Bicycle Helmet-wearing Variation and Associated Factors in Ontario Teenagers and Adults

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ABSTRACT

Background: The incidence of bicycle helmet use and the factors associated with helmet use in Ontario are presented in this study. The Ontario Health Survey (1996), a population-based survey of Ontario residents, was used as the data source.

Methods: As the factors associated with helmet use were found to differ between adults and teens, a separate analysis was performed for each age grouping. A logistic regression model (with Bootstrap confidence intervals – 95%) was used and adjusted odds ratios (OR) are reported.

Results: Of the 7,693 respondents, 41.1% reported wearing their helmets on a regular basis when riding a bicycle. Helmet use was greatest among 12-14 year olds (71.7%) and lowest among those 15-18 years old (33.3%). In teenagers, drinking alcohol (OR: 2.8) and smoking (OR: 4.4) were strongly associated with helmet non-use. In the adult group, female gender (OR: 1.26), higher income (OR: 1.43), higher education (OR: 1.68), non-smoking status (OR: 2.0) and abstinence from alcohol (1.27) were associated with helmet use. Living in a rural area was also associated with helmet use in the multi-variable analysis.

Conclusion: This study indicates that bicycle helmet non-use is a multifaceted problem and thus any strategy for increasing helmet-wearing rates requires multi-dimensional interventions. The results of this study are discussed within the context of other studies and related to their public health implications.

La traduction du résumé se trouve à la fin de l'article.

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Cycling is a popular outdoor recreational activity enjoyed by all age groups, especially young children and adolescents. The popularity of cycling has resulted in a correspondingly high frequency of bicycle-related injury. Since bicycle use is highest among the younger population, the consequence of trauma most often affects this group. For example, admissions to hospital[1] and deaths in Canada are most common in those under the age of 18.[2]

The causes of injuries and the magnitude of these injuries have been extensively studied.[2,3] For example, most severe and fatal bicycle-related injuries result from interactions with motorized vehicles.[2] Most importantly, more than 80% of fatal and 65% of non-fatal crashes involve head injuries.[4] Head injuries not only cause death, but may also result in severe disability. Research has consistently demonstrated that protective helmets may reduce head injury by 85% and brain injury by 82%.[5] Consequently, most bicycle injury prevention strategies involve helmet promotion as an intervention in their campaign.[2-8]

While helmets have been shown to be efficacious in preventing head injuries, studies have demonstrated wide variability in helmet use in Canada (e.g., Winnipeg,[6] Sudbury,[7] Edmonton,[8] Canada[9]). Some countries and regions have successfully implemented helmet legislation and observed a dramatic increase in helmet use[10,11] while a corresponding reduction in subsequent injury statistics has been a more elusive consequence.[12-14] Other areas without legislation have demonstrated poor compliance with helmet use, despite intensive safety campaigns. As a result, in recent years helmet legislation has been widely accepted as a necessary supplement to educational interventions in order to achieve widespread compliance with helmet wearing.[15-17] In October 1995, Ontario implemented bicycle helmet legislation that involved only children under 18 years of age.

Evidence suggests helmet use is highest among females, the very young, the more safety conscious, and those in higher socioeconomic situations.[6,18] However, much of this research is old and may not be generalizable to all Canadian settings. In addition, some studies are small, use only observational data, or include limited

personal or behaviour factors in their analysis. Finally, most do not involve sophisticated analyses using robust and comprehensive databases.

As a result of the above concerns, a study of bicycle helmet-wearing patterns in Ontario was undertaken. This study examines the Ontario Health Survey (OHS) data for the province of Ontario in 1996 which provides data to assess the factors associated with helmet-wearing compliance after the introduction of the legislation. The OHS data have previously been used to examine other safety-related issues in Ontario, such as factors associated with seatbelt use.[19] Specifically, the study objectives were as follows: 1) to determine the self-reported helmet-wearing percentages of cyclists in Ontario, 2) to determine the compliance with helmet-wearing recommendations based on age, and 3) to determine the demographic, behavioural and geographic factors associated with bicycle helmet-wearing use.

