

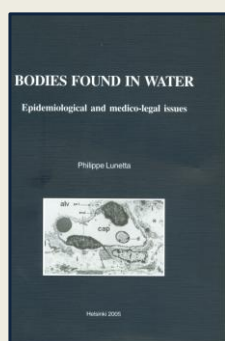
DROWNING, DRUGS AND ALCOHOL

WCDP 2011, Danang (Vietnam)

10.-13.5.2011

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National Institute for Health and Welfare, Finland*



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Department of Forensic
Medicine**

**National Institute for
Health & Welfare
Injury Prevention Unit**



FINLAND



FINLAND



Population: 5,400,000

Lakes: 188,000

Coast-line: 1100 km

Inland water: 33,615 km²

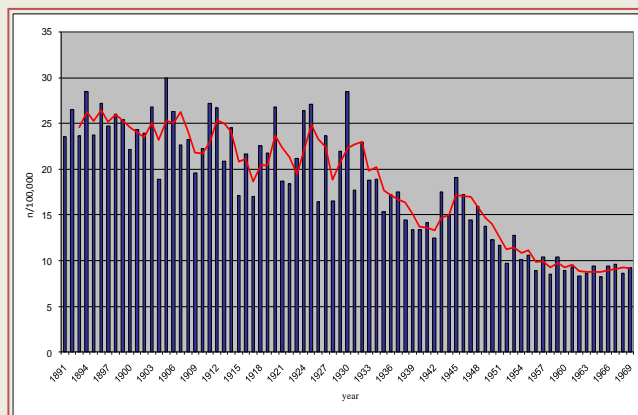
Registered boat: 600-700,000

Swimmers: 500,000

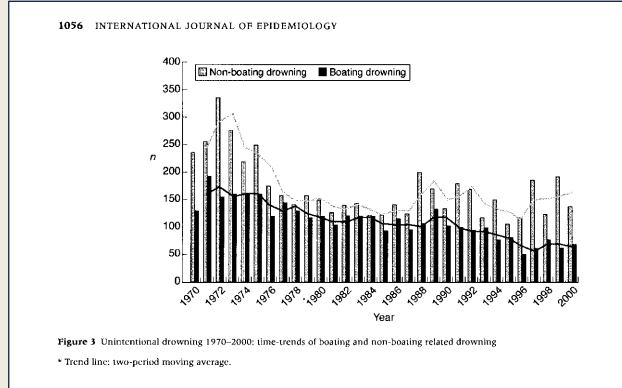
DROWNING RESEARCH

1. High unintentional drowning rates
2. High medico-legal autopsy rates

1. HIGH UNINTENTIONAL DROWNING RATES

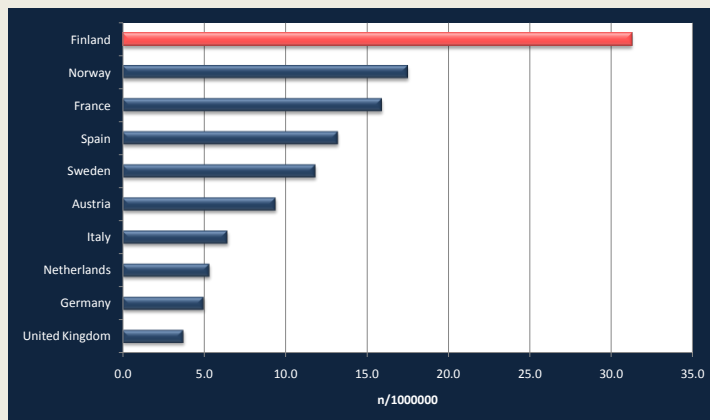


1. HIGH UNINTENTIONAL DROWNING RATES



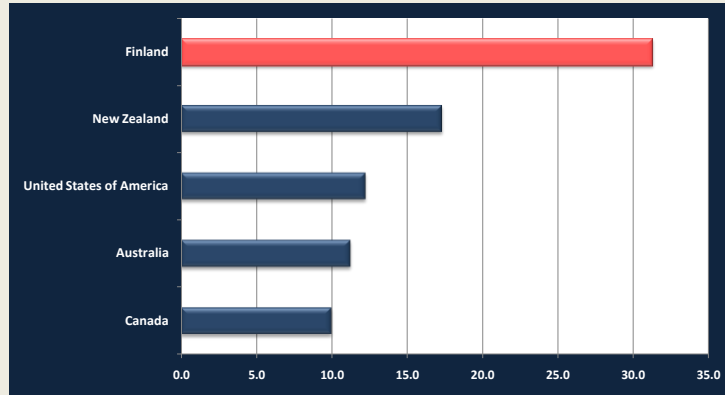
Lunetta P et al. International Journal of Epidemiology 2004; 33: 1058-1063

1. HIGH UNINTENTIONAL DROWNING RATES



Source: WHO database, 2006-2008, ICD-10: V90, W65-74

1. HIGH UNINTENTIONAL DROWNING RATES



Source: WHO database, 2006-2008, ICD-10: V90, W65-74

1. HIGH UNINTENTIONAL DROWNING RATES

Drowning	N – 100%
• Boating-related	37.1%
• Non boating-related	56.5%
• Land traffic	5.7%

