with tiredness upon awakening, delayed alertness and napping behaviour in a Swiss follow up study (Strauch and Meier 1988). An association between moderate/severe daytime sleepiness and napping has also been reported (Ohayon et al. 1997a).

Predictors for daytime sleepiness in schoolchildren and adolescents

Age. The onset of puberty has an essential influence on the development of daytime sleepiness (Carskadon et al. 1980, 1983; Ishihara and Miyake 1998). The most convincing proof has been obtained from the studies by Carskadon et al. where the preadolescents did not sleep in MSLT, but during the pubertal years sleep latency scores shortened. Prepubertal age has also been shown to be an alert period in a Swedish study (Palm et al. 1989).

In epidemiological studies (Simonds and Parraga 1982; Levy et al. 1986; Bearpark and Michie 1987; Tynjälä 1992; Tynjälä et al. 1993, 1997) the effect of age was also seen, as morning tiredness, daytime sleepiness and napping were more common in older adolescents than in younger ones. However, the exact pubertal rate of the participants was not reported in these studies.

Gender. Although sex differences are slight in most of the studies, there is a consistent trend for girls to report more sleep need and to nap more than boys in some reports (Lack 1986; Bearpark and Michie 1987; Tynjälä 1992; Ohayon et al. 1997a; Vignau et al. 1997; Lee et al. 1999).

Sleeping habits. Shortened length of night sleep is the most logical and a well-known cause to daytime sleepiness. In their laboratory studies on adolescents and young adults Carskadon and Dement have shown that a few hours' sleep restriction causes a cumulative daytime sleepiness (Carskadon and Dement 1981, 1982). Other sleep laboratory studies have also shown, by MSLT, a clear association between short night sleep and daytime sleepiness (Levine et al. 1988; Thorpy et al. 1988; Carskadon et al. 1998).

Numerous epidemiological studies have shown that the shorter the adolescents' sleeping time, the sleepier they are during the daytime (Partinen 1982; Rimpelä et al. 1982; Rimpelä and Rimpelä 1983; Lack 1986; Billiard et al. 1987; Ishihara et al. 1987; Gau and Soong 1995; Tynjälä et al. 1997; Epstein et al. 1998; Wolfson and Carskadon 1998; Taillard et al. 1999). Some of these findings have been associated with DSPS (Lack 1986). Attention has also been paid to the irregularity of the sleep rhythm. Weekend sleep schedules differed a lot from the weekday schedules in those adolescents who suffered from daytime sleepiness (Lack 1986; Billiard et al. 1987; Ishihara et al. 1987; Strauch and Meier 1988; Thorpy et al. 1988; Manber et al. 1996; Wolfson and Carskadon 1998; Taillard et al. 1999). It seems that the adolescents follow their natural rhythm during the

weekend but then they also have recovery sleep. Sleepiness caused by sleep lack has been found to be most prominent during mornings and to alleviate later in the day (Thorpy et al. 1988; Carskadon et al. 1998).

Sleep disorders. The impact of sleep quality and its correlates (insomnia, night waking, early awakening) on daytime sleepiness has been found in children and adolescents in many studies (Marks and Monroe 1976; Monroe and Marks 1977; Price et al. 1978; Johnson and Spinweber 1983; Lugaresi et al. 1983; Rimpelä and Rimpelä 1983; Kirmil-Gray et al. 1984; Billiard et al. 1987; Morrison et al. 1992; Tynjälä et al. 1993; Blader et al. 1997; Ohayon et al. 1997a; Pilcher et al. 1997; Pilcher and Ott 1998; Paavonen et al. 2000). Some studies have shown that poor sleep quality has an even greater effect on daytime sleepiness than a small sleep quantity (Tynjälä et al. 1993; Pilcher et al. 1997; Pilcher and Ott 1998). The opposite finding has also been reported, where sleep continuation problems had no association with daytime sleepiness (Strauch and Meier 1988).

An association between parasomnias and daytime sleepiness has been reported. Nightmares have been found more in sleepy persons than in alert ones (Rimpelä and Rimpelä 1983; Ohayon et al. 1997b), and sleeptalking has been found to be associated with daytime sleepiness (Partinen and Putkonen 1980). Increased overall prevalence of sleep problems - including parasomnias - has been reported in children suffering from tiredness (Paavonen et al. 2000).

The most commonly mentioned parasomnias in association with daytime sleepiness are snoring and obstructive sleep apnea, both in adolescents (Billiard et al. 1987; Delasnerie-Laupretre et al. 1993; Ohayon et al. 1997a) and in children (Guilleminault et al. 1981; Carskadon et al. 1993a). It has also been shown that children's breathing disorders during sleep and insomnia may coincide, having a sum effect on daytime sleepiness (Owens et al. 1998).

Rarer sleep disorders that cause daytime sleepiness in children are narcolepsy (Challamel et al. 1994) and idiopathic hypersomnia (Billiard et al.

1998), which are usually more common in the adult population (Guilleminault and Dement 1977; Hublin et al. 1994; Billiard et al. 1998). Narcoleptic phenomenon of cataplexy has also been reported in adolescents and young adults suffering from daytime sleepiness (Partinen and Putkonen 1980; Billiard et al. 1987).

Somatic diseases. Although numerous studies on adults have shown an association between somatic diseases and daytime sleepiness (Gislason and Almqvist 1987; Hyyppä and Kronholm 1989; Fitzpatrick et al. 1991; Klink et al. 1994; Spierings and van Hoof 1997; Vir et al. 1997; Craig et al. 1998; Vgontzas et al. 1998), there exist only a few studies concerning children and adolescents (Rimpelä et al. 1982; Rimpelä and Rimpelä 1983; Bruni et al. 1997; Vignau et al. 1997). Not even any of these, on the other hand, concern the association between asthma and daytime sleepiness, although some of the adult studies do (Gislason and Almqvist 1987; Fitzpatrick et al. 1991; Klink et al. 1994; Vir et al. 1997). It is likely that a similar connection could also be found in young agegroups on the basis of asthma chronobiology (Martin and Banks-Schlegel 1998).

In adolescents with daytime sleepiness, more health problems and chronic diseases have in general been found (Rimpelä et al. 1982; Rimpelä and Rimpelä 1983; Vignau et al. 1997). Respiratory infections were more common in tired adolescents (Rimpelä et al. 1982). In a study concerning different forms of headache the children with tension type headache had more daytime sleepiness (Bruni et al. 1997).

Psychic disorders. Worries and a poor relationship with family have been found in adolescents with daytime sleepiness (Vignau et al. 1997; Vornanen 2000). Depression and anxiety have also been mentioned (Montgomery 1983; Ohayon et al. 1997a; Wolfson and Carskadon 1998), which may sometimes be a part of delayed sleep phase syndrome (DSPS) (Regestein and Monk 1995).

Daytime sleepiness has been reported in patients suffering from seasonal affective disorder (SAD) also described in children and adolescents (Rosenthal et al. 1984, 1986; Carskadon and Acebo 1993; Swedo et al. 1995; Sourander et al. 1999). Chronic fatigue syndrome includes the symptoms of depression and severe tiredness found in children and adolescents in some studies (Walford et al. 1993; Krilov et al. 1998).

Medication. Although the tiring effects of many drugs are well-known, relatively few studies exist on the topic, especially among younger agegroups. Most studies concern antihistamines, comparing the preparations passing the blood-brain barrier with those which do not.