METHODS

Database

The OHS is a province-wide survey that was administered to households during the calendar year of 1996 by Statistics Canada as part of the National Population Health Survey (NPHS). The 1996 OHS received responses from 36,892 individuals, over the course of the year, representing a weighted population of 9,323,354 Ontarians. Data were available for those 12 years of age and older. People living in institutions, on native reserves, in extremely remote locations, and nationals from other countries were excluded from the survey. In order to examine time trends in bicycle helmet use, some comparative data were taken from the 1990 OHS. The 1990 OHS asked the identical question about bicycle helmet use. However, the 1990 OHS did not include respondents under age 16, thus it was impossible to examine the percentage of helmet users under this age. Additional information about these two surveys can be found elsewhere.[20,21]

DATA ANALYSIS

Descriptive statistics were used to provide an overview of the number of bicycle helmet users in the province by age. Logistic regression was used to examine the association between the dependent variable (i.e., helmet use) and a host of independent variables. The data were analyzed using SPSS statistical software (v.9). Both adjusted and unadjusted analyses were performed using the OHS weights to account for the sampling design.

The Wald statistic was used to test the hypothesis that the regression coefficients associated with the independent variables were equivalent to 0.0. Bi-variable analyses of independent variables are reported as odds ratios (OR) with 95% confidence intervals (95% CI).

However, since the OHS uses a complex cluster sampling design, it was not possible to use only "standard" methods to calculate the confidence intervals around each of the odds ratios (point estimates), therefore bootstrapping was employed. Bootstrapping is a Monte Carlo simulation technique involving resampling with replacement and imitates multiple replications of the whole survey to calculate sampling variances.[20]

Since a number of studies suggest that the risk factors associated with bicycle helmet use vary according to age of the cyclist, two separate logistic regression analyses were performed.[9,19] One analysis was performed for those bicycle riders under the age of 19 and one for those 19 years of age and older.

Dependent variable

Logistic regression analysis requires a dichotomous dependent variable (i.e., helmet use, non helmet use). In the 1996 OHS, respondents were asked to respond to the following question: "When riding a bicycle how often did you wear a helmet?" This question was only pertinent to those who indicated they participated in bicycling as an activity. There were four possible responses: always wear a helmet, most of the time wear a helmet, rarely wear a helmet, and never wear a helmet. For the purposes of this analysis, the dependent variable was dichotomized into positive and negative responses. A positive response to bicycle helmet use was defined as those respondents falling within the first two categories (i.e., always and most of the time), while a negative response included respondents from the latter two categories (i.e., rarely and never).

Independent variables

The independent variables were selected on the basis of their biological plausibility and previous association with bicycle helmet identified through a literature review. All the independent variables were categorical. For those variables containing three or more categories, dummy variables were created (0,1) with an assigned reference category (0,0). For example, the age variable was divided into 5 categories (12-14, 15-18, 19-44, 45-65 and 65+). Age category 15-18 was used as the reference category for the under 19 analysis and 65+ was used as the reference category for the 19 and over analysis. Household income in the 1996 OHS was divided into four categories (lowest, lower-middle, higher-middle and highest) based on total household income and family size. For this analysis, the two middle incomes were collapsed creating three categories for analysis. Lowest income was used as the reference category. The education variable was used as it appears in the 1996 OHS and is categorized as: less than secondary school, secondary school graduation, beyond high school, and college or university degree. Less than secondary school was used as the reference category. The education variable was used for the over 18 years of age analysis only. A separate analysis was performed to examine whether there was a significant interaction effect between education and income. It was found that when these two variables were run as interaction terms in

TABLE I

Self-reported Bicycle Helmet-wearing Percentages for Cyclists in Ontario, 1996

Percentage (and weighted n) of Ontarians who reported bicycling in the past three months		20.9 % (1,944,173)
Percentage (and weighted n) of cyclists who reported wearing a bicycle helmet		41.1% (799,795)
Percentage (and weighted n) of cyclists who reported wearing a bicycle helmet by age	>18	39.1% (577,639)
	15-18	33.3% (80,318)
	12-14	71.7% (161,839)

TABLE II

Weighted Percentages of Reported Bicycle Helmet Use by Variables in the Logistic Regression Analysis