Lunetta P et al. International Journal of Epidemiology 2004; 33: 1058-1063

2. HIGH MEDICO-LEGAL AUTOPSY RATES

- **Act of the Inquest into cause of death (L459/73)**
- Death has not been caused by a disease or when during the last illness he/she has not been treated by a physician
- Death caused or suspected to be caused by crime, accident, suicide, poisoning, occupational disease, or medical treatment
- Death otherwise unexpected

2. HIGH MEDICO-LEGAL AUTOPSY RATES

	N/year	Medico-legal autopsies (%)
Overall deaths	50,000	22%
Injury deaths	4000	92%
Drowning	250-300	99.9%

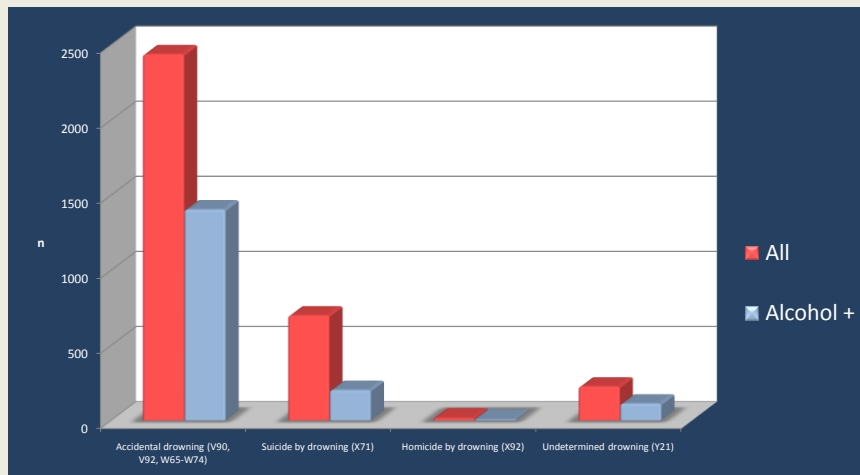
DROWNING AND ALCOHOL

- **Alcohol use is the major individual risk factor for drowning**
- **Most of the international studies: 25-50% of drowning are alcohol-related**

ALCOHOL-POSITIVE DROWNING (1998-2009)

- **Overall unintentional drowning 57.7%**
 - **Boating-related drowning 62.2%**
 - **Non boating-related drowning 55.7%**

ALCOHOL-POSITIVE DROWNING (1998-2009)



Philippe Lunetta, MD, Helsinki University & National Institute for Health and Welfare

DROWNING AND ALCOHOL

- **MEDICAL LITERATURE**
- **PIONEER ARTICLES**
 - Norway: Giertsen JC. Drowning while under the influence of alcohol. Med Sci Law 1970
 - Norway: Arner O. The role of alcohol in fatal accidents among seamen. Br J Addict 1973
 - Australia: Plueckhahn VD, The aetiology of 134 deaths due to "drowning" in Geelong ... Med J Aust. 1972

DROWNING AND ALCOHOL

- **MEDICAL LITERATURE**
- **REVIEW ARTICLES**
 - Howland J, Hingson R. Alcohol as a risk factor for drowning: a review of the literature. *Accid Anal Prev* 1988
 - Driscoll TR et al. Review of the role of alcohol in drowning associated with recreational aquatic activity. *Inj Prev* 2004

DROWNING AND ALCOHOL

- **MEDICAL LITERATURE**
- **ARTICLES IN FOCUS**
 - National
 - Regional
 - Jurisdiction

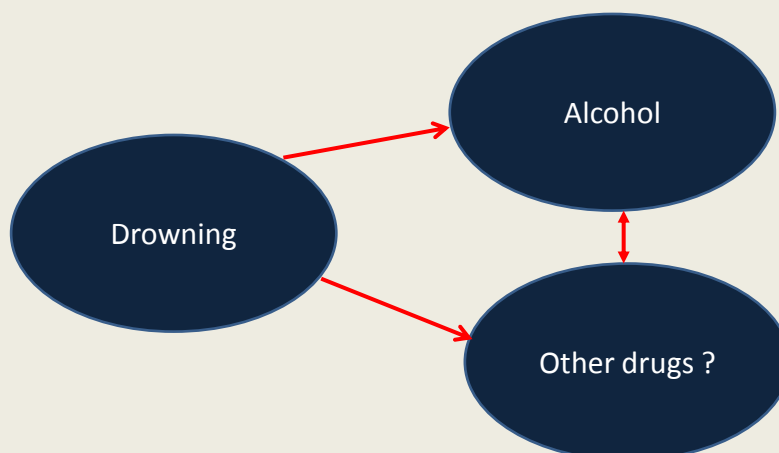
Pub Med search with "drowning" and "alcohol":
293 articles

DROWNING AND ALCOHOL

- **ALCOHOL AS A RISK FACTOR FOR DROWNING**
 1. **Fall into water in different settings**
 2. **Swim or boating in dangerous situation**
 3. **Operate a boat improperly**
 4. **Hamper decision-making regarding safety**
 5. **Decrease the capacity to swim or resist cold in water**

