Gender, Age, and Educational Level Attribute to Blood Alcohol Concentration in Hospitalized Intoxicated Adolescents; A Cohort Study

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Background: The prevalence of adolescents hospitalized with acute alcohol intoxication, mainly because of severe reduced consciousness, is increasing. However, the characteristics of these adolescents are mainly unidentified. In this clinical research, we aimed to identify factors that attribute to higher ethanol concentration, on which targeted alcohol health interventions can be designed.

Methods: Since 2007, alcohol intoxication among adolescents has been one of the leading topics of the Dutch Pediatric Surveillance System. In the current study, we have analyzed which demographic characteristics, general alcohol use behaviors, and clinical intoxication data were related to the blood alcohol concentration (BAC) levels at hospital admittance. We included all adolescents aged <18 years, admitted with BAC >0.0 g/l, and reduced consciousness during the years 2007, 2008, 2009, and 2010.

Results: A total of 2,023 adolescents with alcohol intoxication were reported, and 1,618 questionnaires were returned, of which 1,350 met our inclusion criteria. In univariate analysis, age, gender, educational level, place of alcohol purchase, place of alcohol consumption, age of first drink, and regular alcohol use during the weekend correlated with higher BAC. After multivariate analysis, older adolescents, boys, and higher educational level significantly attributed to higher BAC at admittance.

Conclusions: In alcohol-intoxicated adolescents with reduced consciousness, gender, age, and also educational level correlate with BAC at admittance. Explanatory factors could be found in sensitivity to alcohol, but also in socioeconomic factors, which influence availability. Intervention strategies could be targeted more specific now for the subgroups found in this study to decrease the growing burden of adolescent alcohol intoxication, both on the societal level and on the clinical level.

Key Words: Adolescent, Alcohol Intoxication, Education, Gender.

IDENTIFYING RISK GROUPS is essential for generating foci for intervention and prevention strategies against alcohol intoxication among adolescents. As this is a relatively new phenomenon, the definition is disputable, and characteristics mostly unknown. On the one hand, traditional risk factors for alcohol abuse could apply, such as male gender, living with peers, a family history of alcohol use, psychiatric disorders, and substance abuse (Boot et al., 2010; Mares et al., 2011; Wilens and Biederman, 2006). On the other hand, alcohol use has become a common good in the Netherlands; up to 85% of adolescents consume alcohol (Hibell et al., 2009). So far, Dutch research demonstrated that the population adolescents admitted with alcohol intoxication is a demographic reflection of Dutch society (van Hoof et al., 2011).

According to international research, the amount of alcohol used can be influenced through intervention by national guidelines, commercial policies, or parental involvement (Bellis et al., 2010; Hughes et al., 2011; Purshouse et al., 2010; Schelleman-Offermans et al., 2012). Nevertheless, the number of alcohol-intoxicated adolescents admitted to Dutch hospital continues to rise, bearing witness to a pediatric problem that is not yet being treated successfully (Bouthoorn et al., 2011b; van Hoof et al., 2011). Most of these adolescents binge drink their way into hospital. Binge drinking is defined as drinking 4 (women) to 5 (men) alcoholic drinks in a short period of time (Wechsler et al., 1995). However, as youngsters react differently to alcohol, these definitions could even underestimate the amount of alcohol involved in binge drinking among adolescents (Donovan, 2009). Also, reduced consciousness seems to be a practical criterion that applies to the adolescents that are admitted and could be considered in defining alcohol intoxication.

The acute consequences of alcohol intoxication, such as hypothermia, reduced consciousness, and electrolyte disturbances, are serious but often reversible (Bouthoorn et al., 2011a). Nonetheless, fatal cases of alcohol overdose are also known. In the long term, however, alcohol use at a

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young age is related to several harmful problems, such as unintentional injury, violence, and delinquency (Black et al., 2009; Hingson et al., 2009; Miller and Spicer, 2012), unwanted sexual experience (Dahle et al., 2010), smoking, cannabis, and other drugs use (Miller et al., 2007). Over the past decade, reports have shown a negative effect of alcohol on brain function. Binge-drinking patterns in particular have a negative effect on higher cognitive functions (Tapert et al., 2004/2005). Besides, alcohol use in early adolescence predicts alcohol use in early adulthood and at a mature age (McCarty et al., 2004). The World Health Organization (WHO) recently identified alcohol use among young people (10 to 24 years) as the most important factor contributing to disability adjustable life years (Gore et al., 2011).

