Cigarette smoking and random serum cholesterol levels in a Northern Ireland general practice population of 18- to 20-year-old students and non-students

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SUMMARY

Background. *Coronary heart disease is the commonest cause of death in Northern Ireland, but few data exist on the incidence of risk factors in young adult students and non-students.*

Aim. *To gather data on the prevalence of cigarette smoking and raised serum total cholesterol in a population of 18- to 20-year-old students and non-students.*

Method. *Subjects were patients are Mountsandel Surgery, Coleraine on 1 January 1989 and were 18–20 years of age inclusive on that date. Subjects were interviewed by a research nurse who recorded socio-demographic data, tobacco consumption and random serum total cholesterol. Smoking status validation was by serum thiocyanate and expired air carbonmonoxide estimations.*

Results. *Out of the 832 subjects surveyed, 570 were students and 262 were non-students. Cigarettes were smoked by 239 (28.7%) subjects, and a significantly greater proportion of non-students compared with students were smokers (36.6% and 25.1%, respectively; P<0.001). The proportion of males compared with females who smoked cigarettes was not significantly different, but males smoked significantly more cigarettes per day than females (14 and 11 cigarettes, respectively; P = 0.005). The average age for commencing regular cigarette smoking was 15.3 years, and 49.9% of smokers had started regular smoking by the age of 16 years. A greater proportion of non-students (65.7%) compared with students (39.2%) had started smoking before the age of 16 years. Out of those sampled, 156 (19.2%) had random serum cholesterol levels above 5.2 mmol l^{-1}. Mean total cholesterol for non-students was significantly higher than for students (4.61 and 4.45 mmol l^{-1}, respectively; P = 0.01) and increased significantly with increasing age (P = 0.03). Three subjects recorded cholesterol levels above 7.8 mmol l^{-1}.*

Conclusion. *Cigarette smoking and raised serum total cholesterol were prevalent among an apparently healthy population of students and non-students. These young adults may be significantly more at risk from subsequent coronary heart disease than was previously suspected.*

Keywords: cigarette smoking; serum total cholesterol; young adults.

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Introduction

CORONARY heart disease (CHD) is the commonest cause of death in men and women in Northern Ireland.[1,2,3] Various initiatives within Northern Ireland have been undertaken in an attempt to combat the problem, mainly by means of primary prevention,[4] but little information is available on the prevalence of risk factors for CHD in early adulthood. The risk factor model has been extended to studies of children since the 1970s.[5,6] The rationale for this approach is that post-mortem studies have demonstrated advanced atherosclerotic lesions in the coronary arteries as early as the second decade of life.[7,8] However, the anatomical and physiological changes occurring in children and adolescents may present problems in risk factor assessment in these age groups. Therefore, it is important to consider risk factors for CHD in early adulthood as a logical progression from the research in children and adolescents to act as a link with the many studies of older adults.

A survey was designed to gather data on cigarette smoking and raised serum cholesterol in a population of 18- to 20-year-old students and non-students in a Northern Ireland general practice.

Method

Subjects were selected from young adult patients registered with Mountsandel Surgery, Coleraine, on 1 January 1989 who were 18–20 years of age inclusive on that date. Out of 895 subjects identified, 610 were students and 285 were non-students. Potential subjects were written to and invited to attend a nurse-run heart disease screening clinic. Subjects who failed to reply within 2 weeks received a second letter, and continuing non-respondents were visited at home by a research nurse and invited to participate. The student subjects attended the University of Ulster, Coleraine (UUC), and most came from the UK or Irish Republic.

The survey commenced on 1 January 1989 and only students who were registered patients on or before that date and who had been resident in Northern Ireland from 1 October 1988 (the beginning of the academic term) were included in the survey. This allowed a three-month period for students who formerly resided outside Northern Ireland to adjust to any local dietary factors which may have affected cholesterol levels.

