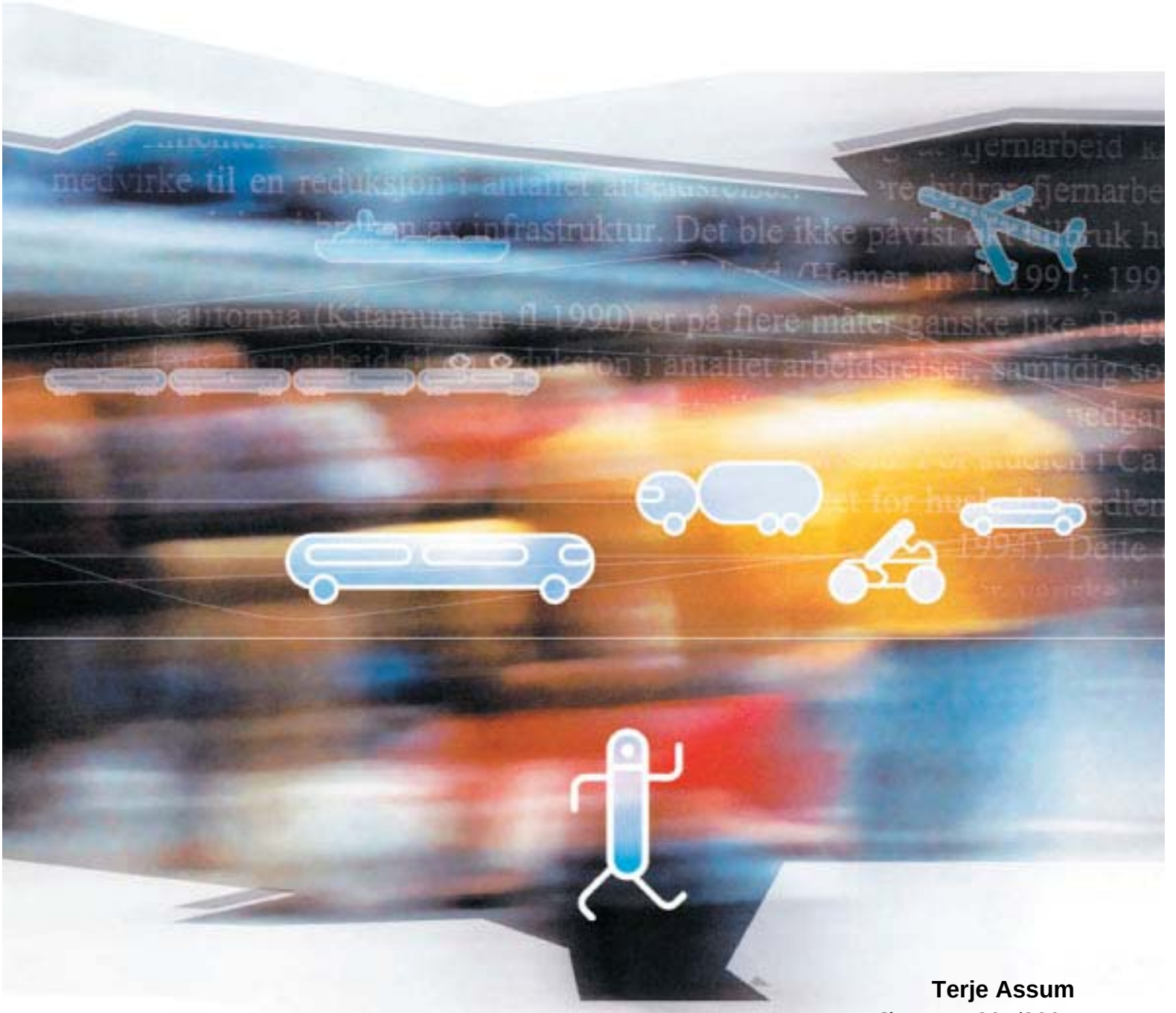
Institute of Transport Economics

The prevalence and relative risk of drink and drug driving in Norway

A case-control study in the Oslo and Bergen areas



Terje Assum

TØI report 805/2005

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Summary:
The relative risk of road trauma associated with psychoactive substance use was determined by comparing the prevalence of seven substances between a sample of killed and seriously injured drivers and a sample of the general driver population. Due to data collection problems both samples obtained were smaller than planned, a fact which limits the conclusions of the study. Nevertheless, the prevalence of five of the seven drugs studied is higher among the killed and injured drivers than among the general drivers. 32 per cent of the killed or injured drivers had taken at least one of the seven drugs studied, wheres only one per cent of the general drivers had taken one or more of these drugs. This is an indication that these drugs cause high accident risk in road traffic.

Tittel: The prevalence and relative risk of drink and drug driving in Norway.

