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Adult versus adolescent onset of smoking: how are mood disorders and other risk factors involved?

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Abstract

Aims—To examine the strength of association between smoking and mood disorders and the association between smoking and its traditional risk factors, comparing those who started smoking in adolescence with those who started smoking in early adulthood.

Design and participants—The analyses relied on prospective data from the Zurich Study. This longitudinal community study started in 1979 with a stratified sample of 591 participants aged 20/21 years, weighted towards those with mental disorders. Follow-up interviews were conducted at ages 23, 28, 30, 35 and 41.

Measurements—In this analysis the adult versus adolescent onset of smoking was regressed on the cumulative prevalence of mood disorders, personality characteristics measured by the Freiburg Personality Inventory, common risk factors such as parental smoking, conduct and school problems, troubles with the family and basic sociodemographic variables (sex, education).

Findings—In the Zurich Study cohort we found that 61.6% were former or current smokers, of whom 87% started smoking before the age of 20 and 13% after the age of 20. Adolescent onset of smoking was associated strongly with later major depression, dysthymia or bipolar disorders and, furthermore, with parental smoking, extroverted personality and discipline problems and rebelliousness in youth. However, only depression and dysthymia were associated with adult onset smoking and other risk factors associated with smoking were not so associated in this group.

Conclusions—Correlates of smoking onset in adolescence are mainly not applicable to the onset of smoking in young adulthood. Smoking onset beyond adolescence is an open research issue.

Keywords

Adolescence; depression; epidemiology; mood disorders; risk factors; tobacco use; young adulthood

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INTRODUCTION

There has been much debate about the role of depression and other mental disorders as risk factors that further the initiation of smoking in young people [1–3]. The association between mood disorders and smoking has been well established in epidemiological research [4–10]; nevertheless, the direction of the relation between smoking and depression has not been understood fully [11]. For example, the findings of Kendler *et al.* [12] supported the causal linkage from depression to smoking, whereas Wu & Anthony [13] found that smoking occurred before depression in older children and adolescents. Fergusson *et al.* [14] applied structural equation modelling to determine the direction of influence in young people between 16 and 21 years of age, but the results did not favour one direction of causality.

Analysis of longitudinal data is necessary to provide evidence for causality [10,14–17], but this is complicated by the fact that risk factors and correlates of substance use change over time. Several studies have differentiated between early and late teen onset smoking [18], but little is known about the onset of smoking after age of 20 years [19]. One might expect that behavioural characteristics which are typical of adolescence, such as novelty seeking or peer group orientation, lose relevance later in life.

The aim of the present study was to differentiate between adolescent and adult onset of smoking by examining the association with depression and other mood disorders, while adjusting for common risk factors (smoking parents, conduct and school problems, troubles with the family) and personality characteristics. The data are from the Zurich Study [20,21], which is one of the few studies in psychiatric epidemiology to provide panel data on mental disorders, psychosomatic and somatic complaints and substance use.

METHOD

The Zurich Study is a prospective longitudinal study in psychiatric epidemiology [21,22]. The study started in 1978, when approximately half of the 20-year-old men and women of the canton of Zurich were screened using the Symptom Checklist 90-R (SCL-90-R) [23]. A stratified random sample of 591 people (292 men and 299 women) was selected from one-third low-scorers and two-thirds high-scorers on the SCL-90-R scale (the cutoff being the 85th percentile on the Global Severity Index (GSI) score of the SCL-90-R). The weighting factor for the low-scorers was 11.3; that is, the stratified sample corresponds to an unweighted sample of 2600 participants.

Participants were interviewed in 1979, 1981, 1986, 1988, 1993 and 1999, when they were aged 21, 23, 28, 30, 35 and 41 years. The interviews were performed by psychiatric residents and clinical psychologists with extensive clinical training, and took place mainly at the participants' homes. In the last interview (1999) 62% of the initial sample participated so that, on average, about 10% of the participants dropped out in each interview. Nearly half the original sample (47%) participated in all six interviews, and 63% participated five or six times. The dropouts did not differ significantly from those who remained in the study until the most recent interview (1999) in terms of stratified sampling and of most demographic characteristics [24].

The main interview instrument of the Zurich Study applied in each interview was the SPIKE (Structured Psychopathological Interview and Rating of the Social Consequences of Psychological Disturbances for Epidemiology)—a semistructured psychopathological interview developed for epidemiological studies [21]. It was based initially on preliminary versions of DSM-III. The SPIKE interview adopted the DSM-III-R and DSM-IV criteria as they were published. The SPIKE assesses a broad range of psychiatric and somatic syndromes and symptoms, and includes questions regarding duration, frequency, treatment

and subjective impairment and distress. The SPIKE does not assess the presence of psychotic or personality disorders. Validity and reliability testing was carried out regarding depression and anxiety [20]. The SPIKE rating of the diagnostic level of depression was found to have high sensitivity and modest specificity (0.95 and 0.59, respectively) for major depression.