Variables		19 Years of Age and Older			12-18 Years of Age		
		% of Respondents (n-weighted)	% of Respondents Who Wore a Bicycle Helmet (n-weighted)	% of Respondents in Reference Category Who Wore a Bicycle Helmet (n-weighted)	% of Respondents (n-weighted)	% of Respondents Who Wore a Bicycle Helmet (n-weighted)	% of Respondents in Reference Category Who Wore a Bicycle Helmet (n-weighted)
Socio-demographic Factors							
Sex (Female)		43.2% (67,727)	41.1% (261,978)	35.2% (295,660)	40.9% (190,855)	53.3% (101,708)	50.9% (140,449)
Income	Low	9.3% (107,780)	NA	34.3% (36,957)	13.3% (43,615)	NA	51.8% (22,583)
	Middle	65.7% (759,181)	35.9% (272,469)	NA	68.7% (225,703)	56.6% (127,661)	NA
	High	9.3% (107,780)	44.4% (128,051)	NA	18.0% (59,196)	58.8% (34,808)	NA
Education	< secondary	12.6% (184,636)	NA	31.2% (57,519)	NA	NA	NA
	Secondary	17.6% (257,384)	15.2% (84,126)	NA	NA	NA	NA
	Other post secondary	26.0% (381,155)	22.5% (124,923)	NA	NA	NA	NA
	University/College degree	43.8% (642,137)	52.0% (288,251)	NA	NA	NA	NA
Behavioural Factors							
Use bicycle to go to work or school		34.7% (511,714)	43.4% (222,046)	34.8% (335,119)	52.6% (243,694)	53.2% (129,563)	50.1% (110,037)
Never drink alcohol		86.7%) (1,273,073)	37.4% (476,614)	42.5% (78,781)	54.9% (255,011)	65.6% (167,341)	35.0% (73,166)
Nonsmoker		79.1% (1,168,074)	41.1% (480,414)	25.0% (77,039)	90.7% (423,234)	55.9% (236,658)	12.0% (5,202)
Geographic Factors							
Live in urban area		87.1% (1,286,126)	38.2% (491,676)	34.6% (65,674)	83.9% (390,883)	51.8% (202,435)	52.3% (39,315)

the logistic regression for those over 18 years of age, there were no significant interaction effects and therefore, they were run as separate variables.

A number of behavioural factors were also included. Non-drinkers were defined as those who indicated that they never drink alcohol or had not done so in the past 12 months. Those respondents who indicated they did not smoke were categorized as non-smokers. Respondents were also classified as to whether they rode a bicycle to work or school or not. The Statistics Canada definition was used to categorize respondents into urban or rural areas.[22]

RESULTS

Helmet percentages

Overall, 20.9% (weighted sample = 1,944,173) of Ontarians reported they had ridden a bicycle in the 3 months prior to the survey (Table I). This resulted in 7,693 cases (unweighted sample) available for analysis. Of those who participated in bicycling as an activity, 41.1% (799,795 Ontarians [weighted sample]) reported they were regular bicycle helmet users as defined by this study. However, helmet use was not consistent over all age groups. While 71.7% of bicycle riders aged 12-14 reported wearing a bicycle helmet all the time, the percentage was lower in adolescents aged 15-18 years of age as only 33.3% reported wearing helmets while bicycling. The percentage of reported helmet users increased to 39.1% in those over the age of 18. In comparison, in 1990, only 6.9% of those 16-18 years of age and 6.5% of those over age 18 used bicycle helmets.[21] Table II presents the weighted percentages of reported helmet use for each of the variables used in the logistic regression analysis.

Table III provides a summary of the results of the logistic regression including the unadjusted and adjusted relationships and the confidence intervals between bicycle helmet use and the independent variables for those over 18 years of age. The bivariable analysis (unadjusted OR+) and logistic regression (adjusted OR+) produced nearly identical results. Females, higher income households and those with university or college degrees were significantly more likely to report wearing bicycle helmets. All the behavioural factors included in the model were also found to be significant. Nonsmokers, nondrinkers, and those who ride a bicycle to work or school more often reported wearing a bicycle helmet. Although living in an urban area was positively associated with helmet use, the differences were not statistically significant in the bi-variable analysis. However, when the other independent variables were controlled for in the multi-variable analysis, this variable became significantly associated with increased bicycle helmet use.