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Sammendrag:
Den relative risiko for trafikkskader i forbindelse med bruken av psykoaktive stoffer er undersøkt ved å sammenligne forekomsten av sju stoffer blant et utvalg av drepte og skadde førere og et utvalg av vanlige førere. På grunn av problemer med datainnsamlingen er begge utvalgene mindre enn planlagt, noe som begrenser de konklusjoner som kan trekkes. Likevel er forekomsten av fem av de sju undersøkte stoffene høyere blant drepte og skadde førere enn blant vanlige førere. 32 prosent av de drepte og skadde førerne hadde tatt minst ett av de undersøkte stoffene, mens bare en prosent av de vanlige førererne hadde tatt ett eller flere av disse stoffene. Dette tyder på at disse stoffene skaper en høy risiko for trafikkulykker.

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Preface

Drivers' impairment by psychoactive substances is known to be one of the most important risk factors in road traffic. However, with the possible exception of alcohol, there is only scant knowledge about the magnitude of the risk caused by the large number of psychoactive substances used for medical or other purposes.

The study presented in this report is part of a Europe-wide investigation of the influence of chronic and acute impairment factors on driving performance and accident risk. This research programme is known as the IMMORTAL project: Impaired Motorists, Methods Of Roadside Testing and Assessment for Licensing. The present study was carried out as part of the work package on "Alcohol, drugs and medicines", and it has been published as part of the deliverable D-R4.2 of the IMMORTAL project, called "*The prevelance of drug driving and relative risk estimations. A study conducted in the Netherlands, Norway and United Kingdom*". This report may be found on the IMMORTAL web-site www.immortal.or.at. The project was funded by the European commission under the Transport RTD Programme of the 5th Framework Programme.

The roadside survey described in this report was planned by TØI according to the project proposal made by the IMMORTAL consortium, especially Wp R4.2. It was carried out in close cooperation with the mobile police of Norway and the Bergen police district. Oral fluid samples and questionnaire data were collected by police officers working for these two police organizations. The TØI wants to thank Mr. Per-Erik Kolstad and colleagues of the mobile police and Mr. Arvid Ask and colleagues of the Bergen police district for their efforts. The oral fluid specimens were analyzed by Altrix Healthcare, UK. Dr. Joe Clarke, Altrix, has provided the description of the analytical methods used.

The hospital surveys of injured drivers were planned by the TØI and Dr. Anette Hylen Ranhoff, Ullevål University Hospital, Oslo, and Dr. Kari Schrøder Hansen, Bergen University Hospital. The blood specimens, the drivers' consents and questionnaire data were collected by Nurse Laila Skogstad, Ullevål University Hospital and Dr. Kari Schrøder Hansen, Bergen University Hospital. The blood specimens were analyzed at the Ullevål University Hospital laboratories under the supervision of Dr. Odd Brørs. Some of the confirmatory analyses were carried out by the Norwegian Institute of Public Health.

Data for fatally injured drivers were supplied by Dr. Marianne Arnestad, the Institute of Forensic Medicine, Rikshospitalet University Hospital and Dr. Peer Kåre Lilleng, Gade's Institute of Forensic Medicine, Bergen University Hospital. The blood specimens from the fatally injured drivers were analyzed by the Norwegian Institute of Public Health, under the supervision of Dr. Asbjørg Christophersen, who has also written the paragraph on blood analyses.

At the TØI senior research officer Terje Assum has been in charge of this project under the IMMORTAL program. Mr. Arne Skogli, Mr. Peter Christensen and Mr. Terje Assum have carried out the statistical analysis of the data, and Mr. Terje Assum has written the report.

The workpackage leader, Ms. Inger Marie Bernhoft, Danish Transport Research Institute, has commented thoroughly upon an earlier version of the report manuscript. Ms. Bernhoft has also been responsible for the quality check of the D-R4.2 of including the text of this report. Authors of the two other studies included in D-R4.2 Mr. René Mathijssen of SWOV, Netherlands, and Ms. Su C. Buttress, TRL, UK, have also commented upon the report of the Norwegian study.

The introduction of this report is somewhat different from that of the D-R4.2 in order to include background and purpose of the study. Some minor corrections have been made in tables 12 – 15. Otherwise, the text of this report is identical to chapter 3 of D-R4.2.

Oslo, December 2005
Institute of Transport Economics

Sønneve Ølnes
Deputy managing director

Marika Kolbenstvedt
Head of departement

Contents

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Summary:

The prevalence and relative risk of drink and drug driving in Norway

In recent years, the number of drivers who drive while under the influence of drugs has been increasing. Previous studies of the presence of drugs in the samples obtained from road traffic accident fatalities have shown that a significant proportion of fatally injured drivers have drugs in their body. This present study of the prevalence of drugs in the driving population forms part of a larger, Europe-wide investigation of the impact of drugs, medications and medical conditions have on road safety. This research programme, known as the IMMORTAL project (Impaired Motorists, Methods of Roadside Testing and Assessment for Licensing) investigates the accident risk associated with different types of driver impairment and examines the implication for licensing assessment and roadside impairment testing (including drug screening).

