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The Comorbidity Between Depressive Disorders and Nicotine
Dependence in a Cohort of 16 Year Olds.

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Abstract

Background: a) to document the comorbidity between depression and nicotine dependence in a birth cohort of 16 year olds; b) to examine the extent to which comorbidity between depression and nicotine dependence could be explained by risk factors associated with both outcomes.

Methods: Data were gathered during the course of a 16 year longitudinal study of a birth cohort of 947 New Zealand children on: a) Depressive disorders and nicotine dependence at age 16 years; b) prospectively measured risk factors including family social position, family history of criminality, parental smoking, life events, parental attachment, conduct problems, self-esteem and affiliations with delinquent peers.

Results: There was evidence of moderate to strong comorbidity between depression and nicotine dependence at age 16 years: teenagers with a depressive disorder had odds of nicotine dependence that were 4.6 times those of teenagers without affective disorder. Analyses using logistic regression and log linear modelling methods revealed that a substantial component of the comorbidity between depression and nicotine dependence was explained by common or correlated risk factors associated with both outcomes. After adjustment for common or correlated risk factors the adjusted odds ratio between depression and nicotine dependence was 2.3.

Conclusions: a) Comorbidities between depression and nicotine dependence appear to be well established by the age of 16 years; b) A large amount of this comorbidity can be explained by common or correlated risk factors associated with depression or nicotine dependence.

There has been growing interest in the associations between cigarette smoking and symptoms of depression. Studies have shown that rates of depressive symptoms or depressive disorders are higher amongst smokers or those with nicotine dependence¹⁻⁵. For example, Breslau et al² reported odds ratios between depression and both mild and moderate criteria of nicotine dependence that ranged from 2.1 to 5.7 in a sample of 1007 US young adults. Romans et al⁵ reported that, for a sample of 272 New Zealand women aged over 20 years, 63.2% of those who showed psychiatric morbidity were smokers compared with only 22.7% of those who did not show psychiatric morbidity. In general, there have been two explanations for the comorbidity between depressive disorders and nicotine dependence.

First, the comorbidity between these disorders may arise from the influence of a range of social, family and individual risk factors that predispose the individual both to depression and to nicotine dependence. There is some evidence to support this proposition to the extent that there have been a number of factors, including measures of social background, family substance use practices and early behavioral tendencies that have been shown to be associated with increased risks of both depressive disorders⁶⁻⁸ and nicotine dependence^{9,10,11}.

This conclusion is supported, to some extent, by the findings of Kendler et al⁴ who examined the comorbidity of depression and cigarette smoking in a sample of 1566 female twins. Their findings suggested that the comorbidity between cigarette smoking and depression arose from common familial factors that were associated with increased risks of both outcomes. They concluded that "the association between smoking and MD (major depression) arises largely from familial factors, which are probably genetic, that predispose to both smoking and MD (major depression)." (Kendler et al⁴, p 36).

A second explanation derives from the self-medication theory of substance use¹²⁻¹⁵. It could be proposed that rates of smoking are higher amongst those with depressive disorders

since smoking may be one means of alleviating depression and/or associated stresses.

An important issue in understanding this association concerns the age at which comorbidities between depression and nicotine dependence develop. Most studies examining this issue have been based on adult populations with respondents being aged 20 or over¹⁻⁵. These studies do not make it possible to determine the age at which clear comorbidity between depression and nicotine dependence is established. However, it seems possible that this comorbidity may be established during adolescence since it has been well documented that rates of both depressive disorders⁶⁻⁸ and cigarette smoking^{9,10} increase rapidly over the period from 14 to 18 years.

This paper reports on the results of a study of the comorbidity between depressive disorders and nicotine dependence in a birth cohort of New Zealand children studied to the age of 16 years. The aims of this study were:

1. To document the extent of comorbidity between depression and nicotine dependence at age 15-16.
2. To determine the extent to which any comorbidity between depression and nicotine dependence could be explained by a series of risk factors assessed by the age of 15 years.