In this study, we investigated the group of adolescents that are admitted to the hospital due to alcohol intoxication with reduced consciousness. We hypothesized that this specific group might be divided into subgroups. For example, insight into generalized or incidental alcohol abuse, social problems, or educational factors could be gained. We used an explanatory multivariate model to investigate the influence of demographic characteristics and patterns of alcohol use on the blood alcohol concentration (BAC) in adolescents with alcohol intoxication. We hereby aim to identify characteristics, which could then be targeted for intervention strategies during follow-up.

MATERIALS AND METHODS

Data Collection

This study analyzed data collected by the Dutch Pediatric Surveillance System (NSCK). All reporting pediatricians are Advanced Pediatric Life Support trained and certified, and assess patients accordingly. In the Netherlands, when an adolescent is admitted to the pediatric department, the pediatrician interviews the patient the morning after admittance. The information from that conversation is coded onto the questionnaire provided. The pediatric department reports an admission and returns the questionnaire by mail or digitally to the research group. Data collection started in 2007 and is on going. To collect information on alcohol intoxication, the NSCK includes all the adolescents (age < 18 years) with any amount of alcohol in the blood (concentration >0.0 g/l). For the current analysis, we selected those patients who had been admitted primarily because of alcohol intoxication and were unresponsive according to AVPU criteria.

Variables

The questionnaire which was used to collect patient information contained 4 main parts: (i) general characteristics of the adolescent, (ii) demographic information, (iii), patterns of alcohol and substance use, and (iv) intoxication characteristics. In this study, the outcome variable was defined as BAC (grams of alcohol per liter blood). The 17 explanatory variables analyzed in this study were as follows:

1. General: gender, age
2. Demographic: family composition, position within the family, siblings, parental knowledge of alcohol use, educational level, school performance, religion, culture, registration to medical aid agencies
3. Alcohol use patterns: age of first alcoholic drink, mean number of glasses per week day, mean number of glasses per weekend day
4. Intoxication characteristics: alcohol-obtaining practice, location of alcohol consumption, people present during consumption

Data Analysis

Data were analyzed using SPSS for Windows, version 18. We performed a multivariate linear regression analysis with BAC as outcome variable. BAC was normally distributed.

Each explanatory variable was analyzed with respect to the outcome variable using univariate analysis. All variables were checked for normality with the Kolmogorov–Smirnov test. Depending on the presence of normality, we used either analysis of variance (ANOVA) or Kruskal–Wallis for the univariate analysis. Analysis of the difference in outcome with respect to 2 groups was performed using the Mann–Whitney test or the independent sample *t*-test. The relation between a continuous variable and the outcome was tested using Pearson's correlation. We used the general linear model method for the multivariate analysis, including the independent variables that were significant in the univariate analysis. A p-value below 0.05 was considered as significant. We only analyzed the main effects of the explanatory variables. No imputation techniques were used.

RESULTS

From 2007 until 2010, a total of 2,023 cases were reported, and 1,618 questionnaires were returned. The response rate was 79.9%, and 90% of the Dutch hospitals had participated. In the beginning of registration, some of the returned questionnaires were given double identification numbers, and a total of 1,536 were eligible. In total, 1,350 questionnaires with main reason of admittance reduced consciousness were analyzed. Most patients admitted with alcohol intoxication are brought to the closest hospital by ambulance, because they are found unconscious in either gatherings at home, on the street, or at a bar. A much smaller amount is brought in by friends or care-takers because they have found them. Other reasons for admittance, in which patients were underage and had a positive ethanol concentration, were excluded in the analysis (traffic accidents [n = 50], other accidents [n = 65], violence [n = 44], suicide attempts [n = 10], and other [n = 17]). From earlier publications in the same cohort, we know that only 9–12% report positive on questions on other drug use, the majority of patients do not combine alcohol with other substances. These percentages are stable over the years (chi-square, p = 0.124).