The Norwegian study presented in this report, is also published as part of a three-country study called "*The prevalence of drug driving and relative risk estimations. A study conducted in the Netherlands, Norway and United Kingdom"*. The intention of the three-country study was to examine whether drivers using one or more of eight defined drug groups have a higher accident risk than drivers not using these drugs; and as far as possible to quantify this risk.

The Norwegian study

The seven drug groups included in the Norwegian part of the study were alcohol, amphetamine, benzodiazepines, cannabis, cocaine, ecstasy, and opiates. The methodology used in Norway included a case-control study, where the prevalence of the selected substances among injured and killed drivers (hospital and forensic institute samples) was compared with the prevalence in the general driving population (a random roadside sample), and risk ratios were calculated.

The study met with severe practical problems in collecting data from the general driving population and especially from injured drivers. The Medical Ethical Committee demanded a written positive approval for the use of blood samples from injured drivers. Although no injured driver refused to participate, obtaining the written approval turned out to be so demanding for the hospital staff, that one co-operating hospital refused to continue after the pilot study, and the other hospital obtained approvals from only 19 admitted drivers of a total of 77 who met the criteria of the project. For this reason, data on fatally injured drivers selected for autopsy by the police were included to compensate for the small number of injured drivers included.

The report can be ordered from:
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Data on substance use by seriously injured drivers (in-patients) were collected in the Ullevål University Hospital in Oslo and the University Hospital in Bergen. Data on substance use by fatally injured drivers were obtained from the forensic medicine institutes in the two cities.

Data on substance use by the general driving population were collected in the above hospitals' catchment areas by means of oral fluid specimens by officers of the national mobile police and the Hordaland police district. The results are weighted by traffic flow.

Of 410 tested general drivers 1 was positive for benzodiazepines, 2 for cannabis and 1 for opiates. In total four general drivers tested positive for drugs above the analytical cut-off limit set by Altrix healthcare. However, providing an oral fluid specimen to the police was voluntary, and there may be reason to believe that drivers having recently used illegal substances or high doses of medical drugs may have refused to provide a specimen. Of 438 drivers stopped by the police for the survey, oral fluid specimens are missing for 28. All stopped drivers had to take a breath test for alcohol, but no driver stopped was positive for alcohol above the legal limit in Norway, BAC 0.2 g/l.

Of the total of 87 killed or injured drivers in the cases sample, 59 were negative for all seven drugs tested. 13 drivers were positive for alcohol, 8 positive for amphetamine, 10 for benzodiazepines, 2 for cannabis, 1 for ecstasy and 7 for opiates. No case driver was positive for cocaine. 18 drivers were positive for one drug. Seven drivers were positive for two drugs and three were positive for three drugs.

Relative risk is calculated by two methods, using percentages and odds ratios. As the total number of cases and controls is small and the cases are a selected sample, it is difficult to compute case/control and odds ratios for all seven drugs. The relative risk of drivers, who have used one or more substances of the seven included in the study, is 32.1 and the odds ratio for the same drivers is 33.7. Even though samples are small, there is no doubt that the risk of a severe accident increases considerably for drivers using one or more of these substances, with the exception of drivers who have taken cannabis only. Their risk is not significantly different from drivers who have taken no drug. However, the relative risk or odds ratio of drivers who have taken amphetamine, ecstasy, cocaine or alcohol alone, cannot be computed, because there is no driver positive of these substances alone among the control drivers. Table S1 below shows the main results from the Norwegian study.

Table S1. Injured or killed drivers and general drivers by impairment of alcohol and psychoactive substances. Odds ratio (relative risk). Norway

Psychoactive substances*	Injured/ killed drivers	General drivers (weighted)	**Odds ratio (Relative risk)**
Negative (for seven substances)	84.5**	406.5**	1
Positive for one or more substances	28	4	33.7
One substance (any of seven)	18	4	21.6
Two or three substances	10.5**	0.5**	101.0
Alcohol > 0.2 g/l + substance(s)	4.5**	0.5**	43.3
No alcohol, one or two other substances	15	4	18.0
Number of drivers (unweighted)	112***	410	

* Alcohol, amphetamine, benzodiazepines (tranquilizers), cannabis, cocaine, ecstasy and opiates.
**0.5 is added to the cases and the controls to make calculations possible for drugs which have no positive controls.
*** 25 negative case drivers added to correct a possible bias in the sample of killed drivers.