The prevalence of smoking and mental disorders in this study was based on ‘life-time’ variables from the Zurich Study; that is, cumulative frequencies based on the 12-month prevalence data assessed in each interview. There are two major sources of information loss in the ‘life-time’ variables. The first source is due to sample attrition. The impact of information loss is stronger regarding the variables representing mental disorders than the smoking variables because of higher average age at onset, leading to slightly smoothed results. The second source is due to focusing on the six 12-month periods covered by extensive questions in each interview. The higher assessment reliability is at the cost of missing information about mental disorders or smoking status occurring between the interviews.

Smoking variables in all interviews encompassed the type of tobacco product smoked and—for cigarette smokers—the number of cigarettes consumed per day. We used the following definitions:

- ‘life-time light smokers’: those who reported consuming any tobacco product regularly at any interview
- ‘life-time moderate smokers’: those who, at any interview, admitted smoking 15–20 cigarettes daily; and
- ‘life-time heavy smokers’: those who, at any interview, admitted smoking more than 20 cigarettes daily.

In the bivariate and multivariate analysis the ‘life-time light smokers’ and ‘life-time moderate smokers’ were pooled into one category.

Information about the onset of smoking was asked at each interview since 1986. If no information was available due to the subject dropping out, smoking status at the first interview at age 20 was used instead. The dependent variable in the statistical analysis was designed to differentiate between adolescent onset smokers (before age 20), adult onset smokers (after age 20) and never-smokers. Moreover, we subdivided the adolescent onset smokers into heavy versus other smokers, thus yielding four categories.

Mood disorders were classified on the basis of DSM-III-R criteria for major depressive disorder (MDD, $n = 192$), and DSM-IV criteria for dysthymia ($n = 42$) and bipolar disorders ($n = 44$) [20]. The latter could be determined only in the last four interviews (1986, 1988, 1993, 1999). The overlap was considerable, with 27 of 192 people with MDD having dysthymia and 31 of 192 with MDD having bipolar disorder. A further four individuals shared bipolar disorders and dysthymia. In the analyses presented below we avoided overlapping categories by excluding cases of dysthymia and bipolar disorders from the group with major depressive disorder. Similarly, bipolar disorders were excluded from the group with dysthymia. Moreover, an additional category (‘other diagnoses’) was introduced in order to account for other mental disorders in the absence of mood disorders. This category included any case with neurasthenia, general anxiety disorder, simple phobia, social phobia, agoraphobia, panic disorder, obsessive-compulsive disorder, alcohol dependence, opioids and other substances of dependence or bulimia.

Confounding variables introduced in multivariate analysis included sex, education level at the beginning of the study (three levels) and whether the parents smoked (assessed at the 1988 interview). Three dichotomous variables represented youth problems and conflicts. They were based on a preliminary factor analysis, which was carried out on 13 variables measuring self-reported problems and conflicts in youth (details of the analysis are in Appendix S1 (and Figure S1 and Table S1), which is available with the online version of this paper; see details at the end). These variables were assessed retrospectively in the 1986 interview. They cover problems and conflicts in different contexts: at school, with friends, the police and the family, as well as behavioural problems. Initially, they were assumed to represent internalizing as against externalizing problems [25]. However, three factors were derived from this factor analysis based on tetrachoric correlations:

1. conduct problems/rebelliousness (discipline problems, lateness, truancy, running away from home, problems with police and delinquency)
2. poor results at school and fights (fear of the teacher, restless during lessons, bad marks, fights with friends); and
3. troublesome context (unpopular and anxious child, troubles within and outside the family).

We chose the simplest operational definition to represent the factors: a single positive answer to any of the variables loading on the respective factor was considered sufficient to return a positive value of the dichotomous variable representing that factor.

We included in the multivariate analysis three scales derived from the Freiburg Personality Inventory (FPI) [26], namely, extraversion, neuroticism and masculinity. The FPI was assessed twice in the Zurich Study, in the 1988 and 1993 interviews. If both assessments were available we used the average scale score, otherwise we used the one which was available.

We included the full sample ($n = 591$) in descriptive analyses and in the bivariate analysis examining the association between mood and other mental disorders and the smoking variable. This minimized information loss in favour of the smoking variable, which has a lower age at onset than mood disorders. This is because the sample attrition influences information loss differently depending on the age at onset of a condition. The alternative choice, i.e. restricting the analysed sample to stayers (participants who completed all or almost all interviews) or to participants of some later interviews (see multivariate analysis below), would minimize information loss regarding mood disorders.

The descriptive calculations were based on weighted figures to offset the sample stratification; that is, to provide population estimates. Bivariate and multivariate statistical analyses were based on unweighted figures in order to avoid the problems of reweighting based on small cell frequencies. In order to adjust for the sample stratification, the stratification variable was introduced as confounder in both analyses. In multivariate analyses the number included was reduced to 381 people because some explanatory variables were missing, as they were assessed only at later interviews.