The results of the analysis for those 18 years of age and younger are shown in Table IV. One of the most striking associations with reported bicycle helmet use was age. Those aged 12-14 years were approximately 3 times (adjusted OR+) as likely to report wearing a helmet in comparison to 15-18 year olds. Like those over 18 years of age, nonsmokers and nondrinkers were more likely to report wearing a helmet. For example, those aged 18 years and younger who did not drink or smoke were approximately 2.8 and 4.4 times (adjusted OR) as likely to report regular helmet use respectively. However, unlike those over age 18, female gender, riding a bike to work or school, living in an urban area and income

TABLE III

Results of the Logistic Regression for Those 19 Years of Age and Older

Variables		Unadjusted OR+	95% CI Lower	95% CI Upper	Adjusted OR+	95% CI Lower	95% CI Upper	B	S.E.	Wald	P-Value
Sociodemographic Factors											
Sex (Female)		1.28	1.14	1.45	1.26	1.09	1.45	0.22914	0.07423	9.5296	0.0020
Income	Low	Ref	Ref	Ref	Ref	Ref	Ref	Ref	Ref	Ref	Ref
	Middle	0.98	.087	1.11	1.04	0.79	1.36	0.04156	0.13569	0.0938	0.7594
	High	1.44	1.21	1.72	1.43	1.06	1.93	0.35741	0.15364	5.4111	0.0200
Education	< secondary	Ref	Ref	Ref	Ref	Ref	Ref	Ref	Ref	Ref	Ref
	Secondary	0.96	0.84	1.19	1.07	0.79	1.44	0.06442	0.15226	0.1790	0.6722
	Other post secondary	0.94	0.83	1.12	1.01	0.77	1.32	0.08480	0.13868	0.0037	0.9512
	University/College degree	1.70	1.50	1.93	1.68	1.30	2.18	0.51942	0.13211	15.458	0.0000
Behavioural Factors											
Use bicycle to go to work or school		1.43	1.25	1.64	1.72	1.48	2.01	0.54303	0.07863	47.692	0.0000
Never drink alcohol		1.27	1.10	1.46	1.30	1.09	1.55	0.26342	0.08865	8.8304	0.0027
Nonsmoker		2.10	1.78	2.47	1.97	1.63	2.38	0.67917	0.09610	49.949	0.0000
Geographic Factors											
Live in urban area		1.17	.979	1.40	1.28	1.04	1.57	0.24482	0.10407	5.5345	0.0187

TABLE IV

Results of the Logistic Regression for Those 12 to 18 Years of Age

Variables		Unadjusted OR+	95% CI Lower	95% CI Upper	Adjusted OR+	95% CI Lower	95% CI Upper	B	S.E.	Wald	P-Value
Sociodemographic Factors											
Sex (Female)		1.10	0.85	1.43	1.22	0.86	1.74	0.20194	0.17812	1.2854	0.2569
Age	12-15	5.09	3.82	6.78	3.20	2.23	4.58	1.16	0.18335	40.2144	0.0000
Income	Low	Ref	Ref	Ref	Ref	Ref	Ref	Ref	Ref	Ref	Ref
	Middle	1.03	0.75	1.42	1.28	0.75	2.15	0.24335	0.26680	0.8320	0.3617
	High	1.13	0.77	1.66	1.45	0.77	0.77	2.72	0.32284	1.3062	0.2530
Behavioural Factors											
Use bicycle to go to work or school		1.13	0.87	1.48	1.15	0.81	1.62	0.13792	0.17633	0.6117	0.4341
Never drink alcohol		4.04	2.79	5.83	2.80	1.66	4.73	1.03	0.26744	14.8044	0.0001
Nonsmoker		9.29	4.52	19.10	4.43	1.63	12.00	1.49	0.50912	8.5361	0.0035
Geographic Factors											
Live in urban area		0.98	0.69	1.38	1.07	0.68	1.74	0.06601	0.24800	0.0708	0.7901

were not significantly associated with reported helmet use.

DISCUSSION

This study examined a large database of Ontario citizens interviewed in 1996 as part of the Ontario Health Survey. Based on a response to a specific question regarding bicycle helmet use, we were able to examine the self-reported bicycle helmet-wearing percentages and compare these to similar data from the same province in 1990. The overall increase in bicycle helmet use between 1990 (<10%) and 1996 (>40%) is encouraging. Moreover, it would indicate at least partial success of strategies (legislation combined with public education programming) to increase awareness about the benefits of wearing a helmet while cycling. Since bicycle injury prevention education programs existed in Ontario prior to 1990, the main change that occurred between the survey periods was the debate, planning and implementation of the bicycle helmet legislation for children in Ontario.