Source: TØI report 805/2005

The data sets were too small to calculate the injury risk of use of single psychoactive substances. Drivers who were positive for one or more of the drugs in question had a risk of injury or death about 30 times higher than drivers without these drugs, whereas drivers positive for only one of the seven drugs had a risk some 21 times higher than those negative for all seven drugs.

The European study will be followed up by a much larger European study called DRUID, about accident risk caused by drugs.

Conclusion

There is no doubt that the use of one or more of the seven drugs studied increases the risk of a road accident. The samples obtained were unfortunately too small to produce relative risks for each of the seven drugs, not to speak about levels of concentration of each drug. More data is needed to produce such results. However, collecting samples from injured drivers is most difficult and time-consuming due to medical-ethical requirements.

TØI-rapport 805/2005
Forfatter: Terje Assum
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Sammendrag:

Forekomst av og relativ risiko ved ruspåvirket kjøring i Norge

Del av det europeiske forskningsprogrammet IMMORTAL

Antall førere som kjører under påvirkning av rusmidler eller medikamenter synes å øke i mange land. Tidligere undersøkelser av forekomst av rusmidler og medikamenter blant drepte bilførere viser at en stor andel av disse drepte førerne har slike stoffer i kroppen. Den undersøkelsen om forekomst av og risiko ved ruspåvirket kjøring, som beskrives i denne rapporten er en del av en større europeisk undersøkelse om virkningen av rusmidler, medikamenter og medisinske forhold på trafikksikkerhet. Dette forskningsprogrammet, IMMORTAL – Impaired Motorists, Methods of Roadside Testing and Assessment for Licensing, har undersøkt ulykkesrisiko knyttet til ulike typer svekkelse eller påvirkning og har utredet konsekvensene for førekortvilkår og for veikantundersøkelser av slik påvirkning. Den norske undersøkelsen er del av et samarbeid mellom tre land, Nederland, Norge og Storbritannia (Skottland). Målet var å undersøke om førere som bruker ett eller flere rusmidler eller medikamenter har høyere ulykkesrisiko enn førere som ikke bruker disse stoffene, og så langt som mulig kvantifisere denne risikoen.

Norsk undersøkelse

Sju stoffer var med i den norske undersøkelsen: Alkohol, amfetamin, benzodiazepiner, cannabis, kokain, ecstasy og opiater. Metoden som er brukt er såkalt "case-control" studie, hvor forekomst av stoffene blant skadde og drepte førere sammenlignes med forekomsten av de samme stoffene blant vanlige førere ute på veien. Relativ risiko for å bli drept eller alvorlig skadd, beregnes ved forholdet mellom forekomsten i de to gruppene av førere.

Det var vanskelige problemer i gjennomføringen av undersøkelsen. Den Regionale komité for medisinsk forskningsetikk, Øst-Norge, krevde positivt skriftlig samtykke fra de skadde førerne for å bruke blodprøver fra førerne i undersøkelsen. Ingen førere nektet å delta, men innsamling å skriftlig samtykke viste seg å være så vanskelig for personalet ved akuttmottakene på de samarbeidende sykehusene, at det ene sykehuset fant å måtte avbryte samarbeidet etter pilotundersøkelsen. Det andre sykehuset klarte bare å få samlet skriftlig samtykke fra 19 av 77 innkomne, skadde førere. Antall skadde førere i undersøkelsen ble derfor for lite, og data for drepte førere ble lagt til for å øke antallet.

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Data for forekomst av de nevnte stoffene blant skadde førere ble samlet inn ved akuttmottakene ved Ullevål universitetssykehus i Oslo og Haukeland universitetssykehus i Bergen. Tilsvarende data for drepte førere ble utlevert fra Rettsmedisinsk institutt i Oslo og Gades institutt i Bergen. Forekomst av stoffene blant vanlige bilførere på veiene ble undersøkt ved spyttprøver og pusteprøver samlet inn av Utrykningspolitiet og Hordaland politidistrikt i de områdene av landet som akuttmottakene ved Ullevål og Haukeland får pasienter fra. Resultatene er vektet etter trafikkmengder.

Av de 410 undersøkte vanlige førerne var 1 positiv for benzodiazepiner, 2 for cannabis og 1 for opiater, i alt 4 førere. Det var imidlertid frivillig å gi spyttprøve til politiet, og det kan derfor være grunn til å tro at førere som nylig hadde brukt ulovlige stoffer eller høye doser av medikamenter kan ha nektet å avgi spyttprøve. Av de 438 førerne som ble stoppet av politiet mangler det prøver for 28 førere. Alle de stoppede førerne måtte avlegge pusteprøve for alkohol, men ingen av dem hadde promille over lovlig grense, dvs. 0,2 promille.