The non-students subjects were those who were not involved in tertiary-level education at the UUC or another university. Non-student patients who attended another university (11 subjects) and non-caucasian patients (four subjects) were excluded from the survey. The remaining 880 subjects were to be interviewed by a research nurse between 1 February and 31 July 1989, and socio-demographic data and the employment status of the non-student subjects were recorded. Social class distribution was examined using the Northern Ireland Registrar General's Classification.[9] This method of classification was thought to be

more accurate than that of interpreting social class by housing tenure because of the large number of students in the survey, the majority of whom were living in rented accommodation. Information about each subject's tobacco consumption was also recorded and subjects were asked to volunteer a venous blood sample for a random serum total cholesterol (TC) estimation. Serum analysis was carried out in the Northern Ireland MONICA (multinational monitoring of trends and determinants in cardiovascular disease) project laboratory in Belfast using an enzymatic method and procedure standard to all MONICA project laboratories.[10] Quality assessment for all lipid measurements was organized by the World Health Organization Lipid Reference Laboratory in Prague, Czechoslovakia, and sample bias was within the limits set at all times. Smoking status validation was undertaken by checking serum thiocyanate levels in the volunteered blood,[11,12,13] and by sampling subjects' expired air using a hand-held carbon monoxide analyser.[14,15]

Chi-square analyses or Fisher's exact probability tests were carried out for comparison of proportions between subgroups, and analysis of variance and Student's *t*-test were used for comparison of means. Data recorded were coded and analysed using SPSS PC.[16]

Results

The potential population consisted of 880 subjects, four of whom (0.5%) could not be contacted; 31 (3.5%) declined to participate. Thirteen subjects (1.5%) were excluded from the survey as they had medical conditions which could have affected TC levels. Out of the remaining 832 subjects (94.6%) who entered the survey, 570 were students and 262 were non-students.

The distribution of sex (Table 1) and age (Table 2) between the students and non-students was not significantly different. The distribution of social class was significantly different ($P<0.05$), with 50.2% of students in social classes I and II as compared with 13.4% of non-students. Only 6.8% of students were in social classes IV and V, as compared with 33.5% of non-students.

Cigarette smoking

Out of the 832 subjects, 239 (28.7%) were cigarette smokers. Two subjects were pipe smokers, but as they were also substantial cigarette smokers they were included in the survey. A significantly greater proportion of non-students compared with students were found to be cigarette smokers (36.6% and 25.1%, respectively; $\chi^2 = 11.14$, df = 1, $P<0.001$). Although a greater proportion of females (29.3%) than males (27.9%) smoked cigarettes, this difference was not significant ($P = 0.65$). However, males smoked on average significantly more cigarettes per day than females (14 and 11 cigarettes, respectively; $P = 0.005$).

When average daily cigarette consumption and employment status was compared, a highly significant difference in the distribution of cigarette smokers was observed with the greatest percentage of non-smokers found among students (75.2%) compared with employed subjects (67.8%) or unemployed subjects (56.0%; $\chi^2 = 16.5$, df = 4, $P = 0.002$). The percentage of moderate smokers (i.e. one to 15 cigarettes per day) was lowest among students (19.0%) and showed an increase among the employed (23.4%) with the highest proportion found among the unemployed (35.2%). A smaller percentage of students (5.8%) compared with unemployed (8.8%) or employed smokers (8.8%) smoked heavily (i.e. 16 or more cigarettes per day).

The average age for commencing regular cigarette smoking was 15.3 years (SD = 2.4 years). The average age of onset of regular cigarette smoking in students and non-students (15.8 and 14.7 years, respectively) was significantly different ($P<0.001$). It was revealed that 49.8% had commenced regular cigarette smoking by the age of 16; indeed, 21.8% were smoking regularly by the age of 14 years. A greater proportion of non-students (65.7%) than students (39.2%) had started smoking before the age of 16 years, and 14.7% of students and 32.3% of non-students were already regular smokers by the age of 14. At the other end of the age range, 25.8% of student smokers had not commenced smoking until they were 18 or older compared with only 8.3% of non-students (Table 3).

The average age of onset of regular smoking in males and females (14.7 and 15.8 years, respectively) was very significantly different ($P<0.0007$). The mean serum thiocyanate level for all smokers in the survey was 70 μmol l^{-1}. Seven self-reported non-smokers recorded levels greater than this. Mean carbon monoxide level in expired air showed a mean level of 8 ppm for smokers. Two self-reported non-smokers had levels greater than this, but there were are large number of missing values for this variable among smoking subjects.