Mean age was 15.1 years (confidence interval [CI]: 15.02 to 15.24), the youngest child admitted was 11 years old. Mean

Table 1. Baseline Characteristics of Continuous Variables

Variable	Number	Value (95% CI)
Age (years)	1,343	15.1 (15.02–15.24)
Age of first alcoholic drink (years)	907	13.5 (13.3–13.7)
Alcohol use during week (glasses per day)	659	0.20 (0.10–0.29)
Alcohol use during the weekend (glasses per day)	662	2.92 (2.63–3.21)

Table 2. Explanatory Variables, Subgroups, and Mean Blood Alcohol Concentration (BAC)

Variable	X	Number	Percentage (%)	Mean BAC (g/l) (95% CI)
Total		1,350		1.84 (1.81–1.88)
Gender		1,335		
	Male	706	52.9	1.93 (1.88–1.97)
	Female	629	47.1	1.76 (1.71–1.81)
Family composition		1,245		
	Traditional	889	71.4	1.86 (1.82–1.90)
	Other	317	25.5	1.83 (1.76–1.90)
	Foster family	19	1.5	1.76 (1.30–2.22)
	Foster home	19	1.5	1.67 (1.31–2.04)
	Independent	1	0.1	
Position		1,011		
	Oldest	328	32.4	1.86 (1.79–1.92)
	Youngest	430	42.5	1.88 (1.82–1.94)
	In between	253	25.0	1.82 (1.74–1.90)
Siblings		1,070		
	Brother	381	35.6	1.90 (1.83–1.96)
	Sister	363	33.9	1.86 (1.80–1.92)
	Brother and sister	247	23.1	1.77 (1.69–1.86)
	None	79	7.4	1.84 (1.68–1.99)
Cultural background		1,256		
	Dutch	1,059	84.3	1.86 (1.83–1.90)
	Moroccan	10	0.8	2.03 (1.50–2.57)
	Surinam	41	3.3	1.92 (1.73–2.11)
	Dutch Antilles	15	1.2	1.87 (1.50–2.24)
	Turkish	27	2.1	1.83 (1.57–2.10)
	Other	104	8.3	1.72 (1.60–1.85)
Religion		885		
	Catholic	152	17.2	1.92 (1.82–2.01)
	Christian	98	11.1	1.87 (1.75–1.99)
	Jewish	3	0.3	2.40 (1.19–3.60)
	Muslim	33	3.7	1.87 (1.68–2.07)
	Hindu	14	1.6	1.62 (1.37–1.87)
	Buddhist	3	0.3	0.70 (0.00–1.43)
	None	533	60.2	1.84 (1.79–1.90)
	Other	49	5.5	1.76 (1.62–1.90)
Educational level		1,122		
	Prevocational	575	44.3	1.79 (1.74–1.84)
	General secondary	247	21.6	1.91 (1.83–2.00)
	Preuniversity	196	17.4	1.92 (1.84–2.00)
	Special Education	32	2.9	1.96 (1.72–2.19)
	Working	3	0.3	2.13 (0.00–4.64)
	Preliminary school	12	0.9	1.54 (1.01–2.07)
	Other	57	5.1	1.70 (1.54–1.86)
School performances		1,036		
	Not-repeated	822	79.3	1.86 (1.82–1.91)
	Repeated	180	17.4	1.76 (1.67–1.88)
	Repeated more than once	12	1.2	1.83 (1.38–2.28)
	Drop-out	22	2.1	1.96 (1.59–2.33)
Place of purchase		1,232		
	Home	143	11.6	1.85 (1.75–1.95)
	Friends	577	46.8	1.86 (1.81–1.91)
	Grocery store	121	9.8	1.78 (1.67–1.89)
	Liquor store	45	3.7	2.20 (1.98–2.42)
	Pubs and restaurant	218	17.7	1.79 (1.71–1.87)
	Other	128	10.4	1.83 (1.73–1.93)
Place of consumption		1,310		
	At home	104	7.9	1.80 (1.70–1.91)
	Independent home	11	0.8	1.60 (1.16–2.04)
	At home of others	462	35.3	1.89 (1.84–1.95)
	On the street	329	25.1	1.82 (1.75–1.89)
	At work	12	0.9	1.63 (0.99–2.27)
	At school party	53	4.0	1.84 (1.68–2.01)
	Cantina	41	3.1	2.01 (1.83–2.18)
	In pub/restaurants	201	15.3	1.77 (1.68–1.85)
	On vacation	9	0.7	2.28 (1.61–2.95)
	Other	88	6.7	1.84 (1.71–1.98)

Continued.