Resultater

Av i alt 87 drepte eller skadde førere var 59 negative for alle sju stoffene. 13 førere var positive for alkohol, 8 var positive for amfetamin, 10 for benzodiazepiner, 2 for cannabis, 1 for ecstasy og 7 for opiater. Ingen av de drepte eller skadde førerne hadde kokain i kroppen. 18 drepte eller skadde førere var positive for ett stoff, 7 førere for to stoffer, og 3 førere var positive for tre stoffer.

Relative ulykkesrisiko er beregnet på to måter, ved forhold mellom prosentandeler og ved oddsforhold. Siden de totale antall førere i begge gruppene er små, er det vanskelig å beregne relativ risiko for hvert av de sju stoffene enkeltvis. Relativ risiko for førere som har brukt ett eller flere av de undersøkte stoffene er 32,1, og oddsforholdet mellom de to gruppene er 33,7. Dette betyr at førere som har brukt ett eller flere stoffer har 32 til 33 ganger så høy risiko for å bli drepte eller skadd som førere som ikke har brukt disse stoffene. Selv om utvalgene av førere er små, er det ingen tvil om at risikoen for alvorlige ulykker øker betraktelig for førere som bruker ett eller flere av de undersøkte stoffene, med mulig unntak for førere som bare har brukt cannabis (hasj eller marihuana). Risikoen for førere som bare har brukt cannabis er ikke signifikant forskjellig fra førere som ikke har brukt noen stoffer. Relativ risiko for førere som har brukt bare amfetamin, bare ecstasy, bare kokain eller bare alkohol, kan ikke beregnes, fordi det ikke er noen førere som er positive bare for et enkelt av disse stoffene blant utvalget av vanlige førere.

Tabell S1 nedenfor viser hovedresultatene fra den norske delen av undersøkelsen.

Tabell S1: Skadde/drepte førere og vanlige førere etter påvirkning av alkohol og andre psykoaktive stoffer. Relativ risiko. Norge

Psykoaktive stoffer*	Drepte/ skadde	Vanlige førere (vektet)	**Odds-forhold (Relativ risiko)**
Negative (ingen stoffer)	84,5**	406.5**	**1**
Positiv for ett eller flere stoffer	28	4	**33,7**
Ett stoff av sju mulige	18	4	**21,6**
To eller tre stoffer	10,5**	0,5**	**101,0**
Alkohol > 0,2 0/00 + stoff(er)	4,5**	0,5**	**43,3**
Ikke alkohol, ett eller to andre stoffer	15	4	**18,0**
Antall førere	112***	410	

* Alkohol, amfetamin, benzodiazepiner (beroligende midler), cannabis (hasj og marihuana), kokain, ecstasy og opiater.
**0,5 er lagt til antall skadde/drepte og antall vanlige førere for å gjøre det mulig å beregne oddsforhold for stoffer som ingen vanlige førere var påvirket av.
*** 25 førere uten stoff lagt til for å rette opp mulig skjevhet i utvalget av drepte førere.

Kilde: TØI rapport 805/2005

Diskusjon og konklusjon

Utvalgene av skadde/drepte førere og vanlige førere var for små til å beregne relative risiko for hvert enkelt stoff som er med i undersøkelsen. Det er ingen tvil om at bruk av ett eller flere av de sju undersøkte stoffene øker risikoen for en trafikkulykke med personskade. Førere som var positive for ett eller flere av de undersøkte stoffene hadde omtrent 30 ganger så stor risiko som førere uten disse stoffene. Førere som hadde brukt ett av de aktuelle stoffene hadde omtrent 21 ganger høyere risiko enn førere uten stoff.

Mer data trengs for å vise relativ risiko for hvert enkelt stoff, for ulike konsentrasjoner av hvert stoff og for kombinasjoner av stoffer. Den europeiske undersøkelsen vil bli fulgt opp av en mye større europeisk undersøkelse DRUID om risiko ved bruk av rusmidler og medikamenter i veitrafikk. Som del av DRUID gjennomføres en veikantundersøkelse av forekomst av rusmidler og medikamenter blant bilførere på Østlandet i Norge. Data fra skadde førere er imidlertid vanskelig å samle inn i Norge på grunn av medisinsk-etiske krav til slik datainnsamling.

1 Introduction

1.1 The IMMORTAL project

The present case-control study in Norway is part of a three-country study called "The prevalence of drug driving and relative risk estimations – a study conducted in the Netherlands, Norway and United Kingdom" (deliverable D-R4.2; Assum et al 2005), funded by the European Commission under the Transport RTD Programme of the 5th Framework Programme, through the IMMORTAL project: **I**mpaired **M**otorists, **M**ethods **O**f **R**oadside **T**esting and **A**ssessment for **L**icensing, a Europe-wide investigation of the influence of chronic and acute impairment factors on driving performance and accident risk. The aim of IMMORTAL is "to provide evidence to propose intervention methods for driver impairment, and support the future development of European policy governing driver impairment legislation". The present research was conducted as part of the work package on "Alcohol, drugs and medicines".