However, these results also illustrate wide variation in helmet use based mainly on age. Using demographic, behavioural and socio-economic linkages to the OHS, models were developed that examined the factors associated with helmet wearing. From this set of analyses, it is clear that factors associated with helmet-wearing also vary in the different age groups. Similar age patterns in helmet use have been observed in other studies,[6,8,9] yet the robust nature of the OHS data allows for richer interpretation of these trends. For example, the role of behavioural and socio-economic factors are more clearly elaborated in this analysis.

What factor(s) could be responsible for such a disparity in helmet use by age? First, much of the public health programming surrounding bicycle helmet safety has been aimed at children and youth. Given the reported increase in helmet use from 1990 to 1996, this focus on children appears to have been effective. However, originally the bicycle helmet legislation was intended to be "universal" (all ages), and by the time of its implementation was reduced to include only children and youth. These data demonstrate the potential consequence of this short-sightedness, in that adolescent and adult bicycle helmet-wearing rates remain low. In jurisdictions where universal helmet laws exist, the percentage of all riders wearing helmets has risen in a proportionate and less age-affected manner. Although it is difficult to evaluate the direct impact this law has had on helmet use, it would seem that it has been less than successful as indicated by the fact that adolescents 15-18 years of age did not use a helmet as frequently as adults, who are not required by law to do so.

Finally, results from studies examining the effects of legislation on helmet use vary widely. One consistent finding is that without enforcement, laws did not result in increased helmet use. In the Ontario context, the law is not strongly enforced. Petridou et al. in assessing the effectiveness of a comprehensive campaign to increase seat belt use in Athens found that an intensive campaign to increase seat belt use, conducted in the absence of increased law enforcement, resulted in moderate gains.[23] The same can be said for bike helmet use in Ontario. However, in Nova Scotia, where helmet legislation was introduced in 1997 for all cyclists, helmet use has increased in all age groups to over 70%.[24]

In addition, this study found that reported helmet use was strongly associated with a variety of other high-risk health behaviours. For example, in both adults and adolescents, nonsmokers and those who do not drink alcohol were much more likely to report wearing their helmets all the time. This result may reflect a greater degree of health and safety consciousness and an overall greater concern with regard to risk taking. Similar findings have been documented in a number of other studies.[25-27] In general, these data support claims to introduce courses dealing with healthy life choices (non-smoking, moderate alcohol consumption, seat belt use and helmet wearing, etc.) in schools.

A number of other factors with important planning implications were also shown to be associated with reported regular helmet wearing. Helmet use in adults was positively associated with high-income households and with higher education, being female and living in an urban area. Although these same variables show the same positive associations with reported helmet use in those 18 years of age and younger, they were not statistically significant. This study also found that adult bicycle commuters were 1.7 times more likely to report regular helmet use than strictly recreational riders.

Limitations

There are a number of limitations that should be kept in mind when generalizing the findings of this study. First, the OHS is self-report data and may be biased as it does not necessarily represent actual behaviour. One strong point to the OHS is that each respondent over age 12 was interviewed directly rather than by proxy response. This is important as a parent's perception of his/her child's helmet-wearing habits may not match reality.[28] Second, there are a number of other factors that may be associated with bicycle helmet use that were not possible to include in the analysis. For example, parental encouragement and role-modelling, whether friends wore a helmet and the type of bicycling (e.g., off-road) have been found to be important correlates to helmet use.[29] Finally, it was also not possible to examine helmet use for those less than 12 years of age. Two other factors, living in the north and frequency of bicycling, were tested in the model but eventually excluded due to sample size factors and the fact that they added little to the model. As well, combining "always wear a helmet" and "most of the time wear a helmet" is a compromise and may result in an underestimation of the magnitude of these results.