METHOD

The data were collected during the course of the Christchurch Health and Development Study¹⁶. The Christchurch Health and Development Study is a longitudinal study of a birth cohort of 1265 children born in the Christchurch (New Zealand) urban region during mid 1977. These children have been studied at birth, four months, one year and annual intervals to the age of 16 years. The data analyzed in this report were measured in the following ways.

Depressive disorders (15-16 years). When the sample members were aged 16 years they

and their parents were questioned about symptoms of depression (major depression, dysthymia) in the young person over the last year. These symptoms were measured by self report using an abbreviated version of the Diagnostic Interview Schedule for Children ¹⁷ and additional items designed to meet DSM-III-R¹⁸ criteria that were not covered in the original version of this instrument. Parental reports were obtained using measures derived from the parent version of the DISC supplemented by items from the Diagnostic Interview Schedule ¹⁹. Subjects were classified as experiencing a depressive disorder if they met DSM-III-R criteria for major depression or dysthymia on the basis of either parental or self report.

Nicotine dependence. At age 16 sample members were questioned about their frequency of cigarette smoking. Teenagers who reported smoking were then asked a series of questions about nicotine dependence. These questions concerned: failure to quit or reduce smoking; irritability when cigarettes were not available; difficulties in going a day without a cigarette; morning cough; needing a cigarette first thing in the morning; continued smoking despite medical advice; stealing money or using savings to obtain cigarettes. On the basis of self-report the young person was classified as meeting DSM-III-R criteria if he/she: a) smoked at least five cigarettes per day; b) reported two or more additional symptoms of nicotine dependence. These criteria broadly correspond to the criterion of mild nicotine dependence used by Breslau et al ².

Common social and contextual factors. There have been a number of factors, including social, family, individual and peer risk factors which have been identified in the literature as being associated with increased risks of both depressive disorders and nicotine dependence ⁶⁻¹⁰. To adjust the associations between depressive disorders and nicotine dependence for the effects of common risk factors, a range of prospectively measured social, family, individual and peer factors were included in the analyses.

Family social position. This was a composite measure of the family's social background based on information about parental education, family occupational status, maternal age, parental ethnicity, and family type (one-parent/two-parent family). The index ranks the sample from children with a highly advantaged profile to those with a highly disadvantaged profile and has been shown to be predictive of a wide range of health, social and behavioral outcomes in this cohort ²⁰.

Family criminality. At age 15 years the young person's parents were asked if they, or the young person's siblings had a record of criminal offending. This measure was based on parental self definition of criminal behavior.

Parental smoking. When the sample members were 11 years old their parents were asked a series of questions concerning the extent to which they smoked cigarettes.

Family life events. Each year from 11 to 14 years parents were questioned about life events occurring in the previous year using a 49 item life event inventory based on the inventory developed by Henderson et al ²¹. To produce a global measure of the extent of family exposure to adverse life events, reports of life events over the four year period were summed to produce an overall measure of exposure to life events.

Parental attachment. Parental attachment was assessed at age 15 years using the parental attachment scale developed by Armsden and Greenberg ²². The full parental attachment scale was used in this analysis and this scale was found to have good reliability ($\alpha = .87$).

Conduct problems (12 years). This was assessed using parental and teacher reports of conduct disorder or oppositional behaviors based on items derived from the Rutter ²³ and Connors ^{24,25} parent and teacher questionnaires. These measures were combined to produce an overall measure of the extent to which the young person was reported to show conduct

disordered or oppositional behaviors²⁶. The reliability of this scale, as measured by coefficient alpha, was .93.

Self-esteem. This was assessed at age 15 years using the Coopersmith Self-Esteem Inventory²⁷. The full scale score was used in this analysis and this score was found to have good reliability ($\alpha = .86$).

Affiliations with delinquent peers (15 years). To measure the extent to which the young person affiliated with delinquent or substance using peers at age 15, a general index of peer affiliations was constructed. This index was based on self reports of the extent to which the young person's best friend and other friends: used tobacco, alcohol and cannabis, truanted or broke the law. These items were summed to produce a scale measure of the extent to which the young person reported affiliations with delinquent or substance using peers²⁸. The resulting scale was of moderate internal consistency ($\alpha = .78$).