Adult studies have shown consistently that antihistamine, entering the central nervous system, has a tiring effect (diphenhydramine, meclizine) while selective preparations (terfenadine, loratadine) have not (Roehrs et al. 1984; Roth et al. 1987; Manning et al. 1992; Murri et al. 1992; Witek et al. 1995). The only study concerning children compared two antitussive agents, one of which contained antihistamine (triprolidine) and also caused drowsiness while the other did not (Jaffé and Grimshaw 1983).

Other groups of drugs have not been commonly mentioned in association with daytime sleepiness. A few adult studies also having a clinical relevance to children have shown the tiring effect of carbamazepine (antiepileptic) and clonidine (antihypertensive) (Carskadon et al. 1989; Bonanni et al. 1997). The sedative effect of psychotropic flunarizine has been shown in a study investigating the prophylaxis of childhood migraine (Sorge et al. 1988).

The correlation between daytime sleepiness and medication is not always clear. It has been shown that the use of psychotropic medication is more prevalent in adolescents with depression and somatic complaints, which may also be associated with daytime sleepiness (Ledoux et al. 1994). Here the use of a drug is rather a consequence of symptoms than a cause.

Living habits. When evaluating the effect of living habits on daytime sleepiness most studies have paid a major attention to the use of alcohol and drugs, including cigarette smoking. A clear association between alcohol drinking and daytime sleepiness in young adults and adolescents has been found in many studies (Partinen 1982; Rimpelä et al. 1982; Rimpelä and Rimpelä 1983; Carskadon 1989; Hallman et al. 1992; Rahkonen et al. 1992; Tynjälä et al. 1997; Vignau et al. 1997; Lee et al. 1999). Cigarette smoking has also been associated with poor alertness (Partinen 1982; Rimpelä et al. 1982; Rimpelä and Rimpelä 1983; Carskadon 1989; Phillips and Danner 1995; Tynjälä et al. 1997; Vignau et al. 1997).

In the Finnish studies the use of drugs has not been evaluated. The American study (Carskadon 1989) reports more daytime sleepiness among marijuana and cocaine users than among non-users and in the French study (Vignau et al. 1997) non-specified drug use is more common in the adolescents needing more sleep than in the adolescents with sufficient sleep.

The use of stimulants (coffee, tea, caffeinated beverages and pills) is more common in adolescents with alertness problems (Carskadon 1989; Phillips and Danner 1995; Ohayon et al. 1997a; Tynjälä et al. 1997; Vignau et al. 1997; Taillard et al. 1999). The use of them makes the early wake-up time possible but, on the other hand, also supports being awake late at night.

The effect of a part-time job in addition to school work has been evaluated in America, and serious sleepiness was found in the adolescents working a lot in their spare time (Carskadon 1989). In that study other leisure time activities also contributed to daytime sleepiness. In a Finnish study, where daytime sleepiness was one of the psychosomatic symptoms to be evaluated, there was no association between the symptoms and physical leisure time activities (Rimpelä et al. 1982). Adolescents exhibiting with antisocial behaviour have been found to need more sleep (Vignau et al. 1997).

Social background. There are quite few and controversial results from studies investigating the effect of the socioeconomic status of a family on a child's daytime sleepiness. In Finland, the greatest alertness has been found in the children of agricultural families and the poorest alertness in children of upper middle class families (Rimpelä and Rimpelä 1983), while in USA the sleepy schoolchildren were more often from lower socioeconomic background (Simonds and Parraga 1982).

Consequences of daytime sleepiness

The many somatic and psychic symptoms described above may as well be seen as a consequence of daytime sleepiness. The point is that in the epidemiological studies the direction between associations is open to interpretation. The following chapters introduce findings which can be clearly seen as consequences of daytime sleepiness.

Effects on cognitive and emotional behaviour. In the studies evaluating the effect of artificial sleep loss in young adults impaired cognitive performance has been found after sleep deprivation (Carskadon and Dement 1979; Wimmer et al. 1992; Pilcher and Walters 1997). However, the sleep deprived group evaluated their performance and concentration higher than the controls (Pilcher and Walters 1997) which showed that the awareness about their own situation was not realistic.

Cognitive function in adolescents after sleep restriction was evaluated in the American study (Randazzo et al. 1998). The main finding was that especially higher cognitive functions, i.e. verbal creativity and abstract thinking, was impaired after a single night of restricted sleep while routine performance was relatively well maintained.

The alteration in emotional behaviour has been described in adults (Carskadon and Dement 1979), adolescents (Wolfson and Carskadon 1998) and children

(Dahl 1996; Owens et al. 1998). The tired children were irritable and easily frustrated and had difficulties in controlling their emotions (Dahl 1996).

Effects on educational achievements. Impaired performance at school and college has been found in some studies on young adults (Montgomery 1983; Lack 1986) and children (Gozal 1998). On the other hand, in a Finnish study no connection was found between daytime sleepiness and chosen educational institution (vocational school or college) in 15-year-old adolescents (Tynjälä 1992).

Effects on traffic. Some studies consider the effect of daytime sleepiness on traffic accidents. It has been found that children causing accidents as pedestrians or cyclists had more vigilance problems than the control children (Pless et al. 1995). In a study on adolescents the most tired participants were at greatest risk of falling asleep while driving a car (Carskadon 1989). The clear association between traffic accidents and sleep disorders with daytime sleepiness has been shown in adult patient groups (Shapiro and Dement 1993).

AIMS OF THE STUDY

The following aims were set for the present study:

1. To evaluate the epidemiology of sleeping habits, sleep disorders and daytime sleepiness, and their evolution in schoolchildren.