The technical and scientific objectives of IMMORTAL are to:

1. Investigate the influence of chronic and acute impairment factors on driving performance and accident risk;
2. Recommend criteria ('tolerance levels') for high risk categories of impairment;
3. Provide key information to support formulation of European policy on licensing assessment and roadside testing.

Deliverable D-R4.2 and this report address objective No. 1 and 2. The central concepts here are acute impairment and accident risk.

1.2 Background

During the 1990s the proportion of drivers stopped in road traffic suspected for driving under the influence of medical or illegal drugs seems to have increased in Norway (Mørland 2000). In a sample of 155 drivers killed in ten counties in Norway during 1994-99 27 percent had a medical and/or illegal drug in their blood (Brevig et al, 2004). Similar trends have been observed in other European countries as part of the IMMORTAL project, see chapter 2 and 4. In a recent meta-analysis of impairment factors the relative accident risk of drivers under the influence of drugs - as part of the IMMORTAL project - was found to be 1.58 for drugs and medicinal products in general, 1.96 for drugs assumed to be abused, and 1.49 for drugs to be assumed to be used as prescribed, as compared to 2.00 for alcoholism or abuse of alcohol (Vaa, 2003). The study described in this chapter was funded by the European Commission.

1.3 Study objectives and research design

The objective of the present study was to examine the relative accident risk associated with the use of one or more of seven defined drug groups by car drivers. The accident rate of users of these substances was related to the accident rate of drivers not using these substances.

The common research design across the three countries (Netherlands, United Kingdom and Norway) was that of a case-control study. In Norway the cases were a sample of seriously injured drivers admitted to two hospitals and fatally injured drivers for whom the police have demanded autopsy (The terms “fatally injured drivers” and “killed drivers” both means drivers killed in road accidents, and these terms are used interchangeably in this report.) Controls were a sample of drivers taken from the general driving population in the hospitals’ catchment areas. The relative accident risk was determined by computing odds ratios.

The seven drug groups included in the study were: amphetamines, benzodiazepines, cannabis, cocaine, ecstasy, opiates and alcohol.

2 Methodology

The methodology used to estimate the relative risk of driving under the influence of one or more of the psychoactive substances under scrutiny, was that of a case-control study. Cases consisted of injured drivers admitted to the Ullevål University Hospital in Oslo and the University Hospital in Bergen and fatally injured drivers from the Institute of Forensic Medicine, Rikshospitalet University Hospital, Oslo, and the Gade's institute of Forensic Medicine at the University Hospital in Bergen. Controls consisted of samples of the general driving population in the hospitals' catchment areas.

2.1 Hospital and forensic institute surveys (case sample)

2.1.1 Description of samples

Cases were seriously injured and killed drivers of passenger cars, small vans and minibuses. The injured drivers were admitted to the Ullevål University Hospital, Oslo, from August 2003 through March 2004 and the University Hospital of Bergen from July through October 2003. The first 10-15 injured drivers admitted were supposed to be considered a pilot study, but they are included in the sample.

The regional medical-ethical committee for Eastern Norway demanded a written positive consent from the injured drivers for their blood samples to be used in this study. The routine in the hospital emergency rooms was supposed to be that blood samples should be taken for all admitted injured drivers, which is normally done for all injured patients upon admittance for therapeutic reasons. As soon as possible after treatment the injured drivers should be asked for consent and a few questions of such as age, gender, time and place of accident, see hospital questionnaire in **Appendix**. No driver refused to participate in the study, but the routine of asking for written consent took so much time and effort that the University Hospital of Bergen declined to continue sample collection after the pilot. The Ullevål University Hospital, Oslo, agreed to continue the collection of samples, but because of the requirement of a written consent, this hospital was only able to obtain samples from 19 injured drivers of a total of 77 admitted drivers, meeting the criteria of the project. No driver refused to participate, but 58 injured drivers left the hospital for home, were transferred to other hospitals before the nurse was able to obtain the consent, or the nurse in charge was simply too busy to get the consent.

Because of the small sample of injured drivers data from 68 killed drivers, for whom the police requested an autopsy, were added to the cases. Data on substance use by drivers killed between June 2003 and June 2004 were obtained from the Institute of Forensic Medicine, Rikshospitalet University Hospital, Oslo, and from the Gade's institute of Forensic Medicine at the University Hospital of Bergen.

As no exact figure exists on the number of fatally injured drivers requested for autopsy, the Institute of Forensic Medicine at Rikshospitalet University Hospital has estimated that 60-70 per cent of all fatally injured drivers are admitted for autopsy (Arnestad 2004). One reason for request for autopsy may be suspicion of drugs or alcohol, a fact which may bias the fatally injured driver data. However, transport of bodies is costly, and the percentage of dead drivers requested for autopsy is higher in areas close to the forensic institutes than in remote areas. As a consequence, this share should be higher than average for the catchment areas of the hospitals used for this project, a fact which generates less bias for the data from fatally injured drivers from the hospital catchment areas than for autopsy data in general. Nevertheless, there may be a bias towards higher use of drugs in this data set.