A series of additional measures of social, family and individual characteristics was also considered for inclusion in the analyses. These measures included measures of family and childhood adversity, neuroticism, early smoking experimentation and parental substance use behaviors. In these preliminary analyses a series of logistic regression equations was fitted including the above factors. In all cases the additional predictors above did not make significant net contributions to either depression or nicotine dependence when due allowance was made for the factors described earlier.

Sample Size

The analyses reported here were based on a sample of 947 respondents for whom there was complete data for depressive disorders and nicotine dependence at age 16 years. This sample represented 74.9% of the initial cohort of children and 85.3% of the sample alive and resident

in New Zealand at the age of 16 years. To examine the effects of sample losses on the representativeness of the sample, comparisons were made of the socio-demographic characteristics of the 947 subjects included in the analysis with the remaining 318 subjects excluded from the analyses. This suggested that losses to follow up during the course of the study were not associated with child ethnicity, gender, maternal age or family size. There were, however, small but statistically detectable tendencies ($p < .01$) for the sample to under-represent children from families in which mothers lacked formal educational qualifications, families of low socioeconomic status and single parent families. However, previous analyses that have incorporated statistical corrections for non-random sample loss suggest that these losses have a negligible impact on study validity^{29,30}.

Statistical Analysis

The analysis is presented in three stages:

- i) The comorbidities between nicotine dependence and depression were described by:
 - a) estimating the odds ratios and 95% confidence intervals between dichotomously scored measures of nicotine dependence and depression, b) testing these associations using the chi squared test of independence (Table 1). Separate estimates were presented for males and females. The homogeneity of associations between nicotine dependence and depression for males and females was tested by log linear modelling techniques³¹.
- ii) The similarity of the risk factors for depression and nicotine dependence was examined using logistic regression methods³¹ to identify significant childhood and family predictors of the outcomes (Table 2). The extent of correlation between risk factors for nicotine dependence and risk factors for depression was assessed by using the logistic regression results to estimate composite risk factors scores representing the individual's risks of nicotine dependence and risks of depression given childhood, family and related factors and by

estimating the correlation between these risk scores.

iii) Finally, the joint relationships between: a) risk factors for nicotine dependence; b) risk factors for depression; c) nicotine dependence at 16; d) depression at 16 years was modelled using log linear modelling³¹ to estimate the linkages between these factors (Figure 1). Log linear modelling methods were applied to a 4x4x2x2 table of risk factors for depression, risk factors for nicotine dependence, nicotine dependence and depression at 16. Model fitting employed both forward and backward selection procedures to identify the best fitting and most parsimonious model. From the fitted log linear model parameters an estimate of the odds ratio between nicotine dependence and depression adjusted for common/correlated risk factors was obtained³¹.

All statistical tests are two tailed and based on an alpha level of .05.

RESULTS

The Association between Nicotine Dependence and Depression at Age 16.

Table 1 shows the relationship between depression and nicotine dependence for males and females. For both males and females significant associations between nicotine dependence and affective disorder were present. Tests of the equality of odds ratios for males and females based on log linear modelling methods showed that the association between nicotine dependence and depression did not vary significantly with gender.

INSERT TABLE 1.

Risk Factors for Nicotine Dependence and Depression

To examine the similarity of risk factors for nicotine dependence and depression logistic regression models were fitted to the data. The results of this analysis are summarized in Table 2 which shows estimates of the logistic regression coefficients and standard errors for each

outcome. Inspection of this Table suggests relatively little overlap between the risk factors for each outcome. However, risk factors that were common to both outcomes were affiliation with delinquent peers and lower self esteem. Subsequent analysis suggested the presence of substantial correlation between the risk factors for the two conditions. To assess this correlation, risk factor scores for each outcome were estimated by solving the logistic regression model for each subject using the regression coefficients for risk factors that were significantly related to each outcome. These risk factor scores gave estimates of the individual's risks of depression and nicotine dependence conditional on the risk factors shown in Table 2. The resulting risk factor scores were highly correlated ($r = .64$).

INSERT TABLE 2.

Modelling the Relationship between Nicotine Dependence, Depression and Risk Factors.