2. To study how these are associated with the subjective feeling of daytime sleepiness (SDS).

3. To do a follow up of the evolution of SDS and find out what predicts the persistence of SDS.

4. To ascertain the influence of living habits and state of health on SDS.
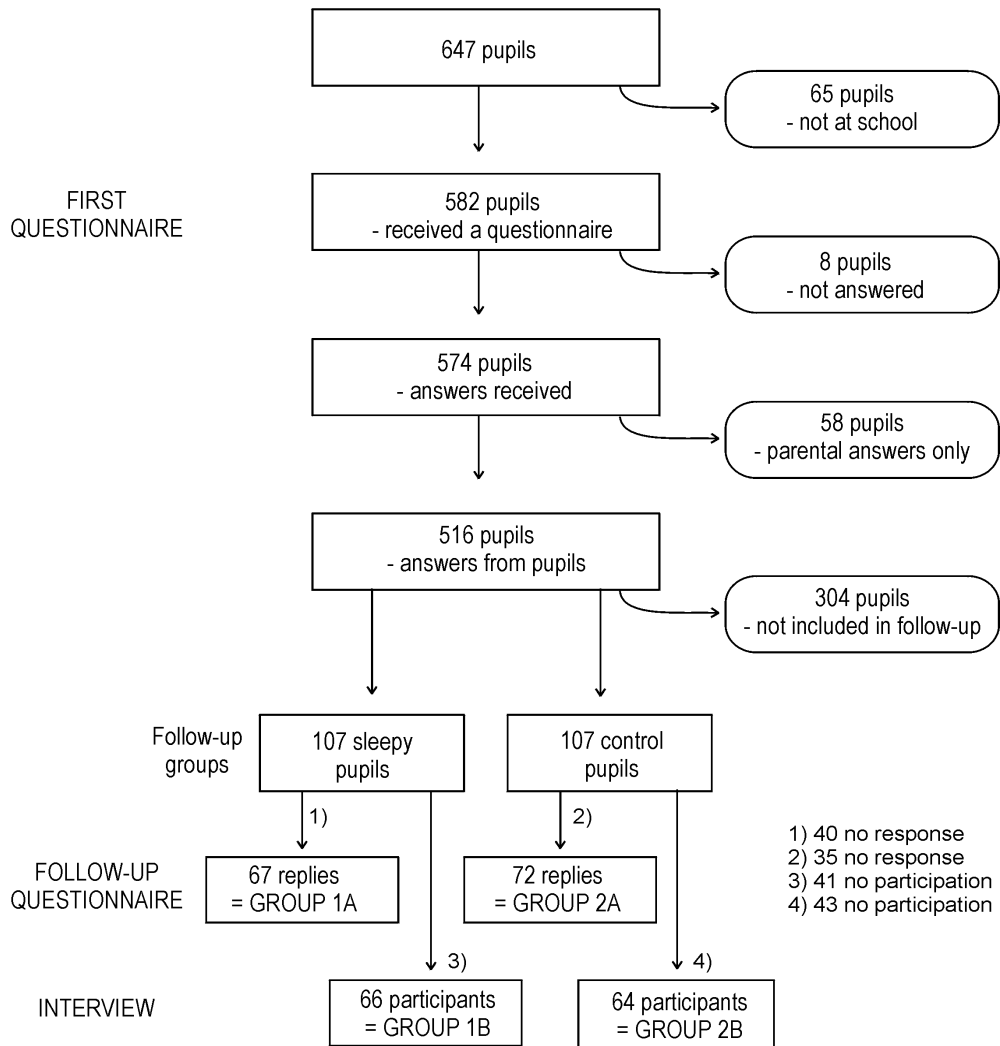
SUBJECTS AND METHODS

Subjects

The sleep and daytime functioning of schoolchildren was the target of the study for which the schoolchildren were chosen from two schools in Tampere, Finland. The schools were selected by the school authorities on the basis of their social re-presentativity. The study was to include the age range covering primary school and secondary school. In the primary school there were 244 pupils in the first six grades aged 7-13 years and in the secondary school 403 pupils aged 13-17 years in the seventh, eighth and ninth grades. There were 114 boys and 130 girls in the primary school and 179 boys and 224 girls in the secondary school. There were music classes in the both schools (110 pupils) and a special class for adolescents with behavioural problems in the secondary school (24 pupils). The parents of the schoolchildren were also asked to take part into the study.

Study design

The study design is described in Figure 1. where the numbers of participants in the different phases of the study series are shown. The first questionnaires were distributed in the schools to 582 pupils and their parents out of a total of 647 in 1988. The children who were away from school on the day the questionnaire was distributed did not complete the questionnaire. The questionnaire was answered at school except for the first and the second-grade pupils. Parental questionnaires were sent simultaneously to the children's homes. The data were gathered from 574 schoolchildren, either the answers from themselves and/or from the parents.

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Figure 1. Study Design

The follow up questionnaires were sent after two years (1990) to the 107 adolescents who had reported being sleepy during daytime and 107 control adolescents who had no daytime sleepiness. The same groups were invited to an interview three years after the first questionnaire (1991).

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Questionnaires

The questionnaires used in the study series are available from the author. These questions have been used previously for adults (Partinen 1982; Hyyppä and Kronholm 1987) and children (Rintahaka and Uusikylä 1987). The first and second questionnaires consisted of the child's form and the parental form. The questions of the interview were based on these questionnaires but new questions were added and the parents were not interviewed. In addition, bedtimes and wake-up times were not elicited but sleeping time on weekdays and at weekends were directly ascertained. Subjective daytime sleepiness (SDS) was inquired from the participants with a question 'Are you sleepy during daytime'. The participant was interpreted to have SDS if the answer was 'always' or 'often' in the questionnaire studies or 'at least three days per week' in the interview. The other questions used in the questionnaires and in the interview are presented more detail in the original publications.

Physical examination

The physical examination of the participants was done at the time of the interview by the interviewer. It included weight, height, pubertal status according to Tanner (Tanner 1962), auscultation of the heart and lungs, blood pressure measurement, laryngological status, stomach palpation, and neurological items.

Data management

Several dichotomising and categorising processes were carried out in each study before the statistical procedures. These processes are described in greater detail in each original publication. Social class is determined according to a Finnish classification (Classification of trades 1976).

Statistics

The computation of the data was carried out using BMDP Statistical Software (versions 1988 and 1990) on a SUN/UNIX mainframe.

Basic analysis of the first questionnaire (I)

In the basic analysis of the first questionnaire study sleeping habits, sleep disorders and daytime sleepiness were compared between the genders and the different agegroups, and also between the children's and the parents' answers. Statistical analysis was made by comparison of means using Student's t-test and analysis of cross-tabulations using χ^2.

SDS in the first questionnaire (II)

The evaluation of SDS was begun with the comparison of the child's and the parents' answers. The relationship between the subjective feeling of sleepiness and the objective phenomena of sleepiness (wake-up difficulties, daily sleep urge, napping, sleeping in lessons, sleeping while watching TV, sleeping in the car) were further evaluated with factor analysis.

In the analysis of daytime sleepiness and related predictors the associations between daytime sleepiness and different variables were studied at first with bivariate analysis (cross-tabulations). The significant variables (limit p<0.09) were arranged into conceptually related blocks for the further multivariate analysis (log linear modelling). In this method three variables at a time from the different blocks were analysed with daytime sleepiness, and the results were formed from the several successive analyses. If several variables in the block were significant in these analyses (limit<0.05) a new variable was formed by combining all the

significant variables in the block. If the variables in the block were strongly correlated only the most significant of these were included in the new variable. The significant variables were studied in greater detail by standardised and Freeman-Tukey deviates. The fit of the model was tested by deleting and regrouping variables. The goodness-of-fit of the model was measured with likelihood ratio chi-square where high p-value indicates a satisfactory fit. The results were further interpreted by odds ratio (OR) with 95% confidence interval. The modelling was carried out in two settings: 1) children's data only (larger number of cases) and 2) data from both children and their parents.

SDS in the follow-up questionnaire (III)

At first the bivariate analyses were carried out separately among those pupils who had had SDS (Group 1A) and among the controls (Group 2A) in order to find out which variables were related to the change in SDS. A comparison was also made between those in Group 1A who still had SDS and those in Group 2A who still had no SDS. A p-value of ≤ 0.1 was chosen as the significance limit because of the small sample size.

The second goal of the follow-up was to find out which variables were associated with SDS in the multivariate analyses. Here the adolescents with SDS in the follow up (both from Group 1A and Group 2A) were compared with those who did not have SDS at the moment. The significant associations between SDS and the variables were at first searched for by logistic regression. After that the remaining significant variables were further tested in log-linear modelling, which was carried out according the same principle as in the analysis of the first questionnaire.

A comparison between those who answered and those who did not answer the follow up questionnaire was also made (Pearson's chi-square).

SDS in the interview (IV)

At first SDS and its associations were searched for bivariately by Pearson's chi-square. Here the groups of adolescents with SDS in the first questionnaire (Group 1B) and the control adolescents (Group 2B) were combined, and SDS was studied as it occurred in the interview regardless of the original SDS status. After that the significant variables (limit p-value 0.09) were further analysed multivariately to find out the most significant predictors for SDS using logistic regression. The odds ratio (OR) and 95% confidence interval were calculated.