Table 2. (Continued)

Variable	X	Number	Percentage (%)	Mean BAC (g/l) (95% CI)
Persons present		1,324		
	Nobody	32	2.4	1.76 (1.52–2.00)
	Friends	1,238	93.5	1.85 (1.81–1.88)
	Parents	7	0.5	1.49 (0.73–2.26)
	Other family members	17	1.3	1.88 (1.59–2.16)
	Strangers	10	0.8	1.91 (1.41–2.40)
	Other	20	1.5	1.92 (1.66–2.17)
Medical history		1,255		
	Nowhere	830	66.4	1.85 (1.81–1.89)
	Pediatrician	137	10.9	1.80 (1.69–1.91)
	Psychologist	44	3.5	1.64 (1.45–1.84)
	Other specialist	36	2.9	2.06 (1.78–2.33)
	GGZ	60	4.8	1.78 (1.60–1.97)
	Youth Care	94	7.5	1.86 (1.73–1.99)
	Other	54	4.3	1.72 (1.52–1.92)

BAC was 1.84 g/l (CI: 1.81 to 1.88). Mean time of reduced consciousness was 2.90 hours (CI: 2.59 to 3.22) (Table 1).

Mean BAC for every subgroup is shown in Table 2. Univariate correlation coefficients of the variables are presented in Table 3. Boys had a significantly higher BAC than girls (1.93 g/l vs. 1.76 g/l, p-value = 0.0001). BAC significantly correlated with age (Pearson's r = 0.182, p-value = 0.0001).

Educational level was correlated with BAC (p-value = 0.037). Mean BAC was high in the adolescents who only worked (2.13 g/l), those attending special education (1.96 g/l) and those with a higher educational level (1.92 g/l). Lowest BAC was found in patients attending preliminary school (1.54 g/l).

Adolescents who had dropped out of school had a higher BAC than those who had only repeated once or had never repeated a class (1.96 g/l, vs. 1.76 g/l vs. 1.86 g/l, respectively), but the differences were not significant (p-value = 0.162).

Of the demographic variables that were considered in the analysis, the family-related variables did not attribute significantly to BAC. Children raised in traditional families, foster care, orphanages, independent living situation, or other compositions (divorced, single parents) did not attribute significantly to BAC (p-value = 0.737). Having siblings (a brother or brothers or a sister or sisters) or not did not correlate with BAC (p-value = 0.116). The position within the family (oldest, youngest, or not-oldest/not-youngest) was not related to BAC, either (p-value = 0.481). Parental involvement, measured by asking patients if their parents were aware of the exact amount of alcohol they drank, was not significantly associated with BAC (p-value = 0.174).

Other demographic factors of interest were religion and cultural background. Neither religion nor cultural background showed a significant relation with BAC (p-value = 0.533, p-value = 0.363, respectively).

Considering medical history, those who had attended a psychologist had the lowest BAC (1.64 g/l). This variable correlated significantly with BAC (p-value = 0.066).

Characteristics of alcohol use were associated with increased BAC. Place of consumption (at home, at a friend's home, in public places, at work) correlated significantly with BAC (p-value = 0.042). BAC was highest when consumption took place on vacation (2.28 g/l) or in a cantina (2.01 g/l).

Place of purchase also correlated significantly with BAC (p-value = 0.012). If alcohol was purchased in a liquor store, BAC was highest (2.20 g/l), compared with obtainment at a bar or restaurant (1.79 g/l), supermarket (1.78 g/l), at home (1.85 g/l), or at a friend's home (1.86 g/l).

General alcohol use during the week was 0.20 glasses per day (CI: 0.10 to 0.29). In the weekend, this increased to 2.92 glasses per day (CI: 2.63 to 3.21). Alcohol consumption during the week was not significantly correlated with BAC at admittance (Pearson's r = 0.022, p-value = 0.600), whereas alcohol use in the weekend was (Pearson's r = 0.160, p-value = 0.0001).