Serum total cholesterol

A total of 12 (1.4%) subjects (four students and eight non-students) refused venipuncture and an additional seven samples (0.8%) were unsuitable for laboratory analysis. Out of the remaining 813 subjects who were sampled, mean TC was 4.50 mmol l^{-1} (SD = 0.85 mmol l^{-1}) and 156 (19.2%) had a random TC above 5.2 mmol^{-1}. Three subjects (one student and two non-students) recorded TC levels greater than 7.8 mmol l^{-1}. Mean TC for non-students was 4.61 mmol l^{-1} (SD = 0.89 mmol l^{-1}) and was significantly higher ($P = 0.01$) than that recorded for students which was 4.45 mmol l^{-1} (SD = 0.83 mmol l^{-1}). Mean TC also increased significantly with increasing age (Table 4, $P = 0.03$). Mean TC in smokers was 4.47 mmol l^{-1} (SD = 0.91 mmol l^{-1}) and in non-smokers it was 4.52 mmol l^{-1} (SD = 0.83 mmol l^{-1}), but the difference in means was not statistically significant.

Discussion

Comparison of social class distribution in our survey showed the anticipated greater preponderance of higher social class among

Table 1. Distribution of sex among student and non-student subjects.*

	Student		Non-student		Total	
Sex	Number	Percentage	Number	Percentage	Number	Percentage
Male	228	40.0	120	45.8	348	41.8
Female	342	60.0	142	54.2	484	58.2
Total	570	100.0	262	100.0	832	100.0

*$\chi^2 = 2.48$; df = 1; $P = 0.12$.

Table 2. Distribution of age among student and non-student subjects.*

Age (years)	Student		Non-student	
	Number	Percentage	Number	Percentage
18	100	17.5	52	19.8
19	222	39.0	82	31.3
20	248	43.5	128	48.9
Total	570	100.0	262	100.0

*$\chi^2 = 4.53$; df = 2; $P = 0.10$.

Table 3. Distribution of age at commencement of regular cigarette smoking among student and non-students.*

Age (years)	Student		Non-student	
	Number	Percentage	Number	Percentage
⩽ 12	12	8.4	18	18.8
13	9	6.3	13	13.5
14	18	12.6	16	16.7
15	17	11.9	16	16.7
16	30	21.0	12	12.5
17	20	14.0	13	13.5
18	20	14.0	5	5.2
⩾ 19	17	11.8	3	3.1
Total	143	100.0	96	100.0

*$\chi^2 = 21.67$; df = 7; $P < 0.005$.

Table 4. Mean total cholesterol values ± standard errors and results of applying analysis of variance by age (standard deviations in brackets).

Age (years)	Mean serum total cholesterol (mmol l^{-1})	*P*
18	4.39 ± 0.08 (0.92)	0.03
19	4.45 ± 0.05 (0.80)	
20	4.59 ± 0.04 (0.85)	

student subjects.[9,17] A significantly smaller proportion of students (25.1%) compared with non-students (36.6%) were cigarette smokers. The inverse association between smoking and social class is well established in adults[18,19] and also in children.[20,21] This relationship may partially explain why a smaller proportion of students compared with non-students were cigarette smokers given the significantly greater proportion of non-students compared with students who were classified as social classes IV and V.

In this survey, the prevalence of cigarette smoking was 28.7%. Barker *et al*[22] have previously indicated that 28.5% of 16- to 29-year-old Northern Irish subjects regularly smoked cigarettes. More recently evidence from Evans *et al*[10] indicated that 32% of Northern Irish 16- to 24-year-olds were regular smokers.

In recent years, there have been sustained reductions in the level of smoking among adults of all ages in England and Wales.[19] Considering the prevalence of cigarette smoking in our survey, particularly among females, it is a matter of concern that more than one-quarter of all the young adults were smokers.

We failed to highlight any significant difference in the prevalence of smoking between the sexes, although a slightly greater percentage of females than males were smokers. This was despite the fact that, on average, female smokers started the habit at an older age than did males. This finding is consistent with other results reported from Northern Ireland and Wales which have shown an increasing popularity in cigarette smoking among young females.[4,23] Additional data from the most recent General Household survey[19] and the USA[24] has shown that more females than males now smoke in the 18- to 24-year-age group. Other international data from the Bogalusa Heart Study[25] has revealed that white girls catch up and then overtake white boys, in terms of the proportion who smoke cigarettes, by the age of 16–17 years. In a telephone survey conducted among a large cohort of young men and women (mean age 19.2 years) in Minnesota, USA, Pirie *et al*[26] found that more females than males (26.5% and 22.6%, respectively) admitted to current smoking.