We used polytomous (or multinomial) logistic regression analysis, which is a variant of the conventional logistic regression for dichotomous dependent variables. Analyses were carried out with the *mlogit* procedure of STATA (version 9.2 for Macintosh).

RESULTS

Of the 591 participants in the Zurich Study, 396 smoked regularly any tobacco product at some point in the study. In terms of population prevalence estimates, i.e. after offsetting the sample stratification, this translated to 61.6%. Of these, 87% (raw $n = 342$) started smoking before the age of 20 and 13% after age 20 (raw $n = 54$).

More detailed sex-specific proportions are shown in Table 1. The main difference may be found in heavy smokers. About a quarter of men but only an eighth of women fell into this category. Moreover, 'life-time' heavy smoking was clearly less prevalent among adult onset smokers (5.3%) than in adolescent onset smokers, where about a third were heavy smokers at any interview (32.5%). It was most prevalent in dysthymia (62.4%) and bipolar disorders (44.8%), whereas it was about 20% in major depression and other diagnoses and, finally, fell below 10% in the 'no diagnosis' category.

Figure 1 shows the percentages of adolescent onset, adult onset and never-smokers in relation to mental disorders and, in particular, to mood disorders. Again, the figures represent weighted prevalence estimates, i.e. after offsetting the sample stratification. Cumulative prevalence of smoking was markedly lower in individuals without compared to individuals with a 'life-time' psychiatric diagnosis. Conversely, life-time smoking was most common in people with dysthymia (88%) and bipolar disorders (80.5%).

Adolescent onset of smoking was most common in bipolar disorders (79.9%). Adult onset of smoking was more frequent in people with unipolar depression (18.3%) than with any other psychiatric condition.

A polytomous logistic regression (Table 2) indicated that the association between smoking and mood (and other mental) disorders was due mainly to heavy smoking. The association was particularly strong in dysthymia and bipolar disorders. In people who became smokers in adulthood, there were borderline significant associations with unipolar depression and dysthymia and the association with bipolar disorder was not significant. Repeating this analysis with reweighted measures produced similar findings. With respect to adult onset smoking the ORs were 6.0 (1.9–19.6) for depression, 7.7 (1.9–31.2) for dysthymia, 3.7 (1.1–12.4) for 'other' disorders, but only 0.4 (0.0–3.7) for bipolar disorders.

In the next step, we included additional explanatory variables into the polytomous logistic regression (Table 3). The ORs of the mental disorder categories showed similar patterns to the unadjusted model. However, in multivariate analysis the ORs for dysthymia increased even further, and dysthymia had the strongest association with adult onset smoking. Both parental smoking and conduct problems in youth were associated with the onset of smoking in adolescence, but there was no association with the onset of smoking in adulthood. Moreover, a high educational level was associated negatively with heavy smoking. Among the FPI variables only the extraversion variable was associated with smoking, in particular with heavy smoking. Neither neuroticism nor the masculinity variables were associated with smoking. The gender and sample stratification variables showed consistent expected patterns, but were not statistically significant.

In contrast to adolescent onset of smoking, adult onset of smoking was associated strongly mainly with dysthymia. Adjustment reduced the strength of the association between 'other' disorders and unipolar depression and bipolar disorders were not associated with smoking. None of the further variables that were associated with smoking in people younger than 20 years were associated with smoking initiation in people older than 20 years. We do not report results with reweighted measures because of erratic estimates occurring due to small cell frequencies.

DISCUSSION

This study addressed a neglected issue in the epidemiological research on smoking: correlates of onset of smoking beyond the age of 20 [10,19]. Using longitudinal data from the Zurich Study we found that only major depression and dysthymia were associated with adult onset smoking, but not other correlates which were found in adolescent onset of smoking: bipolar disorders, parental smoking, extroverted personality, discipline problems and rebelliousness in youth. Because smoking onset takes place typically before the age of 20 years, most known risk factors, among them also depression and other mood disorders [5,16,27], derive from research on younger age groups. More comprehensive perspectives have been introduced by recent studies analysing the trajectories of smoking during adolescence or from adolescence to adulthood [18,28–32]. Our results suggest that more specific study designs are needed to shed more light on adult onset of smoking.

Adult onset smoking

A minority (13%) of all smokers in the Zurich Study were adult onset smokers. This group diverged in several respects from young onset smokers. An obvious preliminary difference derived from the proportion of heavy smokers, which was distinctly lower in the adult onset group. Furthermore, variables known as risk factors for smoking initiation in youth [33,34] were not associated with smoking initiation in adulthood: that is, whether the parents smoked [35,36], conduct problems/rebelliousness in youth [37] (see also Ellickson *et al.* [38]) or exhibiting an extrovert personality. It is obvious that such typical risk factors for smoking onset in adolescence have either no or only a weak impact on smoking onset in adulthood. It is not clear whether this also applies to other risk factors, such as peers smoking or novelty seeking [39], factors which were not assessed in the Zurich Study.