Table 2.1 below shows the case drivers by weekday and hour of accident.

Table 2.1: Injured and killed drivers by weekday and hour of accident

	Number	Per cent
Weekdays		
Monday – Friday 04:00 – 10:00	21	24
Monday – Friday 10:00 – 16: 00	17	20
Monday – Thursday 16:00 – 22:00	13	15
Monday – Thursday 22:00 – 04:00	7	8
Weekends		
Saturday and Sunday 04:00 – 10:00	5	3
Saturday and Sunday 10:00 – 16:00	11	6
Friday to Sunday 16:00 – 22:00	7	13
Friday to Sunday 22:00 – 04:00	3	8
No information as to weekday or hour	3	3
Total	87	100

Source: TØI report 805/2005

2.1.2 Sample size and non-response

The cities of Oslo and Bergen and their surroundings were chosen for the study as these are the largest population centres in Norway. Thus the chance of getting a high number of injured drivers included in the data set should be greater than elsewhere in Norway. One university hospital in each city was asked to participate in the study, and both agreed originally. The municipal emergency rooms, which receive the slight injuries, in both cities were also asked to participate, but both declined, saying that taking blood samples from injured drivers was too much work. This means that only severely injured drivers are included in the data set. As explained in **Section 2.1.1** the Bergen hospital discontinued the participation after the pilot study, due to requirements set by the medical-ethical committee. The Oslo hospital continued, but was only able to collect 19 samples due to the same requirements. No driver refused to have his or

her blood used for the project, but the routine of obtaining a written consent was too demanding, even if a special nurse was hired for a 50 per cent job for this project.

As the number of injured drivers included turned out to be quite small, a total of 29 including the pilot data, an inquiry was made to the forensic institutes in the two cities for data for fatally injured drivers. Both institutes agreed, and data for 58 drivers were included in the data set. In total the cases, i.e. killed and injured drivers, include 87 persons.

2.2 Roadside Survey (control sample)

2.2.1 Research area and selection of research sites

Control drivers were taken from the highways within the catchment areas of the two hospitals, i.e. the counties of Østfold, Akershus and Oslo for Ullevål University Hospital and Hordaland for the Bergen University Hospital. Both hospitals have wider catchment areas than these counties, as explained below. Highway sections and times of week and day were picked at random, and the police collected samples from cars stopped at random within these road sections and times. 59 per cent of all personal-injury road accidents and 77 per cent of fatal accident registered by the police in Norway happened on highways in 1999 (Official Statistics of Norway 2000, p. 70).

2.2.2 Research periods

The main data collection period was July 2003 through June 2004. However, two pilot studies were carried out in May and June 2003, each including 30 drivers. These data are included in the final data set, i.e. the total data collection period is May 2003 through June 2004.

Specimens from control drivers were collected all days of the week and all hours of the day. To ensure a reasonable distribution as to week and day, plans indicating weekday and 3-hour period were made. Within these 3-hour periods the police chose when to carry out the controls. The police stopped 5 cars in each 3-hour period and collected samples from the drivers as well as information by questionnaire. The 3-hour periods can be pooled to match the 6-hour periods used in the British and Dutch data. Three-hour periods were used to avoid a bias towards daytime or “easy” hours. Exact time and date are indicated on the test forms and the questionnaires. The sample of control drivers by time of day and week is shown in Table 2.3 below.

2.2.3 Driver selection and data collection procedure

All samples were collected by the police as part of random breath testing. All drivers stopped had to make a breath test the result of which was noted in the questionnaire, see roadside questionnaire in the appendix. The police did not report any refusals due to positive breath test or drivers missing from the control data because they were taken to a police station for evidential breath test.

Prevalence of alcohol among car drivers in Norway was surveyed in 1981/82, with the result that 0.3 per cent were positive above 0.5 g/l (Glad, 1985). Though newer data on alcohol prevalence do not exist, it is generally assumed that the alcohol prevalence has not changed much since the early eighties. If the prevalence still is as low as in 1981/82, no driver positive for alcohol among some 400 drivers is the most likely result. A telephone survey carried out in 2001 shows that only 3 per cent of drivers in Norway say that they might drink a bottle (0.33 litre) of normal beer (4.5 per cent alcohol) or more before driving (Assum, 2001). However, as drinking and driving is generally regarded as unacceptable in Norway, the answers to questions concerning this topic are likely to be biased. Moreover, this survey had a response rate of 53 per cent, a fact which may contribute to even more bias in the results.