Although Barker *et al*[22] have suggested that the proportion of children under the age of 16 years who smoke has declined in Northern Ireland, the increasing prevalence of smoking among younger females is a particularly worrying trend, especially when seen in the context of the previously reported decrease in smoking among young Northern Irish adults.[4]

Other research has shown that most of those destined to become smokers will have acquired the habit by 18 years of age.[27] It was disconcerting to note that 49.8% of smokers surveyed were smoking regularly before they were aged 16, which is also the age under which it is a criminal offence to sell cigarettes and tobacco products to adolescents.

It is recognized that there may be a problem with the validity of smoking data obtained using self-completed questionnaires in young adult subjects.[28,29,30] Two methods of validating a subject's smoking status were used in this survey. First, serum thiocyanate levels were determined. Thiocyanate is a metabolite present in tobacco smoke; it has a half-life of 7–14 days and is considered a good measure of average smoking exposure.[13,31] The selection of cut-off points for thiocyanate used in this survey was purely arbitrary. Previous research from Northern Ireland has suggested that serum thiocyanate of 70 μmol l^{-1} or above indicates recent cigarette consumption (in the absence of dietary contamination from the consumption of certain vegetables of the cruciferous family such as cabbage and broccoli).[32] If the seven subjects in our survey who had thiocyanate levels greater than 70 μmol l^{-1} were reporting dishonestly, this would account for a deception rate of less than 1%. Other studies had suggested that deception rates of 20–35% of smokers are the norm,[33,34] although these results were from smokers who attended anti-smoking clinics where the pressure to conform and claim abstinence would be great. The apparently low deception rate in our survey may have been because subjects were clearly warned that claimed smoking status would be subject to objective assessment, but this is obviously debatable.

Analysis of carbon monoxide in expired air proved to be a disappointing method of validating smoking status. Only two subjects were identified as having possibly reported their smoking status dishonestly and both were among the seven identified by monitoring thiocyanate levels. However, there were problems with calibrating the carbon monoxide monitor, leading to a considerable number of missing variables, which may explain the low detection rate.

It is now accepted that elevated TC is a major risk factor for CHD.[35,36] This relationship depends on the level of TC, and the risk associated with a single TC measurement persists over long follow-up periods.[37,38,39] From an epidemiological viewpoint, the

assay of TC may give as much information as the determination of its sub-fractions.[40] Mean TC increased with increasing age and this finding supports evidence reported in other studies which have involved older adults.[41] In childhood, there is a gradual increase in TC from the age of 2 years until puberty, when a dip in levels occurs in both sexes. Thereafter, TC increases again reaching pre-pubertal levels by the age of 18 years.[42,43]

In our survey, TC did not appear to be related to cigarette smoking. This finding is consistent with the results of Freedman *et al*,[44] whose sample of 747 adolescents included subjects aged 17 years. In older adults, much the same result has been noted,[45] but increased TC levels have been reported in older adults who smoke very heavily.[10]

The distribution of TC concentrations in the UK population has been criticized by the British Hyperlipidaemia Association (BHA) as being too high,[46] and the BHA has suggested an optimum TC level of less than 5.2 mmol l^{-1}, a figure also recommended by other authorities.[36,37,47] The BHA has advised that it is particularly important for adults of 30 years of age or younger to achieve this target as have authorities in the USA.[48] The American Heart Association[49] has gone further by stating that up to and including the age of 19 years acceptable levels of TC are less than 4.4 mmol l^{-1}. The American Academy of Pediatrics[50] has even stated that up to the age of 19 years a TC level above 4.52 mmol l^{-1} should warrant dietary intervention and counselling. In light of these various recommendations, it was particularly disturbing to find that 19.2% of subjects recorded levels above 5.2 mmol l^{-1}. It was of even more concern that three subjects had TC levels above 7.8 mmol l^{-1}.

Our results indicate that cigarette smoking and raised TC were prevalent among apparently healthy students and non-students, who may be significantly more at risk from subsequent coronary heart disease than was previously suspected.

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