In contrast to youth variables we found a continuing association between smoking onset in adulthood and mood variables, especially dysthymia and major depression. It is noteworthy that their association was stronger in the analysis using reweighting of the stratified sample, rather than in the multivariate analysis which proceeded in a conventional manner. As reweighting enhanced the values of the low-scorer subsample, we may infer that the association between adult onset smoking and dysthymia/major depression has more relevance in young adults without previous substance or mental health problems. However, further studies with larger samples are needed to glean more details.

Adolescent onset smoking and mood disorders

The results show, first, that consumption of any tobacco products in adolescence and becoming a heavy smoker then or later share some common risk factors, such as parental smoking or conduct problems. However, in adolescent onset smokers the overall association between smoking and mood disorders was clearly dominated by the heavy smokers subgroup. This was an expected result [11,40], but the strength of the associations was nevertheless surprising. Above all, bipolar disorders and dysthymia showed outstanding ORs, and require particular attention. In contrast to an analysis on alcohol use disorders with the same data set [41,42], the adjustment for bipolar disorders did not suppress the association between smoking and depression. Interestingly, bipolar disorders were not associated with adult onset smoking but were associated with adolescent onset smoking. This pattern of associations is similar to that found between use of cannabis and psychotic disorders, which seems to originate in heavy use of cannabis during adolescence [43,44] and, indeed, an association between smoking and schizophrenia onset has been also reported [45].

Almost 90% of the Zurich Study participants with dysthymia have been regular smokers, and almost two-thirds of them were heavy smokers. In contrast to bipolar disorders, the association between dysthymia and smoking was present in both adolescent and adult onset of smoking [11]. This is despite the fact that the average age at onset in dysthymia (slightly above 30 years) is clearly higher than in bipolar disorders. Understanding the different mechanisms which determine the associations with smoking in dysthymia and in bipolar disorders might yield a key to the role of smoking in mental disorders.

Notes on causal relationships

Thus far, the results presented above do not provide enough information about the nature and the direction of the causality between smoking and mental disorders, which was not the primary focus of this study. There is formal evidence of both uni- and bidirectional effects, as well as of indirect causation [10,46–48]. Moreover, there is growing evidence of a primary effect of smoking on mental disorders [49]. The increasing availability of longitudinal data in psychiatric epidemiology, which cover both adolescence and young adulthood, will be helpful in this instance.

However, several challenges remain:

- more frequent (for example, quarterly) assessment of data on smoking and mental health in order to assess the sequencing of events and symptoms and in order to assess transient processes
- specific models for different disorders (see above discussion on dysthymia and bipolar disorders)
- better assessment of subthreshold disorders and symptoms yielding distress: because people with subthreshold disorders smoke more frequently than ‘healthy’ people, the role of subthreshold disorders and subsequently the continuum of mental disorders [50–52] deserves particular attention; and
- a more realistic and specific assessment of the psychopathological symptoms after stressful life events (such as bereavement, loss of a friend, etc.) [53].

Limitations

This study is restricted to an ‘eagle eye’ perspective on smoking including correlates, such as cumulative prevalence of mood disorders. The advantage of using cumulative prevalence data is at the cost of disregarding life events, or other time-dependent variables. Among others, the sequence of smoking and mental disorders over the subject’s life-span has not been considered. It cannot be concluded directly from this study that these correlates are also risk factors in the narrow sense.

Cumulative prevalences over the age 20–40 years were influenced differently by sample attrition. In conditions with onset in adolescence or young adulthood (e.g. smoking), fewer cases were lost than in conditions with later onset (e.g. mental disorders).

In the Zurich Study bipolar disorders and dysthymia were first assessed appropriately in 1986, when the participants (men) were 27 (women: 28) years old. We have no reliable information on when participants first developed bipolar disorders. Similarly, we lack reliable information about the onset of other mental disorders before 1979 and between the interview years.

Nevertheless, the Zurich Study data are more comprehensive on mental disorders than most other studies in psychiatric epidemiology. However, the Zurich Study includes only retrospective and relatively scarce information on smoking behaviour before age 20.