DROWNING AND OTHER DRUGS

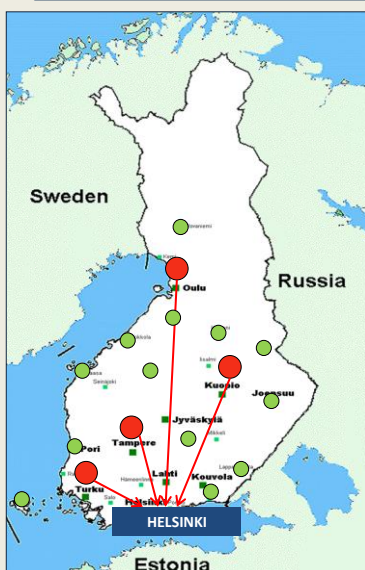
- **MEDICAL LITERATURE:**



MATERIAL AND METHODS

- **Setting: Finland, 2000-2009**
- **Helsinki Department of Forensic Medicine, Toxicological Laboratory database**
- **Selection criteria: ICD-10 nature of injury code for drowning: T75.1**

MATERIAL AND METHODS



- **5 UNIVERSITY FORENSIC MEDICINE DEPT.**
- **15 HOSPITALS, MEDICO-LEGAL AUTOPSY**

MATERIAL AND METHODS



- 7000 POSTMORTEM TOXICOLOGICAL ANALYSIS
- 2500 MEDICO-LEGAL AUTOPSIES
- 2900 CLINICAL FORENSIC EXAMINATIONS

MATERIAL AND METHODS

A. Rapid alcohol screening (QED) cerebral liquid



MATERIAL AND METHODS

OikeuskemiaNo	ikä	sp	veAiko	KLK	ULKsyy	lääki	pitoisuus	ATC	hoitoalue
2000/0156b	74	nainen	0	I	X71	karbamatsiini	7,6	N03AF01	hoitoalue 5 - 10 mg/l
2000/0179b	75	mielis	0	I	X71	vetofalaksiini	0,5	N02AX16	hoitoalue 0.07 - 0,3 mg/l
2000/0205b	36	mielis	0	T	W74	ketoprofeeni	1,6	N05BA02	hoitoalue 0.1 - 1,0 mg/l
2000/0214b	22	mielis	0	I	X71	diakarbamiini	0,2	N06AB04	hoitoalue 0.06 - 0,4 mg/l
2000/0381b	43	mielis	0	T	V499	lofeeni	2	N06BC01	viitealue 8 - 15 mg/l
2000/1143b	53	nainen	0	E	Y21	tolbutamidi	142,9	A10BB05	hoitoalue 45 - 100 mg/l
2000/1235b	26	mielis	1,7	E	Y21	demoksepaami	0,2		hoitoalue 0.3 - 2,8 mg/l
2000/1392b	61	nainen	0	I	X71	aminofenatsoni, 4-metyyli	25		hoitoalue 10 - 10 mg/l
2000/1395b	51	nainen	0	I	X71	sitoproraami	1,1	N06AB04	hoitoalue 0.06 - 0,4 mg/l
2000/1439b	57	nainen	0	T	W68	hydroksikarbamatsepiini	16,5		hoitoalue 2 - 30 mg/l
2000/1450b	60	mielis	1,1	T	W69	amitriptyliini	0,1	N06AA09	hoitoalue 0.04 - 0,2 mg/l
2000/1538b	67	nainen	0	I	X71	parasetamoli	6	N02BA01	hoitoalue 10 - 25 mg/l
2000/1584b	78	nainen	0	I	X71	lofeeni	4	N06BC01	viitealue 8 - 15 mg/l
2000/1594b	47	mielis	0	T	W74	karbamatsiini	12	N03AF01	hoitoalue 5 - 10 mg/l
2000/1609b	55	mielis	1,6	I	X71	tematsepaami	3,2	N05CD07	hoitoalue 0.4 - 0,9 mg/l
2000/1609b	41	mielis	2,6	T	W74	midatsolami	0,07	N05CD08	hoitoalue 0.08 - 0,2 mg/l
2000/1713b	61	mielis	1,8	T	V19	oksetsepaami	0,4	N05BA04	hoitoalue 0.1 - 1,4 mg/l
2000/1893b	32	nainen	1,9	I	X71	topiksiini	0,8	N05CF01	hoitoalue ad 0.1 - 0,3 mg/l
2000/1946b	48	mielis	2,6	T	W69	sitoproraami	0,7	N06AB04	hoitoalue 0.06 - 0,4 mg/l
2000/1946b	88	nainen	0	I	X71	amitriptyliini	0,4	N06AA09	hoitoalue 0.04 - 0,2 mg/l
2000/2064b	74	nainen	0	T	W69	karbamatsiini	3,7	N03AF01	hoitoalue 5 - 10 mg/l
2000/2109b	31	mielis	2,9	I	X71	diakarbamiini	0,9	N06AB04	hoitoalue 0.1 - 2,5 mg/l
2000/2114b	57	nainen	0	I	X71	oksetsepaami	0,2	N05BA04	hoitoalue 0.1 - 1,4 mg/l
2000/2161b	18	mielis	0	E	Y21	okskarbatsepiini	2,0	N03AF02	hoitoalue ad 1 mg/l
2000/2198b	60	mielis	0,3	I	X71	metoprololi	1,6	C07AB02	hoitoalue 0.1 - 0,6 mg/l
2000/2213b	74	mielis	0,5	E	Y21	trimepramiini	1,2	N06AA06	hoitoalue 0.01 - 0,3 mg/l
2000/2274b	73	nainen	0	I	X71	tematsepaami	0,1	N05CD07	hoitoalue 0.4 - 0,9 mg/l
2000/2319b	44	nainen	0,3	I	X71	miritsapidiini	0,6	N06AX11	hoitoalue ad 0.2 mg/l
2000/2341b	87	mielis	0	I	X71	tramadololi	0,2	N02AX02	hoitoalue ad 0.2 mg/l
2000/2393b	51	mielis	2,6	T	W74	metoprololi	0,3	C07AB02	hoitoalue 0.1 - 0,6 mg/l
2000/2423b	37	nainen	2	I	X71	topiksiini	0,3	N05CF01	hoitoalue ad 0.1 mg/l
2000/2502b	41	nainen	2	I	X71	amitriptyliini	12	N06AA09	hoitoalue 0.04 - 0,2 mg/l
2000/2591b	65	mielis	1,2	T	W68	tematsepaami	0,5	N05CD07	hoitoalue 0.4 - 0,9 mg/l
2000/2606b	47	mielis	2,1	E	Y21	sitoproraami	0,5	N06AB04	hoitoalue 0.06 - 0,4 mg/l
2000/2616b	47	mielis	2,9	E	Y21	lofeeni	2	N06BC01	viitealue 8 - 15 mg/l