The second part of the analysis included the evaluation of chronic SDS. In this analysis the children with chronic SDS (SDS present in each survey) were compared with those who had been constantly alert. The odds ratio (OR) and 95% confidence interval was calculated.

Finally the comparison between those who had taken part in the interview and those who had not was made separately in Groups 1B and 2B. Pearson's chi-square was used for the analysis.

Ethics

The ethical validity of the first and the follow-up questionnaires was evaluated by the school authorities. The interview study was approved by the Ethical Committee of the local health centre. The permission of the parents was obtained for participants under 18 years of age.

RESULTS

More detailed data is presented in the text and the tables of the original publications.

Basic analysis of the first questionnaire (I)

Answers were received from 574 (88%) children: 277 boys (48%) and 297 girls (52%). Their distribution was as follows: first and second grade (younger preadolescent group) 56 (10%; age range 7.4-9.3, 23 boys and 33 girls), older preadolescent group 161 (28%; 9.4-13, 73 boys and 88 girls) and adolescent group 354 (62%; 13.1-17.1, 178 boys and 176 girls). The number of replies from music classes was 84 (15%; 24 boys and 60 girls) and behavioural classes 22 (4%; all boys).

There were 459 (71%) parental replies including 455 mothers and 394 fathers. There were 115 pupils (20%) without any parental reply and 58 pupils (10%) with parental reply only. The demographic data of the families is presented in the first original publication.

The parents' views of their children's sleeping habits, sleep disorders and daytime sleepiness pattern were similar and statistically well in agreement with the children's answers. Only in the categories '*always*' and '*often*' there was some variation in the evaluation of sleep disorders and daytime sleepiness.

According to the parental answers there were no differences between boys and girls in the younger preadolescent group in sleeping habits, sleep disorders or daytime sleepiness. The habits were very regular as most children had their bedtime

before 10 p.m. and wake-up time before 7 a.m. even at weekends. Sleep disorders occurred mostly occasionally and daytime sleepiness did not occur at all in categories 'always' or 'often'.

Sleeping habits were compared between the older preadolescent group and the adolescent group according to the children's own answers. Bedtime (all days of the week included) was significantly later in the adolescent group than in the preadolescent group (nearly half of the adolescents on weekdays and over 80% at weekends went to bed after 10 p.m. though less than 10% of the preadolescents on weekdays and 60% at weekends did the same). The same applied to wake-up times at weekends (less than 10% of the preadolescents woke up after 10 a.m. but almost 30% of the adolescents did so). The adolescents' sleeping time was shorter than the preadolescents' both during the week and at weekends. There were sex differences in bedtime and wake-up time during the week which were earlier in girls than in boys.

Some sleep disorders were different between sexes and agegroups. The girls reported more dreaming than the boys. The preadolescent girls woke more during the night than the boys or the adolescent girls. The adolescent boys snored more than the girls of same agegroup and more than the younger agegroup of boys.

Differences between boys and girls were found in all daytime sleepiness items. Daytime sleepiness was more common among the adolescent girls but wake-up difficulties were more common among the adolescent boys. The adolescent boys reported daily sleep urge more often. Napping was more frequent in the preadolescent girls than the boys of the same age. The boys slept more often in the lessons than the girls.

Differences related to age were found in daytime sleepiness, napping and sleeping in lessons. Daytime sleepiness and napping were more frequent among the adolescents, and sleeping in lessons was more common among the adolescent than the preadolescent girls.

When the reported sleeping habits and sleep disorders were compared between the parents and children the only positive correlation was between daytime sleepiness of children and daily sleep urge of fathers.

SDS in the first questionnaire (II)

In this study only those children who returned their own questionnaire and thus answered to the question concerning SDS (516 out of 582, 89%) were taken into the analysis. Of the parents of these children 398 of the 582 mothers (68%) and 345 of the 582 fathers (59%) returned their questionnaires. One hundred and seven children (21% of the answers) reported SDS. In factor analysis the question of daytime sleepiness correlated strongly with daily sleep urge, napping, wake-up difficulties and sleeping in the car.

The variables which were significantly related to SDS in bivariate analysis were child's age, grade in mathematics, video watching, bedtimes all days of the week, wake-up times at weekends, sleeping time on weekdays, sleep latency, night waking, insomnia, sleeptalking, dreaming, mother's sleep quality, father's sleep urge, insomnia, social class and educational level.

In the multivariate analysis of the children's data only (Model 1, 397 completely answered) sleeping habit variable (sleeping time on weekdays and bedtime on Saturdays), sleep disorder variable (sleep latency, night waking, insomnia, sleeptalking, dreaming) and time spent watching videos came out as predictors for SDS. The fit of Model 1 was p=0.44. The model showed that the children with SDS had poorer sleeping habits: sleeping time ≤8.5 hours on schooldays and /or bedtime >24 hours on Saturdays. They also had more sleep disorders: long sleep latency, night waking, insomnia, sleeptalking and dreaming. The children with SDS spent more time watching videos. The sleeping habit predictor and the video watching predictor were significantly associated.

In the multivariate analysis of the combined data of children and their parents (Model 2, 312 complete cases) child's sleep disorder variable (sleep latency, night waking, insomnia, sleeptalking, dreaming), parents' sleep disorder variable (mother's sleep quality, father's sleep urge and insomnia) and father's social class came out as predictors for the SDS in Model 2. The fit of model 2 was p=0.896. The model showed that the children with SDS had parents who also had sleep disorders. Their mothers had poorer sleep quality and fathers had more sleep urge and insomnia. Their fathers were also more likely to be entrepreneurs. The children also had more sleep disorders themselves in Model 2.

SDS in the follow-up (III)

Replies were received from 143 adolescents (67%): 68 from Group 1A (64%) and 75 from Group 2A (70%) (Figure 1.). The age varied from 12 to 19 years (mean 15.8 years) in Group 1A and from 12 to 20 years (mean 16.1) in Group 2A. There were 28 boys and 40 girls in Group 1A, and 31 and 44 in Group 2A respectively. Four participants were excluded because of incomplete data. In Group 1 SDS was still present in 36 / 67 pupils (54%) and in Group 2 20 / 72 pupils (28%) had acquired SDS. Parental replies were received from 133 mothers and 113 fathers.

The persistence of SDS in Group 1A was associated with older age, shorter sleeping time during the week, later bedtime on weekdays and Fridays, later wake-up time on Sundays and more frequent night waking when adolescents with persistent SDS were compared with those who had become alert. In Group 2A the adolescents with SDS had a higher average grade at school (AG) than those who were still alert.

When comparing those having SDS in both phases of the study (SDS+ in Group 1A) with those consistently alert (SDS− in Group 2A) the first mentioned group had shorter sleeping time during the week, later bedtime during the week and

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Fridays, later wake-up time on Saturdays and Sundays, more frequent night waking, and more fathers with insomnia and poor sleep quality than the latter, constantly alert group.

In further analysis, the following nine significant variables were found in the logistic regression: the adolescents' bedtime during the week, Fridays and Saturdays, night waking and AG, the mother's educational level, sleeping time on working days, night waking and snoring. When the analysis was continued with log linear modelling three predictors were finally found from these: adolescents' sleeping habit predictor (bedtime during the week and on Fridays) and AG, and mothers' educational level (Table 1).