To describe the relationships between the risk factors in Table 2, nicotine dependence and major depression at age 16 years, methods of log linear modelling were used. In this analysis the individual's risk of nicotine dependence or depression conditional on childhood factors was represented by the risk factor scores described above. Using these risk factor scores a $4 \times 4 \times 2 \times 2$ contingency table was formed using the two risk factors scores classified into quartiles and the dichotomous measures of nicotine dependence and depression. This Table was then analysed using log linear modelling methods to find the best fitting and most parsimonious model to describe the data. The final fitted model is shown in Figure 1. This Figure shows the statistically significant linkages between the four measures (risk factors for nicotine dependence; risk factors for depression, depression at 16 and nicotine dependence) using the log likelihood ratio chi square estimate. The Figure shows:

- i) Risk factors for depression and risk factors of nicotine dependence were strongly associated with each other.

- ii) Each risk factor set was predictive of its respective outcome.
- iii) When the common influences of the correlated risk factors were taken into account there was a small but significant association ($LR\chi^2 = 6.8, p < .01$) between nicotine dependence and depression.

INSERT FIGURE 1

From the log linear model it was possible to estimate the extent to which the common and correlated effects of risk factors explained the comorbidity between nicotine dependence and depression. This analysis showed that after adjustment for common or correlated risk factors the odds ratio between nicotine dependence and depression reduced from 4.6 (95% CI = 2.5 - 8.4) to 2.3 (95% CI = 1.2 - 4.4).

Supplementary Analyses

Analyses were conducted to determine whether these conclusions differed when: a) the sample was stratified by gender; b) when depressive disorders were defined on the basis of self-report only and c) when the data were analyzed using continuous measures of outcomes and methods of structural equation modelling. These analyses showed that: a) the conclusions above held for both males and females; b) the same conclusions were reached when depression was defined on the basis of self report data only and; c) the analysis of continuous measures of tobacco use and symptoms of depression using methods of structural equation modelling produced the same general conclusions.

COMMENT

There was evidence of clear comorbidity between depressive disorders and nicotine dependence in this cohort of 16 year olds: young people with depression had odds of nicotine dependence that were over 4.5 times the odds for those without depression. This relationship

was similar for males and females. These results suggest that comorbidities between nicotine dependence and depression are well established by the age of 16 years.

Examination of the risk factors associated with vulnerability to depressive disorders by age 16 years and the risk factors associated with nicotine dependence at this age suggested the presence of some overlap and considerable correlation between the risk factors for depression and the risk factors for nicotine dependence. When the effects of common or correlated risk factors were taken into account using methods of log linear modelling the extent of comorbidity between depressive disorders and nicotine dependence was reduced substantially. However, even after this adjustment, there was a small to moderate (OR = 2.3) association between depressive disorders and nicotine dependence.

These findings are generally consistent with the conclusions drawn by Kendler et al ⁴ that the association between nicotine dependence and depression is largely or wholly non-causal and is likely to reflect antecedent factors that are associated with both conditions. However, the findings differ from those reported by Kendler to the extent that Kendler et al ⁴ concluded that the factors leading to this comorbidity were likely to be genetic in origin whereas the present analysis suggests that a substantial component of the association is explained by common or correlated social and childhood factors. It is difficult to reconcile these findings in an absence of a more general model that shows the linkages between genetic factors, life course factors and the onset of nicotine dependence and depression. One explanation that reconciles these conclusions is to suggest that the risk factors identified in this analysis may describe some of the common pathways by which genetic predispositions to nicotine dependence and depression are expressed. Irrespective of the extent to which the comorbidity between nicotine dependence and depression arises because of the effects of common genetic or common environmental factors, both studies make it clear that a substantial amount of this comorbidity

is likely to arise from familial, social and other processes that are antecedent to the onset of nicotine dependence or depression. The results of this study show that these processes operate in such a way that the comorbidity between nicotine dependence and depression is well established by mid adolescence.