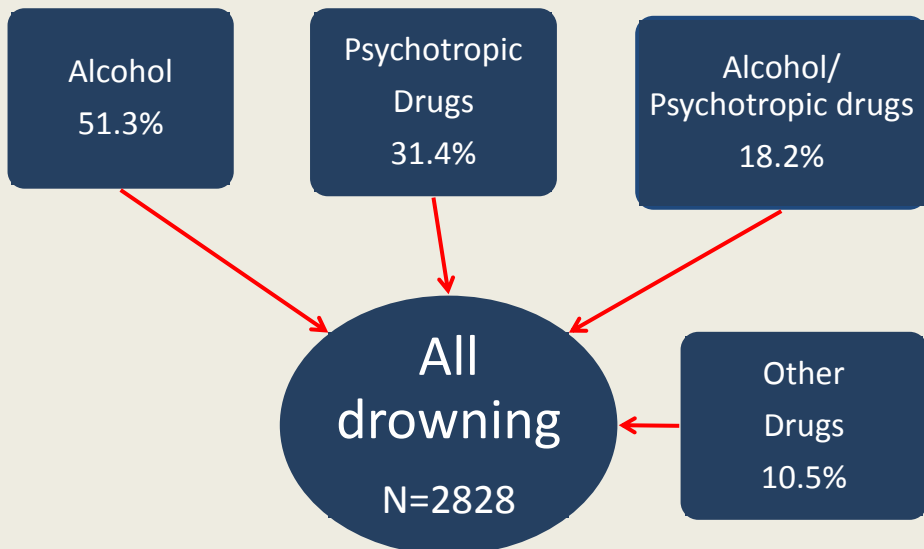
MATERIAL AND METHODS

- ATC codes (Anatomical Therapeutic Chemical classification)
- N central nervous system
 - N01 Anesthetics
 - N02 Analgesics
 - N03 Antiepileptics
 - N04 Anti-Parkinson drugs
 - N05 Psycholeptics
 - N06 Psychoanaleptics
- Other drugs

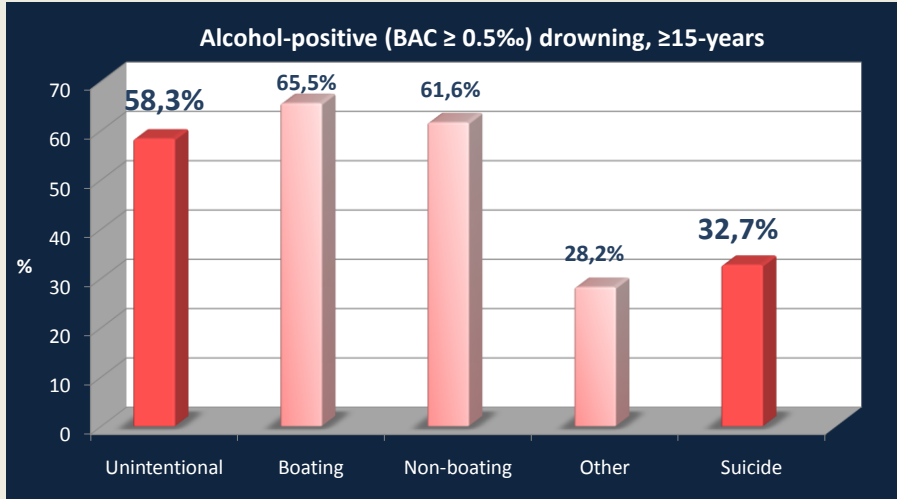
RESULTS

Drowning	N	% tested	
		alcohol	other drugs
All	2828	100%	94.4%
unintentional	2058	100%	92.9%
suicide	547	100%	98.4%
homicide	11	100%	100%
undetermined	208	100%	98.6