Table 1. SDS and the predictors of the multivariate model (sleeping habit, average grade = AG, mother's education) in cross-tabulation with odds ratio (OR) and 95% confidence intervals (CI).

PREDICTORS		SUBJECTIVE DAYTIME SLEEPINESS					
		SDS +	SDS −	total			
		N (%)	N (%)	N		OR	95% CI
SLEEPING	1	13 (28)	43 (60)	56	1 vs. 2	3.47	1.45-8.30
HABIT[x)]	2	21 (46)	20 (28)	41	2 vs. 3	1.27	0.440-3.66
	3	12 (26)	9 (12)	21	1 vs. 3	4.41	1.52-12.8
	total	46 (100)	72 (100)	118			
AG	< 8.0	16 (35)	42 (58)	58		2.62	1.22-5.65
	≥ 8.0	30 (65)	30 (42)	60			
	total	46 (100)	72 (100)	118			
MOTHER'S	lower level	24 (52)	50 (69)	74		2.08	0.969-4.48
EDUCATION	upper level	22 (48)	22 (31)	44			
	total	46 (100)	72 (100)	118			

[x)]1 = bedtime ≤ 10.30 p.m. during the week and bedtime ≤ 12 p.m. on Fridays
  2 = bedtime > 10.30 p.m. during the week or bedtime > 12 p.m. on Fridays
  3 = bedtime > 10.30 p.m. during the week and bedtime > 12 p.m. on Fridays

The children with SDS had later bedtimes during the week and on Fridays, their AG was better and their mothers had a higher educational level than their alert peers. The fit of the model was p=0.457. These predictors had complicated additional mutual associations: SDS was connected to late bedtime especially among those with better AG, those with better AG more often had mothers with higher educational level and those with later bedtimes more often had mothers with lower educational level.

In both Group 1A and 2A the participants were more often girls, were younger, and had earlier bedtime and longer sleeping time during the week than those who did not take part in the follow-up. In addition, in Group 1A the participants had earlier bedtime on Saturdays, watched less TV, had higher AG and had fewer fathers with their own enterprise than the non-participants.

SDS in the interview (IV)

A total of 130 adolescents (61%) took part in the interview : 66 participants (62%) from Group 1B and 64 (60%) from Group 2B (Figure 1.). There were 26 boys and 40 girls in Group 1B, and 25 boys and 39 girls in Group 2B. The mean age in Group 1B was 16.4 years and 16.5 years in Group 2B (range from 12 to 19 years).

At the interview 42 adolescents had SDS and 88 had not. Of the adolescents in Group 1B 32 out of 66 (48%) still had SDS and 54 out of the 64 adolescents (84%) in Group 2B were still alert. There were 20 adolescents who had had SDS in both questionnaires and in the interview (chronic SDS); 37 adolescents had been constantly alert.

In bivariate analysis the following significant associations with SDS were found: the adolescents with SDS napped more, had more frequent daytime sleep urge, insomnia, difficulties in falling asleep, night waking, snoring, dreaming,

illness, medication, depressive feelings and irregular breakfast eating than the adolescents without SDS.

In multivariate analysis all significant variables were used except napping and daytime sleep urge, which were not considered to cause SDS, but to be caused by it. In logistic regression sleep disorders, depressive emotions, irregular breakfast eating and permanent medication were significantly more common among sleepy schoolchildren. Goodness of chi-square fit was p = 0.712.

Comparing the adolescents with chronic SDS with the constantly alert adolescents napping, difficulty in falling asleep, night waking, dreaming, medication, alcohol drinking and irregular breakfast eating were significantly more common among those with chronic SDS. When the results from the previous questionnaire studies in these two subgroups were compared, the following significant differences were found: chronic SDS was associated with later wake-up times on Saturdays and Sundays (both questionnaire studies), later bedtime during the week (the first questionnaire) and Fridays (the second questionnaire), shorter sleeping time during the week (the first questionnaire), more night waking (the first questionnaire) and difficulty in falling asleep (the second questionnaire).

The significant differences between those who took part in the interview and those who did not were as follows in Group 1B: the non-participants were older, had later bedtime on weekdays, watched more TV, had poorer performance at school and napped more. In Group 2B the non-participants were older, had later bedtime during the week and at weekends and later wake-up time on Saturday, had poorer performance at school and napped more.

DISCUSSION

Subjects

The schools chosen for the study were evaluated to be socially representative. They were in the same district, and the children from the primary school usually continued in the secondary school used in the study. The uneven number of schoolchildren in these two schools was due to the fact that in the secondary school there were also pupils from other parts of the city.

Although the questionnaire was given to all pupils the children in the first and second grade did not answer by themselves. We assumed that their ability to read and write would not be good enough to complete a long questionnaire. Because we selected the children for the follow-up according to their own answers about daytime sleepiness the children from the two first grades were dropped. However, according to the parental evaluation, none of them had daytime sleepiness in categories 'always' or 'often'.

Questionnaires

The questionnaires used in the first study and in the follow-up study were based on the questions used in earlier Finnish studies (Partinen 1982; Hyyppä and Kronholm 1987; Rintahaka and Uusikylä 1987). It was important to use Finnish questions validated in our population and not to translate the questions from e.g. English questionnaires. Thus the questions used can be considered to be valid in this study.

The questions used in the interview remained the same concerning the sleep disorders but sleeping habits were evaluated by a direct question about sleeping time. New items about living habits and health were formed for this interview.

The answer alternatives in the first and the follow-up questionnaires were 'always / often / sometimes / never'. This may lessen the accuracy of the answers because each category could be interpreted differently by participants. The exact definition of each category based on times per week was thus used in the interview.

Epidemiology of sleeping habits, sleep disorders and
daytime sleepiness pattern

The most noteworthy finding in the first questionnaire study was the change of sleeping habits during puberty as has been reported in many other studies (Anders et al. 1978; Lugaresi et al. 1983; Rimpelä and Rimpelä 1983; Kirmil-Gray et al. 1984; Rugg-Gunn et al. 1984; Lack 1986; Strauch and Meier 1988; Szymczak et al. 1993; Tynjälä et al. 1993). Longer sleeping time at weekends was a common phenomenon in both younger and older groups but the shift of the weekend rhythm was a typical finding especially in the older group. Differences between genders were found in bedtimes and wake-up times, girls having earlier rhythm, which has also been reported previously (Rugg-Gunn et al. 1984; Macgregor and Balding 1988b).

There were some interesting gender differences concerning sleep disorders and phenomena. The girls reported more dreaming than the boys, which has also been reported previously (Simonds and Parraga 1982; Rintahaka and Uusikylä 1987; Nielsen et al. 2000). Night waking was more common among the preadolescent girls than in other subgroups, also including the adolescent girls. The same trend has been mentioned by some other authors (Welstein et al. 1983; Macgregor and Balding 1988b; Fisher et al. 1989). The third significant finding

about sleep disorders was the increasing prevalence with age of snoring in boys. The girls did not exhibit the same phenomenon. Changes in testosterone levels during male puberty could explain the difference, which is reported later in life (Sandblom et al. 1983).