Table 3. Results of Univariate and Multivariate Analysis of Explanatory Variables with Outcome Blood Alcohol Concentration (BAC) (g/l)

Variable	Univariate p-value	Multivariate p-value
Age (years)	0.0001[a]	0.001
Gender	0.0001[b]	0.000
Family situation	0.737[c]	
Position family	0.481[d]	
Siblings	0.116[d]	
Parental involvement	0.174	
Religion	0.533[d]	
Cultural background	0.363[c]	
Educational level	0.037[c]	0.006
School performance	0.162[c]	
Place of purchase	0.012[c]	0.495
Place of consumption	0.042[d]	0.069
Persons present	0.643[c]	
Age of first drink	0.001[a]	0.096
Alcohol use during the week	0.600[a]	
Alcohol use during the weekend	0.0001[a]	0.091
Medical history	0.066[c]	

[a]Pearson's correlation.
[b]Mann–Whitney.
[c]Kruskal Wallis.
[d]ANOVA.

The mean age of first alcoholic drink was 13.5 years (CI: 13.3 to 13.7). Age of first alcoholic drink was associated significantly with BAC (Pearson's $r = 0.115$, p-value = 0.001).

Multivariate Analysis

Outcome of multivariate analysis is shown in Table 3. A general linear model was used for multivariate analysis of the significant explanatory variables age, gender, educational level, place of purchase, place of consumption, age of first alcoholic drink and alcohol use during the weekend. Age (p-value = 0.001) as well as gender (p-value = 0.0001) continued to be associated with BAC.

Educational level (p-value = 0.006) was also significant. Analysis of parameters' estimates showed that preuniversity educational level (p-value = 0.047) and work (p-value = 0.005) accounted for the significance of educational level. The R^2 was 0.160, and the adjusted R^2 was 0.115.

No significant correlation with BAC was found for the remaining factors, place of obtainment (p-value = 0.495), place of consumption (p-value = 0.069), age of first alcoholic drink (p-value = 0.096), and alcohol use during the weekend (p-value = 0.091).

DISCUSSION

This study shows that BAC was higher in males and rose with age in alcohol-intoxicated adolescents admitted to the hospital because of reduced consciousness. More surprisingly, higher educational level was also significantly associated with increased BAC levels, while the role of parents' involvement and family composition was not associated with higher BAC.

Our findings are in line with earlier studies describing a gender difference in sensitivity to alcohol (Baraona et al., 2001; Bouthoorn et al., 2011b; Zeiner et al., 1983). The male adolescents admitted with a higher BAC had consumed larger amounts of alcohol before they became unconscious. BAC directly represents the amount of alcohol consumed, as the number of glasses drunk can be calculated from the ethanol concentration using the equation of Widmark (1981). Independent of gender differences, alcohol concentration in blood is directly related to level and duration of unconsciousness (Lamminpaa, 1995). Although this finding is not new, admitted male adolescents can be targeted for strategies to change their drinking behavior.

Higher BAC in relation to age may also be explained by a decreased sensitivity to alcohol, caused by more frequent alcohol use. In comparison with adults, adolescents eliminate alcohol at the same rate, whereas younger children process alcohol more rapidly (Lamminpaa et al., 1993). According to Silvers and colleagues (2003) a chronic intermittent alcohol drinking pattern (binge drinking) leads to a better and thereby faster metabolic tolerance of alcohol in rats.

However, neurological effects between adults and adolescents differ. The severe toxicity by ethanol, manifesting in coma, occurs in lower BACs in children than in adults (Lamminpaa et al., 1993). In another animal study, binge-drinking adolescents reacted differently to alcohol in comparison with adults, specifically hippocampal function was altered (Tokunaga et al., 2006). Although younger adolescents have a lower BAC, they should be warned for the risk of passing out and other possible unwanted neurological effects.