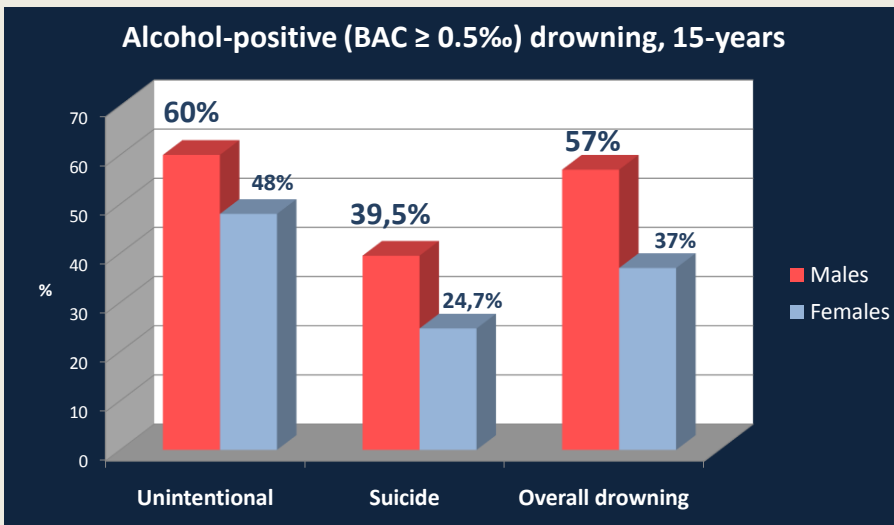
RESULTS



RESULTS - ALCOHOL

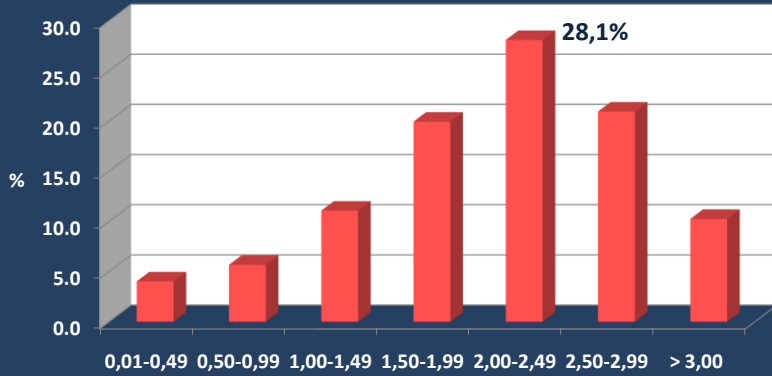


RESULTS - ALCOHOL



RESULTS - ALCOHOL

Unintentional drowning, by BAC (%) groups



- Ante-mortem alcohol consumption
- vs.
- Post-mortem alcohol production



PERGAMON

ACCIDENT ANALYSIS
PREVENTION

Accident Analysis and Prevention 35 (2005) 763-769

Evidence for an early onset of endogenous alcohol production in bodies recovered from the water: implications for studying alcohol and drowning

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Received 17 August 2001; received in revised form 1 April 2002; accepted 30 May 2002

Abstract

Endogenous alcohol production can increase the blood alcohol concentration (BAC) of drowning victims following submersion and confound epidemiological studies of the role of alcohol. This study seeks to determine how soon after a drowning death a victim's BAC is influenced by post-mortem alcohol production. The step in mean lung weight that occurs after time in the water was hypothesized to serve as a proxy for the time course of decomposition, and thus provide an empirical measure to determine how soon after death the first significant endogenous alcohol. The average lung weights of 56 previously healthy males who drowned were compared across six submersion time groups (0-11 h, 12-23 h, 24-47 h, 48-69 h, 70-147 h and >148 h) and raw ratios of gross (water and non-water) to net (water) lung weight that increased 12-23 h post submersion in the non-water months, but not until 70-147 h in the colder water months; and (2) a significant drop in lung weight was not observed in the group of cases with some BAC. With a parallel finding that an increase in the proportion of cases with a positive BAC first occurred in the 12-23 h submersion group during the warmer non-water months, we concluded that production of alcohol can occur in bodies recovered from the water as early as 12 h after death. Because excluding drownings with submersion durations greater than 12 h would exclude almost half of our cases from epidemiological studies of alcohol and drowning, additional evidence from the forensic literature was used to develop an adjustment procedure to account for endogenous alcohol production the submersion times of up to 1 week.