Daytime sleepiness pattern included seven questions: daytime sleepiness (subjective feeling), wake-up difficulties, daily sleep urge, napping, sleeping in lessons, sleeping in the car and sleeping while watching TV. As a whole, daytime sleepiness, daily sleep urge, napping and sleeping in lessons were more common in the adolescent group. The prevalence of excessive daytime sleepiness in children and adolescents has varied between 0–35% in epidemiological studies depending on the agegroups studied (Anders et al. 1978; Partinen and Rimpelä 1982; Simonds and Parraga 1982; Lugaresi et al. 1983; Levy et al. 1986; Billiard et al. 1987; Morrison et al. 1992). The increase in daytime sleepiness during puberty is quite a universal finding (Carskadon et al. 1980; Lugaresi et al. 1983; Tynjälä et al. 1993). However, the differences between genders have been reported less often (Welstein et al. 1983; Tynjälä et al. 1997). In the present study these were controversial. The girls reported to have more daytime sleepiness while the boys reported more daily sleep urge and sleeping in lessons. Thus it seems that the girls reported more subjective feelings of sleepiness but the boys had more objective signs of serious tiredness. Whether this means that girls have more mild sleepiness than boys or that boys are just more straightforward in answering the questions remains unresolved. In fact, it can be seen through all the questions that the girls used the answer category 'sometimes' more frequently than boys, and the boys answered more commonly in the categories 'always' and 'never'.

The parents' and children's answers were quite concordant. However, some logical differences could be seen in the evaluation of sleep disorders. Disorders which were hard to evaluate personally (sleeptalking, sleepwalking, snoring, bruxism) were reported more commonly in parental answers. As a whole, the

reliability of the children's answers was good when a concordance to the parental answers was used as a measurement.

Predictors for subjective daytime sleepiness

First questionnaire

The aim of the first questionnaire study was to give emphasis to the subjective feeling of daytime sleepiness compared to the more objective findings (daily sleep urge, napping, wake-up difficulties, sleeping in car, sleeping while watching TV, sleeping on lessons). However, a clear correlation was found between daytime sleepiness and the first four of the latter parameters.

The multivariate method was chosen as a statistical tool in the analysis in order to form a total view of subjective daytime sleepiness (SDS) and its predictors. Combining the variables of similar aspects to group variables was necessary. In log linear modelling the number of variables used reliably in an analysis is limited depending on the size of the material. However, it was not practical to group all significant variables, and some choices were made between the significant variables. In the selection process those significant variables were left out which clearly represented the same thing as other variables having more powerful significance.

The most difficult choice was made between the sleeping habit variable, age and video watching. Each of these was a significant predictor for SDS and they had also a significant association with each other. Age was left out because we interpreted poor sleeping habits and long video watching time to be consequences of pubertal age; thus age effected SDS secondarily. However, this can be criticised on the basis of the previous studies (Carskadon et al. 1980, 1993b, 1998). It has been claimed that daytime sleepiness increases during puberty regardless of

sleeping time, and circadian melatonin rhythm shift to later at night along with pubertal development thus causing delayed sleep phase.

The age distribution of SDS was unexpected. SDS was almost as common in the third grade pupils (9−10 yrs) as in the seventh, eighth and ninth grades (13−17 yrs), although previous studies have reported daytime sleepiness to be very rare among preadolescents (Anders et al. 1978; Palm et al. 1989). One possible explanation is that in Finland the length of schooldays and the amount of homework increases in the third grade. The questionnaire was answered at the end of the term (May), thus perhaps adding a stressful effect of a hard school year.

The analyses in the two subgroups (the children's answers only and the parental and children's answers together) were chosen because in the former case the number of the answers analysed was larger. The results differed in these two subgroups. It is possible that the children whose parents did not take part in the study had different causes for their daytime sleepiness than the others.

The sleep disorder predictor was strongly related to SDS. It was one of the predictors in both subgroups. Three of the single disorders (sleep latency, insomnia and night waking) clearly caused poor sleep quality, and the association to daytime sleepiness is easy to comprehend. An association between daytime sleepiness and poor sleep quality has been frequently reported (Price et al. 1978; Lugaresi et al. 1983; Kirmil-Gray et al. 1984; Billiard et al. 1987). Sleeptalking and dreaming (which is rather a sleep phenomenon than a disorder) are more rarely related to the symptom (Partinen and Putkonen 1980; Rimpelä and Rimpelä 1983). Dreaming may cause poor sleep quality if the contents are emotionally distressing as in nightmares. The prevalence of nightmares was not separately elicited in our questionnaire. Sleeptalking has been considered quite a harmless phenomenon but in some studies it has been reported that sleeptalking occurs together with a poor sleep quality (Salzarulo and Chevalier 1983; Kahn et al. 1989).

It was not surprising that children with SDS slept less during the week than their more alert peers. This was caused by later bedtime. They also had later

bedtime and wake-up time at weekends, thus leading to greater irregularity in their weekly sleep rhythm than in the schoolchildren with no SDS. In the study by Billiard et al. (1987) the irregular sleep/wake schedule was also more common in subjects with daytime sleep episodes than in subjects without them. The delayed sleep phase syndrome has also been found to be connected to irregular sleeping time (Thorpy et al. 1988).

According to our study SDS, older age, insufficient sleep and excessive time spent with video were associated with each other. The irregular sleeping habits of teenagers have also been detected in other studies (Lugaresi et al. 1983; Kirmil-Gray et al. 1984; Levy et al. 1986; Strauch and Meier 1988; Tynjälä et al. 1993). Video watching is not often mentioned in the literature in association with daytime sleepiness although the effect of watching TV on sleep has been evaluated and controversial results have been obtained (Weissbluth et al. 1981; Tynjälä and Kannas 1993; Owens et al. 1999). It seems that in older schoolchildren the life style changes: they go later to bed and, at least partly, spend their time watching video. Surely their life style also includes other items but in this questionnaire there were no further questions about living habits. Probably video watching would not be so important in nowadays because the developing computers have greatly changed the lives of children and adolescents during the 1990s.

The association between the child's SDS and the parental sleep problems could be explained according to the literature by psychological stress in the family or genetic effect. Kahn et al. (Kahn et al. 1989) found that boys with poor sleep quality had fathers with the same problem more often than the controls. In a Finnish study (Partinen et al. 1983b) self-reported sleeping data from monozygotic and dizygotic twins indicated a significant hereditary effect on sleep length and sleep quality. Psychological stress may also be an explanation for SDS of the children of entrepreneur fathers. In an adult study of Partinen and Rimpelä (Partinen and Rimpelä 1982) daytime sleepiness is also reported most frequently among the retired, unemployed and entrepreneurs.

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Follow-up questionnaire

The main focus in the analysis of the follow-up questionnaire was on the persistence of SDS. On the basis of the earlier study (Strauch and Meier 1988), it was expected that only half of the schoolchildren having SDS in the first questionnaire still had it. On the other hand, part of the control group reported SDS. Thus the group with SDS in the follow-up questionnaire was not the same as the group with SDS two years earlier.

Because the number of participants in both Group 1 and 2 was relatively small it was not possible to use multivariate techniques in separate analyses of the groups. However, we wanted to evaluate if the multivariate models found in the first questionnaire were valid in the follow-up study, too, and thus analysed the predictors of SDS among those who had the symptom at the moment of the follow-up.

The age differed significantly in Group 1 between those who still had SDS and those who did not. In the older agegroups the persistence was higher than in the younger agegroup. In fact, in the youngest agegroup all had become alert. Thus puberty did not explain their tiredness because the tiredness disappeared when they approached pubertal age. The disappearance of SDS gives support to our interpretation that SDS in the third grade was caused greatly by intensified schoolwork itself.