Because retrospective questions on smoking onset were included for the first time in 1986, we have no information on adolescent smoking in those who dropped out of the study after the 1979 or 1981 interviews. We estimate that about 10 additional transitory smokers in adolescence and a further 10 transitory adult onset smokers were missclassified as ‘non-smokers’, thus ‘contaminating’ the reference group, which will tend to reduce the strength of the association between smoking and mental disorders.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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References

- Escobedo LG, Reddy M, Giovino GA. The relationship between depressive symptoms and cigarette smoking in US adolescents. *Addiction* 1998;93:433–40. [PubMed: 10328050]
- Patton GC, Carlin JB, Coffey C, Wolfe R, Hibbert M, Bowes G. Depression, anxiety, and smoking initiation: a prospective study over 3 years. *Am J Public Health* 1998;88:1518–22. [PubMed: 9772855]
- Killen JD, Robinson TN, Haydel KF, Hayward C, Wilson DM, Hammer LD, et al. Prospective study of risk factors for the initiation of cigarette smoking. *J Consult Clin Psychol* 1997;65:1011–16. [PubMed: 9420362]
- Sieber, M.; Angst, J. Drogen-, Alkohol- Und Tabakkonsum [Consumption of Drugs, Alcohol and Tobacco]. Hans Huber; Bern: 1981.
- Merikangas KR, Mehta RL, Molnar BE, Walters EE, Swendsen JD, Aguilar-Gaziola S, et al. Comorbidity of substance use disorders with mood and anxiety disorders: results of the International Consortium in Psychiatric Epidemiology. *Addict Behav* 1998;23:893–907. [PubMed: 9801724]
- Angst J, Sellaro R, Merikangas KR. Depressive spectrum diagnoses. *Compr Psychiatry* 2000;41:39–47. [PubMed: 10746903]
- Paperwalla KN, Levin TT, Weiner J, Saravay SM. Smoking and depression. *Med Clin North Am* 2004;88:1483–94. x–xi. [PubMed: 15464109]
- Angst J, Gamma A, Benazzi F, Ajdacic V, Rossler W. Melancholia and atypical depression in the Zurich study: epidemiology, clinical characteristics, course, comorbidity and personality. *Acta Psychiatr Scand Suppl* 2007:72–84. [PubMed: 17280573]
- Angst J, Gamma A, Pezawas L, Ajdacic-Gross V, Eich D, Rossler W, et al. Parsing the clinical phenotype of depression: the need to integrate brief depressive episodes. *Acta Psychiatr Scand* 2007;115:221–8. [PubMed: 17302622]
- Brook JS, Schuster E, Zhang C. Cigarette smoking and depressive symptoms: a longitudinal study of adolescents and young adults. *Psychol Rep* 2004;95:159–66. [PubMed: 15460371]
- Dierker LC, Avenevoli S, Stolar M, Merikangas KR. Smoking and depression: an examination of mechanisms of comorbidity. *Am J Psychiatry* 2002;159:947–53. [PubMed: 12042182]
- Kendler KS, Neale MC, MacLean CJ, Heath AC, Eaves LJ, Kessler RC. Smoking and major depression. A causal analysis. *Arch Gen Psychiatry* 1993;50:36–43. [PubMed: 8422220]
- Wu LT, Anthony JC. Tobacco smoking and depressed mood in late childhood and early adolescence. *Am J Public Health* 1999;89:1837–40. [PubMed: 10589312]
- Fergusson DM, Goodwin RD, Horwood LJ. Major depression and cigarette smoking: results of a 21-year longitudinal study. *Psychol Med* 2003;33:1357–67. [PubMed: 14672244]
- Brook JS, Cohen P, Brook DW. Longitudinal study of co-occurring psychiatric disorders and substance use. *J Am Acad Child Adolesc Psychiatry* 1998;37:322–30. [PubMed: 9519638]