Keywords: Drowning; Alcohol; Endogenous alcohol; Decomposition; Lung weight

1. General introduction

Forensic pathologists have long been aware that the immersion of bodies for long periods post-drowning can give a complete understanding of the circumstances of death. The fact that decomposition can lead to the production of endogenous blood alcohol and thus overestimate ante-mortem blood alcohol concentration (BAC) has generated much discussion regarding the best means of interpreting the occurrence of these tests (Coffin, 1991; Collins and Fothergill, 1994). Blood samples taken from post-mortem bodies have shown wide variations in endogenous production that have been reported to result in BACs as high as 150 mg/dl (Coffin, 1970; Collins and Fothergill, 1994; Mayne, 1987; Zimwald et al., 1982). Many

decomposed bodies however do not produce any alcohol at all, and when endogenous alcohol is found, a majority result in BACs less than 70 mg/dl (Collins and Fothergill, 1994; Zimwald et al., 1982). Indeed, Levine et al. (1995) reviewed 181 cases with BACs less than 50 mg/dl and concluded that only 19% of BACs as high as 40 mg/dl could be attributed solely to endogenous production.

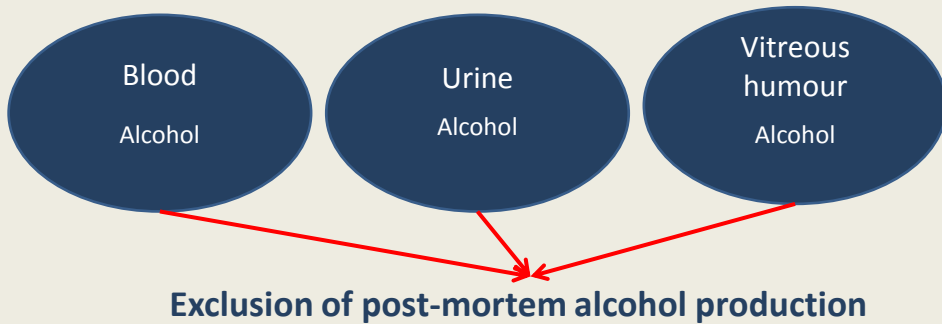
Most critical to determining the role of alcohol ingestion as a contributing factor in drowning is the possibility that a person who had not been drinking would nevertheless have a positive BAC at autopsy, thus giving the false impression that even very low BACs are associated with an increased risk of drowning. Most studies that have examined the role of alcohol in drowning have not however addressed this confounder (Coffin et al., 1965; Collins-Coxson and Chan, 2000; Collins, 1991; Davis and Smith, 1985; Haskberg et al., 1990; Loomer et al., 1990; Nicklas and Brown, 1995; Peters

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- Ante-mortem alcohol consumption vs. post-mortem production

Important
blood + urine + vitreous humour samples !



- Ante-mortem alcohol consumption vs. post-mortem production

Important
blood + urine + vitreous humour samples !



RESULTS – PSYCHOACTIVE DRUGS

Psychoactive drugs (n=922)

351 drowning victims	1 drug
250 drowning victims	2 drugs
158 drowning victims	3 drugs
92 drowning victims	4 drugs
37 drowning victims	5 drugs
34 drowning victims	6 to 9 drugs

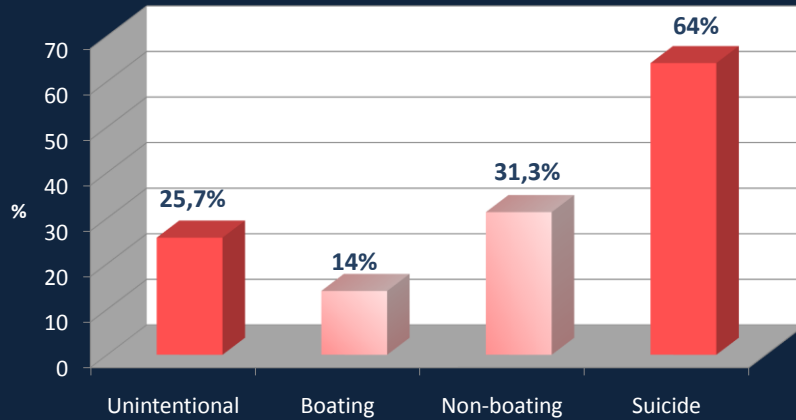
RESULTS – PSYCHOACTIVE DRUGS

83 different psychoactive drugs

Diazepam	239
Oxazepam*	258
Temazepam*	239
Citalopram	131
Zopiclone	81
Chlordiazepoxide	61
Olanzapine	51
Carbamazepine	36
Alprazolam	32
Amitriptyline	28
Tramadol	23