In contrast to previous studies, we found that higher educational participation was related to higher BACs and therefore to increased alcohol use. The Dutch secondary school system contains 3 major educational levels, prevocational, general secondary, and preuniversity, which take 4, 5, and 6 years, respectively. Therefore, patients with higher educational levels were older, but multivariate analysis corrected for this factor. Not many studies address the clinically evaluated adolescents with alcohol use. Binge drinking appeared to be more confined to the lower educated, although heavy drinking was more common among better educated women than among lower educated women (Helasoja et al., 2007). In general, risky health behavior is more often related to lower socioeconomic position (Drieskens et al., 2010). In adults, according to a Danish study on the effect of education on health behavior, higher education appears to have a suppressive effect on the variability of smoking and alcohol use (negative health behavior) (Johnson et al., 2011). Another north European study concluded that socioeconomic circumstances during childhood particularly influenced educational level and therefore health in adulthood (Kestila et al., 2009).

Although our data are restricted by the age range of the patients, our patient group does not fit the general observation that associates risky health behavior with lower educational levels. Besides the higher educated adolescents, adolescents who worked instead of going to school were also admitted with higher BAC levels. These findings may be explained by social and economic availability of alcohol, which are known risk factors for alcohol use (Institute, 2005; Spijkerman et al., 2008). Higher educated adolescents could have access, for example, at home, to stronger liquor instead of more readily available and cheaper beer. This should be further analyzed.

From a health-promotion point of view, campaigns against alcohol abuse have had little success. Although they are targeted toward the young, they are possibly overshadowed by marketing and political strategies (Wakefield et al., 2010). Our results could indicate that it is time for a shift in focus. Alcohol intoxication among adolescents is not confined to the lower educated, and it is the higher educated whom are admitted with a higher BAC. Differentiated campaigns, directed toward more specific subgroups, can be tried out to gain an effect.

Other possible predictors and background variables turned out not to be significantly associated with BAC. Interestingly, the role of parents' involvement and family composition was not associated with higher BAC, while evi-

dence exists for their influence on health and drinking behavior (van der Vorst et al., 2006; Windle et al., 2010). This may be explained by inaccurate measurement by insufficient discrimination of subgroups. An improved questionnaire is currently in use to investigate these possible risk factors more thoroughly.

Another possible explanation may be a form of selection bias due to the fact that only binge-drinking adolescents were included. Perhaps, there is a more prominent difference to be found between drinking and nondrinking adolescents or between moderate and binge-drinking adolescents. However, as the ESPAD study demonstrated, up to 85% of adolescents in the Netherlands consume alcohol (Hibell et al., 2009).

One of the strengths of this study is the large number of included patients. The registration system used was designed in 2007, and since then, the total cohort has been growing, due to increasing numbers of adolescents admitted to hospital with an alcohol related issue. Moreover, the hospital participation rate and the high response rate ascertain a good representation of the population of adolescents with alcohol intoxication.

A possible limitation of this study may be that not all the reports had been filled in completely, which might have caused random errors in statistical analysis, as well as systematic bias. Measurement bias could have played a role as well, due to the use of questionnaires which have not been validated and are based on an interview by the physician. This could inhibit providing certain information. However, the questionnaire was designed to collect information in particular on demographic information and not to psychosocially screen more delicate subjects. Most questions are also considered in the anamnesis with patients and their parents. Self-report questionnaires are considered a valid tool in many studies, and clinical decisions are based on patients' answers. Another drawback is that not all possible risk factors for general alcohol use are taken into account. Familial predisposition, psychiatric disorders, and other drug abuse are factors that could play a role. As mentioned, an improved questionnaire is currently in use, which contains these factors.

The multivariate model used in this study cannot predict so much as explain the existence of certain risk groups for severe alcohol use within the adolescent population that is clinically visible. In spite of an academic discussion on the interpretation of explained variances, it is worth mentioning that we found a 0.160 R^2. In other words, about 16% of the high BAC in intoxicated adolescents can be explained by age, gender, and educational level. If we are able to design targeted campaigns here, alcohol related harm in youth would be decreased significantly. Also, family treatment, (short) motivational enhancement therapy, and behavioral therapy could be used to decrease alcohol and substance use (Caria et al., 2011). A promising attempt in the Netherlands was established in the form of an individualized follow-up program in the outpatient department of pediatrics and child psychology. As these adolescents are admitted to the pediatric ward, alcohol intoxication is not only a societal, but also a medical problem. More insight into who these children are is necessary for their treatment. Boys, older adolescents, and higher educated or working adolescents could be targeted for specific intervention strategies.

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