CONCLUSIONS

While bicycle helmet use has increased in Ontario in the 1990s, especially in those under 15 years of age, the overall rate of helmet-wearing remains unacceptably low in this province. There remain a number of groups at high risk, such as older adolescents, risk-takers and recreational riders. Targeted educational and other programming need to be developed for these groups. A number of such programs have been initiated with varying degrees of success. Such programs are most efficacious when linked closely to bicycle helmet legislation covering all ages that is actively enforced.[30] Parents should also be involved in such programs as their use of helmets is vital to their serving as role models.[20]

This study indicates that bicycle helmet non-use is a multifaceted problem and thus any strategy for increasing helmet-wearing rates requires multi-dimensional interventions. Such an approach has been shown to be most effective in producing sustained success and eventual improved outcomes.[31-33] This is especially true as non-use of bicycle helmets is part of a general pattern of risk taking, thus any interventions should be designed to target multiple problem behaviours. Such an approach would also be most cost effective.

Finally, while the associated factors are reflective of the published literature and were derived using appropriate methodological principles with a large-scale population database, further research is needed to uncover other factors associated with the non-use of bicycle helmets. There is an urgent need to understand the reasons for bicycle helmet non-compliance in the adolescent population and implementation of strategies to address these issues. In addition, since self-report and actual wearing may differ, strategies of encouraging complete compliance with helmet-wearing recommendations (such as use at all times, and helmet-wearing positioning) are also required in order to achieve the ultimate goal of reducing the burden of bicycle-related head injuries in Canada.

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RÉSUMÉ

Contexte : Nous avons étudié l'incidence du port du casque de vélo et les facteurs connexes en Ontario. Nos données provenaient de l'Enquête sur la santé en Ontario (1996), une enquête représentative auprès de résidents de la province.

Méthode : Après avoir constaté que les facteurs associés au port du casque n'étaient pas les mêmes pour les adultes et pour les adolescents, nous avons analysé séparément les deux groupes. Nous avons utilisé un modèle de régression logistique (avec intervalles de confiance auto-amorcés de 95 %) et des rapports de cotes (RC) standardisés.

Résultats : Sur 7 693 répondants, 41,1 % ont dit porter habituellement le casque à bicyclette. C'est chez les 12 à 14 ans que le port du casque était le plus élevé (71,7 %), et chez les 15 à 18 ans qu'il était le plus faible (33,3 %). Chez les adolescents, la consommation d'alcool (RC : 2,8) et le tabagisme (RC : 4,4) étaient fortement associés au fait de ne pas porter le casque. Chez les adultes, le fait d'être une femme (RC : 1,26), d'avoir un revenu élevé (RC : 1,43), d'avoir fait des études supérieures (RC : 1,68), d'être non-fumeur (RC : 2,0) et de ne pas consommer d'alcool (RC : 1,27) étaient associés au port du casque. Le fait de vivre en milieu rural était également associé au port du casque dans l'analyse multivariable.

Conclusion : L'étude montre que la non-utilisation du casque de vélo est un problème multidimensionnel, et que toute stratégie visant à accroître le port du casque exige des interventions plurielles. Les résultats de l'étude sont expliqués dans le contexte d'autres études et en fonction de leurs incidences pour la santé publique.

In Memory

Dr. Jorge Segovia died July 2, 2002. One of the most longstanding members of the Faculty of Medicine, Dr. Segovia came to Newfoundland in 1976 to join the faculty in the Division of Community Medicine; he served as associate dean for the division from 1991 to 1996 and in 2000 retired his full-time faculty post. He maintained involvement with the faculty and students through a part-time appointment and was appointed professor emeritus in 2001.

Dr. Segovia graduated with a doctor of medicine degree from the Faculty of Medicine at the University of Buenos Aires in 1959 and completed a master's of public health at that school in 1961. With a Milbank Faculty Fellowship, he then pursued postgraduate studies in medical sociology at the University of Pittsburgh. He held faculty positions at the University of Buenos Aires, Columbia University and the University of Campinas (Brazil) before being appointed as associate professor of social medicine in the Division of Community Medicine at Memorial University in 1976. Dr. Segovia was the principal investigator of the Health and Medical Care Research Group, which has received funding from the National Health Research and Development Program over a 15-year period to study the influence of demographic, socio-economic, and health status variables on medical care utilization in Newfoundland.

Dr. Segovia was a longstanding member of the Canadian Public Health Association and a former CPHA Board of Directors member.

The Dr. Jorge Segovia Scholarship Fund will be established and donations are welcome. Inquiries regarding the scholarship may be directed to Ms. Alison Edwards in the Division of Community Health, Tel. (709) 777-6218, E-mail: aedwards@mun.ca.