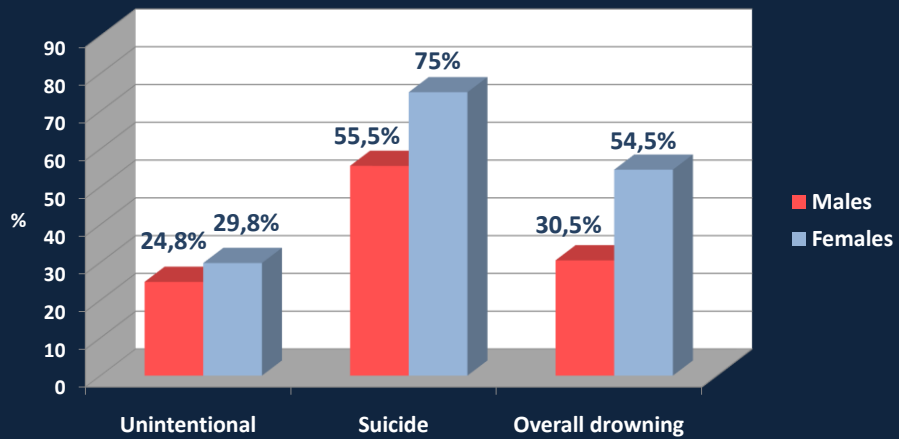
RESULTS – PSYCHOACTIVE DRUGS

Drowning associated with psychotropic drugs, ≥15-years



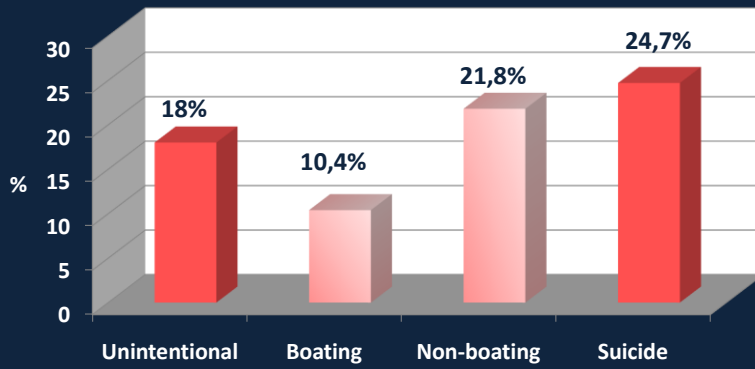
RESULTS – PSYCHOACTIVE DRUGS

Drowning associated with psychotropic drugs, ≥15-years, by sex



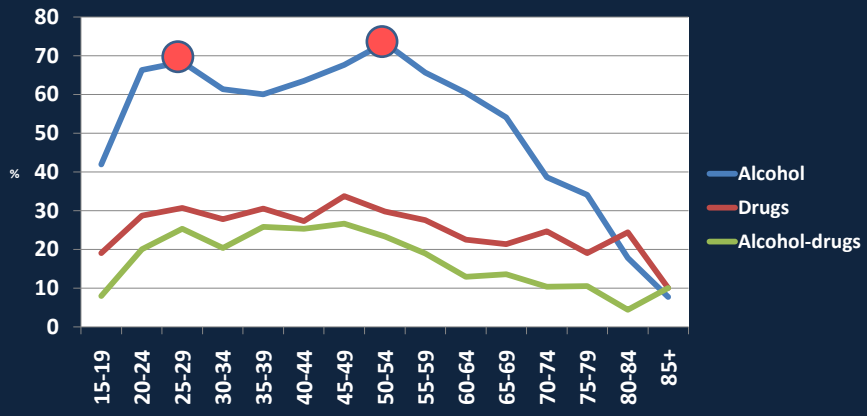
RESULTS – ALCOHOL/PSYCHOTROPIC DRUGS

Drowning associated with alcohol and psychotropic drugs
≥15-years



RESULTS

Unintentional drowning, % of positive cases
by age groups



HOW TO EVALUATE THE EFFECTS OF DRUGS?

degree of psychomotor impairments caused by
different drugs









studies on driving under the
influence of alcohol and drugs



limitations but most objective criteria available

EFFECTS OF DRUGS: SCORING SYSTEM

- Grade 0: no effects  BAC = 0,0‰
- Grade 1-2: unprobable  BAC = 0,0‰
- Grade 3: no definite  BAC = <0,5‰

- Grade 4: possible  BAC = 0,5-1.1‰
- Grade 5: probable  BAC = 1.2-2.0‰
- Grade 6: very probable  BAC = > 2.0‰

EFFECTS OF DRUGS: SCORING SYSTEM

- **Blinded by two expert toxicologists**
- **For each case, score (0-6) for**
 1. alcohol
 2. every single drug
 3. overall drugs
 4. alcohol and drugs
- **Divergent scores**
 - Consensus meeting

EFFECTS OF DRUGS: SCORING SYSTEM

Pirjo Lillsunde, Head of Laboratory
Department of Alcohol, Drugs and Addiction
National Institute for Health and Welfare

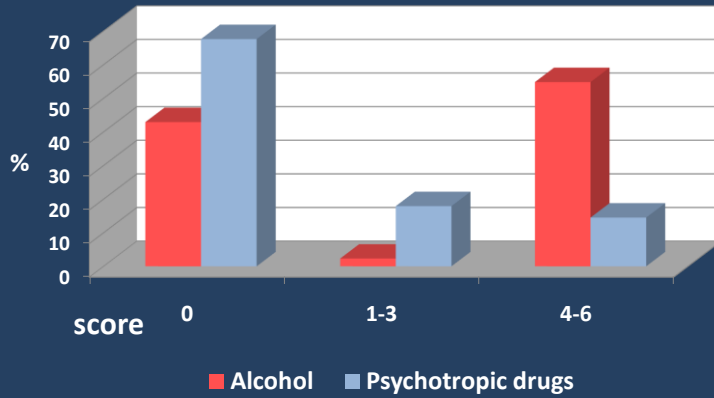


Erkki Vuori, Professor emeritus
Laboratory of Toxicology
Department of Forensic Medicine
University of Helsinki