16. Brook JS, Whiteman M, Cohen P, Shapiro J, Balka E. Longitudinally predicting late adolescent and young adult drug use: childhood and adolescent precursors. *J Am Acad Child Adolesc Psychiatry* 1995;34:1230–8. [PubMed: 7559319]
17. Fergusson DM, Lynskey MT, Horwood LJ. Comorbidity between depressive disorders and nicotine dependence in a cohort of 16-year-olds. *Arch Gen Psychiatry* 1996;53:1043–7. [PubMed: 8911227]
18. Wills TA, Resko JA, Ainette MG, Mendoza D. Smoking onset in adolescence: a person-centered analysis with time-varying predictors. *Health Psychol* 2004;23:158–67. [PubMed: 15008661]
19. Kendler KS, Schmitt E, Aggen SH, Prescott CA. Genetic and environmental influences on alcohol, caffeine, cannabis, and nicotine use from early adolescence to middle adulthood. *Arch Gen Psychiatry* 2008;65:674–82. [PubMed: 18519825]
20. Angst J, Gamma A, Neuenschwander M, Ajdacic-Gross V, Eich D, Rossler W, et al. Prevalence of mental disorders in the Zurich Cohort Study: a twenty year prospective study. *Epidemiol Psychiatr Soc* 2005;14:68–76. [PubMed: 16001703]
21. Angst J, Dobler-Mikola A, Binder J. The Zurich study—a prospective epidemiological study of depressive. *Eur Arch Psychiatry Neurol Sci* 1984;234:13–20. [PubMed: 6333343]
22. Binder J, Dobler-Mikola A, Angst J. A prospective epidemiological study of psychosomatic and psychiatric syndromes in young adults. *Psychother Psychosom* 1982;38:128–40. [PubMed: 7146261]
23. Derogatis, LR. SCL-90. Administration, Scoring and Procedures Manual for the R (revised) Version and Other Instruments of the Psychopathology Rating Scale Series. Johns Hopkins University School of Medicine; Chicago: 1977.
24. Eich D, Ajdacic-Gross V, Condrau M, Huber H, Gamma A, Angst J, et al. The Zurich Study: participation patterns and Symptom Checklist 90-R scores in six interviews, 1979–99. *Acta Psychiatr Scand Suppl* 2003;11–14. [PubMed: 12956807]
25. Ernst C, Angst J. The Zurich Study. XXIV. Structural and emotional aspects of childhood and later psychopathology. *Eur Arch Psychiatry Clin Neurosci* 1997;247:81–6. [PubMed: 9177953]
26. Fahrenberg, J.; Hampel, R.; Selg, H. Das Freiburger Persönlich-keitsinventar (The Freiburg Personality Inventory) FPI. Hogrefe; 1970.
27. Lasser K, Boyd JW, Woolhandler S, Himmelstein DU, McCormick D, Bor DH. Smoking and mental illness: a population-based prevalence study. *JAMA* 2000;284:2606–10. [PubMed: 11086367]
28. White HR, Pandina RJ, Chen PH. Developmental trajectories of cigarette use from early adolescence into young adulthood. *Drug Alcohol Depend* 2002;65:167–78. [PubMed: 11772478]
29. Orlando M, Tucker JS, Ellickson PL, Klein DJ. Developmental trajectories of cigarette smoking and their correlates from early adolescence to young adulthood. *J Consult Clin Psychol* 2004;72:400–10. [PubMed: 15279524]
30. Audrain-McGovern J, Rodriguez D, Teracyak KP, Cuevas J, Rodgers K, Patterson F. Identifying and characterizing adolescent smoking trajectories. *Cancer Epidemiol Biomarkers Prev* 2004;13:2023–34. [PubMed: 15598757]
31. Dierker L, He J, Kalaydjian A, Swendsen J, Degenhardt L, Glantz M, et al. The importance of timing of transitions for risk of regular smoking and nicotine dependence. *Ann Behav Med* 2008;36:87–92. [PubMed: 18704617]
32. Bernat DH, Erickson DJ, Widome R, Perry CL, Forster JL. Adolescent smoking trajectories: results from a population-based cohort study. *J Adolesc Health* 2008;43:334–40. [PubMed: 18809130]
33. Fergusson DM, Horwood LJ, Boden JM, Jenkin G. Childhood social disadvantage and smoking in adulthood: results of a 25-year longitudinal study. *Addiction* 2007;102:475–82. [PubMed: 17298656]
34. Alvarado GF, Breslau N. Smoking and young people's mental health. *Curr Opin Psychiatry* 2005;18:397–400. [PubMed: 16639132]
35. Patton GC, Coffey C, Carlin JB, Sawyer SM, Wakefield M. Teen smokers reach their mid twenties. *J Adolesc Health* 2006;39:214–20. [PubMed: 16857533]