The sleeping habits were the most important predictors of the persistence of SDS. The participants still having SDS had later bed going time during the whole week and later wake-up time at weekends, and their sleeping time during the week was shorter than those who no longer had SDS. In the follow-up questionnaire sleeping habits were also one of the predictors for SDS. Thus, sleep lack seems to have a remarkable role in causing daytime sleepiness.

Night waking was the only sleep disorder having an effect on the persistence of SDS. It was also vaguely associated with SDS bivariately in the

follow-up but was dropped out in the final multivariate analysis. The lack of associations between SDS and sleep disorders was a surprise because they were found to be very strong in the first questionnaire.

High AG emerged as a predictor both in the multivariate analysis of the follow-up study and in the analysis of SDS in Group 2. It seems that there was a subgroup of schoolchildren who had got SDS as a consequence of hard schoolwork. Further support for this interpretation comes from the finding that later bed going times were significantly associated with SDS in the schoolchildren with better AG but not in the group with lower grades. Thus it seems that there is a group of schoolchildren who are studying at the cost of their night sleep. There was also an association between AG and the mother's educational level. Better AG was more common among the children with highly educated mothers. Therefore, it is possible that the demand for success at school is greater in well-educated families.

Paternal sleep problems were found to have an association with persistent SDS when those having SDS in both studies were compared to those who had no SDS in either of the studies. This finding was similar to that in the first study, where parental sleep disorders were found to be associated with SDS. The most probable explanation may be a genetic predisposition to poor sleep quality.

Interview

In the interview the first aim was also to collect data on the living habits and health of the adolescents. It was hypothesised that the use of stimulants, many daily activities and poor physical and mental health would also cause daytime sleepiness. Clinical examination was done especially in order to identify possible signs of obstructive sleep apnea syndrome (narrow pharynx structures, obesity and high blood pressure).

The main finding was the association between SDS and the sleep disorder predictor which included five disorders or phenomena (snoring, insomnia, night waking, difficulty in falling asleep) disturbing the quality of sleep in different ways. This finding concurred with the results in the first questionnaire but not the results in the follow-up questionnaire. The contradiction is not easy to understand, though the variation in the answers and in the participants could explain some of it. The interesting finding is that snoring has become significantly associated with SDS during the whole follow-up, which could mean that its clinical importance increases during adolescence.

Problems in physical and mental health were associated with the risk of SDS. The connection with medication was especially clear. The medications used were the same among both sleepy and alert adolescents. The most common drugs were for allergy, although the distribution was heterogeneous. Unfortunately, the sedative property of antihistamines was in most cases unknown. However, most adolescents who remembered the name of their antihistamine used non-sedative terfenadine which was available without prescription at the time of the study. Thus it is probable that also those who did not remember the name of their medication were also using terfenadine. It is therefore probable that SDS was associated with illnesses that were severe enough to require regular medication, not to the medication itself. The connection between daytime sleepiness and chronic illness has been formerly described in the literature (Vignau et al. 1997). At the time of the interview (May) allergic symptoms were at their annual peak because in May birches bloom in Finland.

Depressive mood was a significant predictor to SDS, although its prevalence was not very high. Almost all the adolescents suffering from depression often also had SDS. The finding was to be expected and has been formerly described both among adolescents (Morrison et al. 1992; Vignau et al. 1997) and adults (Claghorn et al. 1981; Montgomery 1983; Ford and Kamerow 1989).

The second aim in the interview was to evaluate the persistence of SDS. There were only 20 adolescents who reported SDS both in the questionnaire studies and in the interview. The predictors in this subgroup were mainly the same (napping, dreaming, difficulty in falling asleep, night waking, medication, irregular breakfast eating) as in the analysis of SDS in the interview. However, drinking alcohol was significantly more common among these adolescents than among the constantly alert adolescents. No other connections between alcohol and SDS were found. Because this question was not included in the questionnaire studies we do not know if drinking had been a long-term habit among these adolescents.

Conclusions

The following conclusions can be drawn from the present study: *1)* Sleeping habits changed dramatically during the puberty. Bedtime became later, and also the wake-up time, but the latter only at weekend. *2)* Daytime sleepiness also increased during puberty, although it was not totally uncommon in prepuberty. *3)* Poor sleeping habits leading to lack of sleep were clearly associated to daytime sleepiness. *4)* Sleep disorders, in particular those which cause poor sleep quality, were one reason for daytime sleepiness. *5)* Poorer physical and mental health was associated with daytime sleepiness. *6)* The use of stimulants was more vaguely associated with daytime sleepiness than expected. *7)* Parental sleep problems related to daytime sleepiness of the child may indicate either genetic or social influence. *8)* Daytime sleepiness was not a very permanent symptom although it was quite common. *9)* There were, however, 20 adolescents who had a feeling of subjective daytime sleepiness through every step of the study. *10)* As the data of this follow up study were collected a decade ago, the results concerning living habits might be somewhat different today.

In the future, more accurate methodological procedures should be developed for daytime sleepiness studies. More extensive follow-up studies are needed, in which schoolchildren in various cultural environments can be compared . The effect of season and latitude on daytime sleepiness also needs more studies. Finally, school health care professionals should actively search for those school-children who continuously have problems with alertness.

SUMMARY

Sleeping habits and sleep disorders in schoolchildren have been an object of interest in recent decades. However, epidemiological studies are few in Finland. The epidemiology of daytime sleepiness and its causes in the same agegroup have also been increasingly studied. It seems clear that changes have occurred in sleep behaviour and daytime alertness as a whole which may be a consequence of the life style of modern society.

In this study sleeping habits, sleep disorders and daytime sleepiness in schoolchildren were epidemiologically researched. Two questionnaire studies and one interview study were conducted over a period of three years (1988-1991) among schoolchildren in two schools in the city of Tampere, Finland. The questionnaires were answered by children and their parents; only children took part in the interview study.

The first questionnaire was given to children aged 7 to 17 years. The children from the first and the second grades did not answer themselves but parental replies were gathered. Both parents' and children's answers were received from the older agegroups. Replies were obtained from 574 children.

The main result concerning sleeping habits was the delay in sleep rhythm with age. In sleep disorders there were some gender differences: girls dreamed more than boys, preadolescent girls had more night waking than boys or adolescent girls, and adolescent boys snored more than girls or preadolescent boys. Daytime sleepiness was unknown among the first and the second graders, but increased during puberty years. Its prevalence in the whole group was 21%.

In the first study daytime sleepiness was analysed among those schoolchildren who had answered personally. In a multivariate analysis irregular sleeping habits, frequent sleep disorders (dreaming, insomnia, night waking, delayed sleep latency and sleeptalking) and excessive video watching time were more common in the children who reported daytime sleepiness than in those who did not. When parental variables were taken into consideration the results were different: children's sleep disorders and parental sleep disturbances (mothers' poor sleep quality and fathers' insomnia and daily sleep urge) were more frequent and fathers were more often entrepreneurs in the families with sleepy children than in those with alert ones.