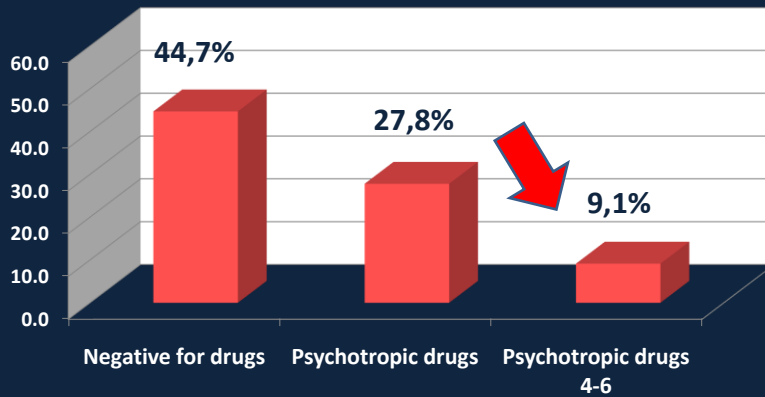
RESULTS

Unintentional drowning alcohol and psychotropic drugs, by score



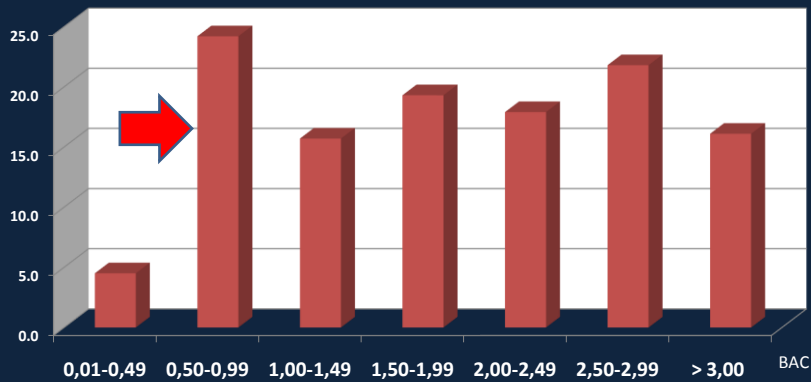
RESULTS

Unintentional drowning, psychotropic drugs in alcohol-negative cases



RESULTS

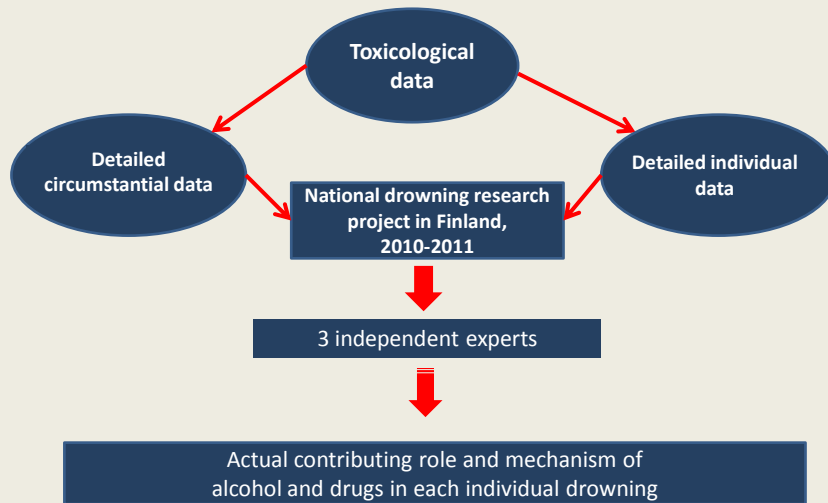
ACCIDENTAL DROWNING, % OF CASES WITH PSYCHOTROPIC DRUGS (SCORE 4-6), BY BAC



FUTURE STEPS

1. Statistical data assessment
2. Comparisons of these toxicological data with corresponding data on:
 - injury deaths due to other causes

FUTURE STEPS




CONCLUSIONS


1. Despite declines in drowning rates and various prevention programs, the drowning rates in Finland are still high
2. Finland has had much success in reducing alcohol- (and drug) related motor traffic accidents but

CONCLUSIONS

3. To reduce drowning rates to levels comparable to other HIC we must further address the issue of alcohol (and drugs?) use in aquatic settings
4. The opportunity exists in Finland for scientific advancements in drowning research

CONCLUSIONS

 **Psyco-active drugs are likely an unrecognised risk factor for unintentional drowning...**

 **but do not forget the role of alcohol in adult drowning in LMIC**



another unexplored and possibly underscored drowning-related issue

THANK YOU FOR LISTENING...

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