36. den Exter Blokland EA, Engels RC, Hale WW III, Meeus W, Willemsen MC. Lifetime parental smoking history and cessation and early adolescent smoking behavior. *Prev Med* 2004;38:359–68. [PubMed: 14766120]
37. Brook JS, Whiteman M, Czeisler LJ, Shapiro J, Cohen P. Cigarette smoking in young adults: childhood and adolescent personality, familial, and peer antecedents. *J Genet Psychol* 1997;158:172–88. [PubMed: 9168587]
38. Ellickson PL, McGuigan KA, Klein DJ. Predictors of late-onset smoking and cessation over 10 years. *J Adolesc Health* 2001;29:101–8. [PubMed: 11472868]
39. Lynskey MT, Fergusson DM, Horwood LJ. The origins of the correlations between tobacco, alcohol, and cannabis use during adolescence. *J Child Psychol Psychiatry* 1998;39:995–1005. [PubMed: 9804032]
40. Dierker L, Donny E. The role of psychiatric disorders in the relationship between cigarette smoking and DSM-IV nicotine dependence among young adults. *Nicotine Tob Res* 2008;10:439–46. [PubMed: 18324562]
41. Angst J, Gamma A, Endrass J, Rössler W, Ajdacic-Gross V, Eich D, et al. Is the association of alcohol use disorders with major depressive disorder a consequence of undiagnosed bipolar-II disorder? *Eur Arch Psychiatry Clin Neurosci* 2006;256:425–57.
42. Merikangas KR, Herrell R, Swendsen J, Rossler W, Ajdacic-Gross V, Angst J. Specificity of bipolar spectrum conditions in the comorbidity of mood and substance use disorders: results from the Zurich cohort study. *Arch Gen Psychiatry* 2008;65:47–52. [PubMed: 18180428]
43. Rössler W, Riecher-Rössler A, Angst J, Murray R, Gamma A, Eich D, et al. Psychotic experiences in the general population: a twenty-year prospective community study. *Schizophr Res* 2007;92:1–14. [PubMed: 17363221]
44. Moore TH, Zammit S, Lingford-Hughes A, Barnes TR, Jones PB, Burke M, et al. Cannabis use and risk of psychotic or affective mental health outcomes: a systematic review. *Lancet* 2007;370:319–28. [PubMed: 17662880]
45. Weiser M, Reichenberg A, Grotto I, Yasvitzky R, Rabinowitz J, Lubin G, et al. Higher rates of cigarette smoking in male adolescents before the onset of schizophrenia: a historical-prospective cohort study. *Am J Psychiatry* 2004;161:1219–23. [PubMed: 15229054]
46. Brown RA, Lewinsohn PM, Seeley JR, Wagner EF. Cigarette smoking, major depression, and other psychiatric disorders among adolescents. *J Am Acad Child Adolesc Psychiatry* 1996;35:1602–10. [PubMed: 8973066]
47. Breslau N, Novak SP, Kessler RC. Daily smoking and the subsequent onset of psychiatric disorders. *Psychol Med* 2004;34:323–33. [PubMed: 14982138]
48. Korhonen T, Broms U, Varjonen J, Romanov K, Koskenvuo M, Kinnunen T, et al. Smoking behaviour as a predictor of depression among Finnish men and women: a prospective cohort study of adult twins. *Psychol Med* 2007;37:705–15. [PubMed: 17181913]
49. Klungsoyr O, Nygard JF, Sorensen T, Sandanger I. Cigarette smoking and incidence of first depressive episode: an 11-year, population-based follow-up study. *Am J Epidemiol* 2006;163:421–32. [PubMed: 16394201]
50. Angst J, Gamma A, Benazzi F, Ajdacic V, Eich D, Rossler W. Toward a re-definition of subthreshold bipolarity: epidemiology and proposed criteria for bipolar-II, minor bipolar disorders and hypomania. *J Affect Disord* 2003;73:133–46. [PubMed: 12507746]
51. Merikangas KR, Zhang H, Avenevoli S, Acharyya S, Neuenschwander M, Angst J. Longitudinal trajectories of depression and anxiety in a prospective community study: the Zurich Cohort Study. *Arch Gen Psychiatry* 2003;60:993–1000. [PubMed: 14557144]
52. Gamma A, Angst J, Ajdacic-Gross V, Rossler W. Are hypomanics the happier normals? *J Affect Disord* 2008;111:235–43. [PubMed: 18405979]
53. Zisook S, Kendler KS. Is bereavement-related depression different than non-bereavement-related depression? *Psychol Med* 2007;37:779–94. [PubMed: 17306046]

Figure 1.

Percentages of adolescent onset (up to age 20) smokers, adult onset (after age 20) smokers and never-smokers in relation to mood disorders and other mental disorders over 20 years in young adulthood; population prevalence estimates after offsetting the sample stratification. 'Other diagnoses' included any case with neurasthenia, general anxiety disorder, simple phobia, social phobia, agoraphobia, panic disorder, obsessive-compulsive disorder, alcohol dependence, opioids and other substances dependence or bulimia

Table 1

Percentages of adolescent onset (up to age 20) smokers, adult onset (after age 20) smokers and non-smokers: raw figures and weighted percentages after offsetting sample stratification; $n = 591$.

	Raw figures			Weighted percentages (%)		
	All	Men	Women	All	Men	Women
Adolescent onset						
Heavy smokers ^a	133 (22.5%)	79 (27.1%)	54 (18.1%)	17.4%	22.3%	12.7%
Moderate smokers ^b	103 (17.4%)	48 (16.4%)	55 (18.4%)	19.8%	19.0%	20.6%
Light smokers	106 (17.9%)	40 (13.7%)	66 (22.1%)	16.4%	12.8%	19.9%
Adult onset	54 (9.1%)	29 (9.9%)	25 (8.4%)	8.0%	7.9%	8.1%
Never-smokers	195 (33.0%)	96 (32.9%)	99 (33.1%)	38.4%	38.1%	38.8%

^aSmoking more than one packet of cigarettes daily

^bsmoking 15–20 cigarettes daily.