The second questionnaire (follow-up questionnaire) was sent to the adolescents who reported daytime sleepiness in the first questionnaire (n=107) and an equal number of controls chosen from the group of alert participants. Replies were received from 143 participants. In the group of sleepy adolescents 54% were still sleepy; in the control group 28% had become sleepy. Those who were still sleepy were older and had more irregular sleeping habits and more night waking than those who had become alert. In the control group those who had become sleepy had better AG than those who were still alert. When evaluating daytime sleepiness in the follow-up with multivariate methods later bedtimes, better average school grade and mothers with higher education were found more often among the sleepy participants than among the alert ones.

The interview took place in the two schools. The same adolescents were invited to the interview, and 130 participants took part in it. Questions about living habits and health situation were added, as their effect on daytime sleepiness was hypothesised to be remarkable. In a multivariate analysis frequent sleep disorders (insomnia, difficulties in falling asleep, night waking, snoring, dreaming), irregular breakfast habits, depressive feelings and permanent medication were more common in the sleepy adolescents than in the alert group.

When evaluating chronic sleepiness (participants who were sleepy at every step of the study) difficulty in falling asleep, night waking, dreaming, medication, drinking alcohol and irregular breakfast eating were significantly more common among the chronically sleepy adolescents (n=20) than in their continuously alert peers (n=37).

In conclusion, this study showed that the evolution of sleeping habits during puberty in Finland is similar to that found in other countries. Daytime sleepiness is a common symptom among Finnish youth, although it was not very persistent during the follow-up. Sleeping habits and sleep disorders have an effect on daytime sleepiness, but a new association was found with parental sleep disturbances. Social background and health conditions also seem to affect daytime sleepiness. Living habits, on the contrary, had a vaguer effect than expected. The latter finding could be different if the study were now repeated.

FINNISH SUMMARY

Lasten ja nuorten nukkumistavat ja unihäiriöt ovat viime vuosina olleet kiinnostuksen kohteena. Suomessa epidemiologisia tutkimuksia on kuitenkin vähän. Päiväväsymyksen ja sen syiden epidemiologiaa on myös lisääntyvästi tutkittu. Näyttää selvältä, että niin nukkumiskäyttäytymisessä kuin päiväväsymyksessäkin on tapahtunut muutoksia, jotka voivat olla seurauksia nykyisestä elämäntyylistä.

Tässä tutkimuksessa selvitettiin epidemiologisesti nukkumistottumuksia, unihäiriöitä ja päiväväsymystä. Kaksi kyselyä ja haastattelu tehtiin kolmen vuoden kuluessa (1988-1990) kahdessa tamperelaiskoulussa. Kyselytutkimuksiin vastasivat lapset ja heidän vanhempansa; ainoastaan lapset osallistuivat haastatteluun.

Ensimmäinen kysely jaettiin 7-17-vuotiaille koululaisille. Ensimmäisen ja toisen luokan oppilaat eivät vastanneet itse, vaan heidän tietonsa perustuivat vanhempien vastauksiin. Vanhemmilta lapsilta kerättiin sekä oma että vanhempien arvio. Vastauksia saatiin 574 lapsesta.

Keskeisin nukkumistapoja koskeva löydös oli unirytmin viivästyminen iän myötä. Unihäiriöissä esiintyi joitakin sukupuolten välisiä eroja: tytöt näkivät enemmän unia kuin pojat, ala-asteikäisillä tytöillä oli enemmän yöheräilyä kuin pojilla ja vanhemmilla tytöillä ja yläasteikäiset pojat kuorsasivat enemmän kuin tytöt ja nuoremmat pojat. Kahden ensimmäisen luokan oppilailla ei esiintynyt päiväväsymystä, mutta se lisääntyi murrosiän myötä. Oireen esiintyvyys aineistossa oli 21%.

Ensimmäisessä kyselyssä arvioitiin päiväväsymystä lapsen omaan vastaukseen perustuen. Monimuuttuja-analyysissä epäsäännölliset nukkumistottumukset, usein esiintyvät unihäiriöt (unien näkeminen, unettomuus, yöheräily, viivästynyt nukahtaminen ja unissapuhuminen) ja runsas videoiden katselu olivat väsyneillä

lapsilla yleisempiä kuin virkeillä. Kun analyysiin otettiin mukaan myös vanhempia koskevia tietoja, tulokset saivat uusia ulottuvuuksia: niissä perheissä, joiden lapsella oli päiväväsymystä, esiintyi enemmän lapsen unihäiriöitä (samat kuin edellä) ja vanhempien nukkumisongelmia (äitien huono unen laatu sekä isien unettomuus ja pakonomainen nukahtamisen tarve päivisin) kuin virkeiden lasten perheissä. Lisäksi väsyneiden lasten isät olivat useammin yksityisyrittäjiä kuin virkeiden lasten.

Toinen kysely (seurantakysely) lähetettiin nuorille, joilla oli päiväväsymystä ensimmäisessä kyselyssä (107 kpl), ja samalle määrälle virkeitä verrokkeja. Vastauksia saatiin yhteensä 143. Väsyneiden ryhmässä oli 54%:lla edelleen päiväväsymystä; kontrolliryhmässä 28% oli tullut väsyneeksi. Ne, jotka olivat edelleen väsyneitä, olivat vanhempia ja heillä oli epäsäännöllisemmät nukkumistavat ja enemmän yöheräilyä kuin niillä, jotka olivat seurannan aikana virkistyneet. Kontrolliryhmässä ainoa merkittävä ero väsyneiden ja virkeiden välillä oli todistuksen keskiarvossa: väsyneillä se oli parempi kuin virkeillä. Arvioitaessa päiväväsymystä monimuuttujamenetelmällä havaittiin väsyneillä olevan myöhäisemmät nukkumaanmenoajat, parempi keskiarvo ja korkeammin koulutettu äiti kuin virkeillä.

Haastatteluun kutsuttiin sama ryhmä kuin seurantakyselyyn, ja siihen otti osaa 130 nuorta. Kysymyksiä elämäntavoista ja terveydentilasta oli lisätty, koska niiden arveltiin olevan merkittäviä. Monimuuttuja-analyysissa väsyneillä nuorilla oli enemmän unihäiriöitä (unettomuus, nukahtamisvaikeus, yöheräily, kuorsaus, unien näkeminen), epäsäännöllisempi aamiainen, enemmän masennuksen tunteita ja useammin säännöllinen lääkitys kuin virkeillä.

Arvioitaessa kroonista väsymystä (osanottajilla, joilla olivat väsyneitä kaikissa tutkimuksen vaiheissa) nukahtamisvaikeus, yöheräily, unien näkeminen, säännöllinen lääkitys, alkoholin nauttiminen ja aamupalan epäsäännöllisyys olivat yleisempiä pysyvästi väsyneillä (20 kpl) kuin pysyvästi virkeillä (37 kpl).

Yhteenvetona voi todeta, että tutkimus osoitti nukkumistapojen kehityksen olevan samanlaista puberteetin aikana Suomessa kuin muuallakin. Päiväväsymys on yleinen oire myös suomalaisnuorilla, vaikkakaan se ei ole seurannassa kovin pysy-

vä. Nukkumistavat ja unihäiriöt vaikuttavat tietysti päiväväsymykseen, mutta uutena löydöksenä havaittiin vanhempien nukkumisongelmien yhteys lapsen väsymykseen. Myös sosiaalinen tausta ja terveydentila näyttävät vaikuttavan oireen esiintymiseen. Sen sijaan elämäntavoilla oli odotettua vähäisempi merkitys, mikä seikka voisi olla toisin, jos tutkimus tehtäisiin nyt.

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