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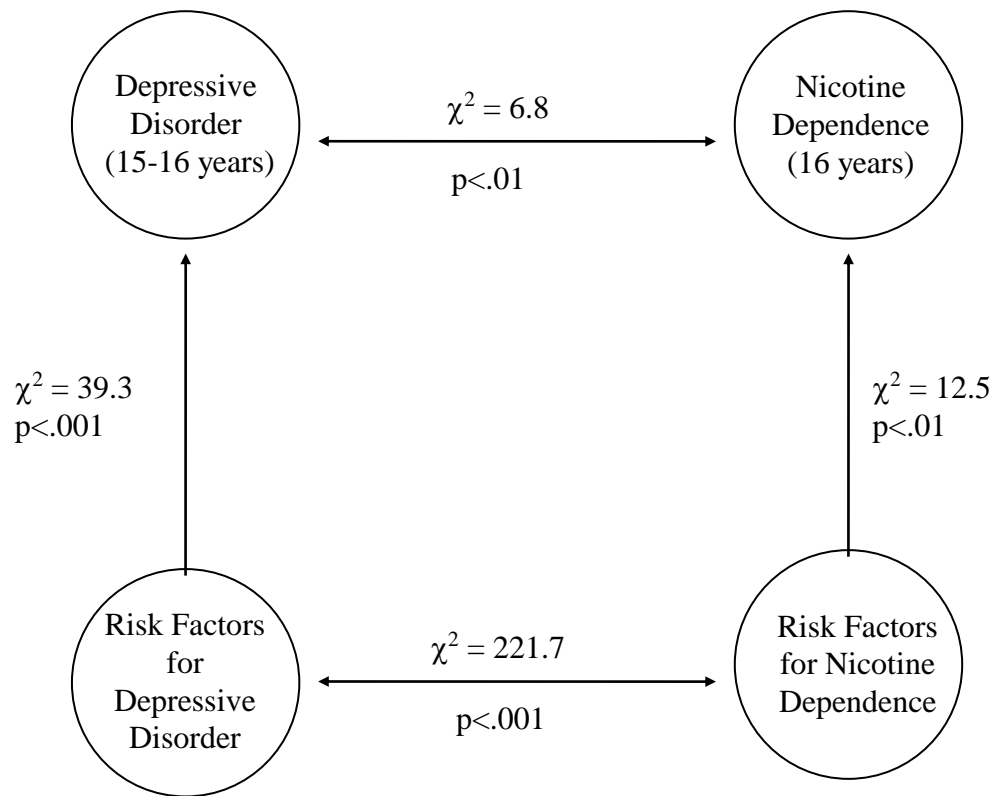
Table 1: Rate (%) of nicotine dependence amongst sample members meeting criteria for a depressive disorder and remaining sample members

	Depressive Disorder	No Depressive Disorder	Odds Ratio (95% C.I.)
1. Total Sample			
% Nicotine Dependent	20.0	5.1	4.6
N	90	857	(2.5-8.4)
2. Males			
% Nicotine Dependent	23.1	5.2	5.5
N	26	447	(2.0-15.1)
3. Females			
% Nicotine Dependent	18.9	5.1	4.3
N	64	410	(2.0-9.2)

Table 2: Logistic regressions of odds of depressive disorder and nicotine dependence at age 16 years on (prospectively measured) risk factors

	Depressive Disorder			Nicotine Dependence		
	β	S.E.	p	β	S.E.	p
Family Social Position	.23	.11	<.05	-.03	.14	>.80
Family History of Criminality	.86	.33	<.05	.33	.46	>.40
Parental Smoking	.54	.31	<.10	.15	.36	>.60
Life Events (11-14 years)	.04	.02	<.05	-.01	.02	>.50
Parental Attachment (15 years)	-.03	.02	<.05	.00	.01	>.90
Conduct Problems (12 years)	.00	.01	>.70	.04	.01	<.005
Self Esteem (15 years)	-.08	.02	<.005	-.06	.03	<.05
Affiliations with Delinquent Peers	.13	.06	<.05	.48	.07	<.001
Gender	.75	.32	<.05	.31	.39	>.40

Figure 1: Fitted log-linear model of: a) risk factors for depressive disorder; b) risk factors for nicotine dependence; c) depressive disorder (15-16 years); d) nicotine dependence (16 years).



LR χ^2 Goodness of fit of model = 14.5 (df = 39), $p > .90$