Table 2

Polytomous logistic regression of adolescent onset of smoking (heavy smokers/other smokers) and adult onset of smoking on mood disorders in the Zurich Study; category denoted by 1 (ref.) is the reference category; $n = 591$.^a

Explanatory variable	Raw n before weighting	Adolescent onset/heavy smokers versus never-smokers odds ratio (95% CI)	Adolescent onset/other smokers versus never-smokers odds ratio (95% CI)	Adult onset smokers versus never-smokers odds ratio (95% CI)
Mood disorder				
No diagnosis	225	1 (ref.)	1 (ref.)	1 (ref.)
Other diagnosis ^b	146	5.0 (2.6–9.8)	1.2 (0.8–2.1)	1.6 (0.7–3.6)
Major depression	138	4.6 (2.3–9.1)	1.4 (0.8–2.3)	2.3 (1.1–5.1)
Dysthymia	38	10.1 (3.6–28.2)	1.5 (0.5–4.1)	3.4 (0.9–12.2)
Bipolar disorder	44	9.1 (3.7–22.8)	1.5 (0.6–3.6)	0.5 (0.1–4.3)
Stratification subsample				
Low risk	195	1 (ref.)	1 (ref.)	1 (ref.)
High risk	396	1.5 (0.9–2.6)	1.2 (0.8–1.8)	1.4 (0.7–2.8)

^aIn order to facilitate reading and comparing the results the parameters for each model section (adolescent onset/heavy smoker versus never-smokers, adolescent onset/other smoker versus never-smokers, adult onset versus never-smokers) were not presented one below the other but one next to other.

^bOther diagnoses as assessed in the Zurich Study comprised neurasthenia, general anxiety disorder, simple phobia, social phobia, agoraphobia, panic disorder, obsessive-compulsive disorder, alcohol dependence, opioids and other substances dependence or bulimia. CI: confidence interval.

Table 3

Polytomous logistic regression of adolescent onset of smoking (heavy smokers/other smokers) and adult onset of smoking in the Zurich Study; category denoted by 1 (ref.) is the reference category in nominal variables; $n = 381^a$.

Explanatory variables	Raw n before weighting	Adolescent onset/heavy smokers versus never-smokers odds ratio (95% CI)	Adolescent onset/other smokers versus never-smokers odds ratio (95% CI)	Adult onset smokers versus never-smokers odds ratio (95% CI)
Mood disorder (life-time)				
No diagnosis	107	1 (ref.)		1 (ref.)
Other diagnosis	103	7.2 (2.7–19.8)	1.2 (0.6–2.6)	0.9 (0.3–2.6)
Major depression	104	6.0 (2.3–18.7)	1.2 (0.6–2.5)	1.6 (0.6–4.5)
Dysthymia	28	31.5 (5.9–168.1)	2.8 (0.6–12.5)	6.4 (1.0–39.3)
Bipolar disorder	39	7.1 (1.9–25.9)	0.9 (0.3–2.7)	0.3 (0.0–3.3)
Education in 1979				
Primary and secondary school I	125	1 (ref.)		1 (ref.)
Secondary school II	143	1.0 (0.5–2.0)	1.0 (0.6–2.1)	1.3 (0.5–3.5)
High/grammar school	113	0.4 (0.2–0.8)	1.0 (0.5–2.0)	1.7 (0.6–4.7)
Gender				
Women	201	1 (ref.)		1 (ref.)
Men	180	1.2 (0.6–2.6)	1.4 (0.8–2.8)	1.1 (0.4–2.8)
Smoking parents				
No	135	1 (ref.)		1 (ref.)
Yes	246	2.7 (1.4–5.4)	2.4 (1.4–4.2)	1.8 (0.8–4.0)
Conduct problems/rebelliousness (youth)				
No	276	1 (ref.)		1 (ref.)
Yes	105	6.1 (2.8–13.2)	2.9 (1.4–5.8)	0.7 (0.2–2.3)
Problems and bad results at school (youth)				
No	195	1 (ref.)		1 (ref.)
Yes	186	0.9 (0.4–1.7)	0.9 (0.5–1.6)	1.6 (0.7–3.6)
Troubles within family and elsewhere (youth)				
No	145	1 (ref.)		1 (ref.)
Yes	236	0.8 (0.4–1.5)	0.7 (0.4–1.3)	0.5 (0.2–1.2)
FP/ extraversion		1.04 (1.00–1.09)	1.03 (0.99–1.08)	1.05 (0.99–1.12)

Explanatory variables	Raw n before weighting	Adolescent onset/heavy smokers versus never-smokers odds ratio (95% CI)	Adolescent onset/other smokers versus never-smokers odds ratio (95% CI)	Adult onset smokers versus never-smokers odds ratio (95% CI)
FPI/neuroticism		0.97 (0.92–1.03)	1.00 (0.95–1.05)	1.01 (0.94–1.09)
FPI/masculinity		1.01 (0.96–1.07)	0.98 (0.94–1.03)	1.02 (0.95–1.10)
Stratification subsample				
Low risk	121	1 (ref.)	1 (ref.)	1 (ref.)
High risk	260	1.8 (0.9–3.8)	1.5 (0.8–2.7)	1.5 (0.6–3.8)

^aIn order to facilitate reading and comparing the results the parameters for each model section (adolescent onset/heavy smoker versus never-smokers, adolescent onset/other smoker versus never-smokers, adult onset versus never-smokers) were not presented one below the other but one next to other.

CI: confidence interval

FPI: Freiburg Personality Inventory.