The police officers asked whether the drivers were willing to provide an oral fluid specimen and answer a few questions such as age and approximate number of km driven annually. Time and place of sample collection were also noted in the questionnaire. The questionnaire and the specimen were marked with identical bar codes to ensure correct matching of the specimen data and questionnaire data later on. Altrix K-SM-1P Identa oral fluid drug screen kit was used to collect the specimens and to ship them to Altrix laboratories, UK. (Altrix Healthcare plc. is a private laboratory. Specimen collection is described in Altrix (undated). Altrix analysis methods are described in **Section 2.3.2.**)

To secure a random selection of cars the police instruction said that the police should get ready for stopping cars, and then the first car should pass and the second should be stopped. If the police had the capacity to collect several specimens at the same time, up to five cars could be stopped. If the police could only handle one car at the time, the first car after the police was ready again, should pass, and then the second car should be stopped. Exceptions were made for times and roads where traffic volumes were extremely low.

The controls (general drivers) by weekday and hour and the weighting to make the distribution of controls comparable to the general driver population are shown in **Section 2.2.5.**

2.2.4 Sample size and non-response

A total of 438 drivers were stopped and asked to provide an oral fluid specimen and answer a few questions for the IMMORTAL survey. 25 drivers refused to provide a sample, but answered the questionnaire. In addition 3 samples were not identified by bar codes and were rejected by the laboratory. For the remaining 410 drivers the lab sent screening and confirmatory analysis results to the TØI. The questionnaires with the data were kept by the police and sent to the TØI in batches. For the 410 drivers for which oral fluid specimens were analyzed, 36 questionnaires were not received by TØI. Thus a total of 374 controls with a complete data set were obtained. These figures are summed up in **Table 2.2** below.

Table 2.2: Number of control drivers by type of information (unweighted)

	Questionnaire	No questionnaire	Total
Oral fluid specimen	374	36	410
No specimen	28	0	28
Total	402	36	438

Source: TØI report 805/2005

The specimen collection was carried out as part of police routine random breath testing for drinking and driving. Providing a breath test is mandatory, and all 402 questionnaires returned contained information about the result of the breath test.

2.2.5 Weighting of the control sample

In order to make the control sample representative of the general driving population, it had to be weighted. The weighting procedure was based on 2004 traffic volume data for a major highway south of Oslo. Even if the control drivers are stopped in both the Oslo and Bergen areas, the traffic volumes by week and hours are quite similar on most major roads. For the sake of simplicity the data for one major highway are used as weights. These data, collected by the Norwegian Public Roads administration, are shown in **Table 2.3** below.

Table 2.3:Road traffic volumes by weekdays and hour on road E-6 south of Oslo.

	1000 vehicles	Per cent
Weekdays		
Monday – Friday 04:00 – 10:00	99.3	22.9
Monday – Friday 10:00 – 16: 00	119.9	27.7
Monday – Thursday 16:00 – 22:00	86.3	19.9
Monday – Thursday 22:00 – 04:00	14.8	4.1
Weekends		
Saturday and Sunday 04:00 – 10:00	9.5	2.2
Saturday and Sunday 10:00 – 16:00	34.7	8.0
Friday to Sunday 16:00 – 22:00	56.0	12.9
Friday to Sunday 22:00 – 04:00	12.3	2.8
No weekday or hour		
Total	432.8	100.5

Source: Norwegian Public Roads Administration, 2005.

Table 2.4: Comparison between day/time distributions of the control sample of drivers and the general traffic volumes on road E-6 outside Oslo. Per cent

	Control sample*	Traffic volume	Weight
Weekdays			
Monday – Friday 04:00 – 10:00	8.0	22.9	2.86
Monday – Friday 10:00 – 16: 00	32.7	27.7	0.85
Monday – Thursday 16:00 – 22:00	17.9	19.9	1.11
Monday – Thursday 22:00 – 04:00	7.1	4.1	0.58
Weekends			
Saturday and Sunday 04:00 – 10:00	2.7	2.2	0.81
Saturday and Sunday 10:00 – 16:00	9.3	8.0	0.86
Friday to Sunday 16:00 – 22:00	15.9	12.9	0.81
Friday to Sunday 22:00 – 04:00	6.3	2.8	0.44
Total	99.5	100.5	

* excluding 74 drivers without information on day and hour. Source: TØI report 805/2005

Table 2.4 shows the control sample and traffic volume distributions.

The comparison shows that weekdays 10:00 – 16:00 hours and, to a lesser degree, weekend evenings and nights were strongly over-represented in the control sample. Weighting the control sample makes the control sample data representative for the eight day/hour categories. Weight factors for each of the eight day/time categories were computed by dividing traffic flow (trip) fractions by control sample fractions.

The idea of a case-control study is that the control should be from the same population as the cases. For killed, injured and general drivers that would mean that the general drivers should be checked at exactly the same time and place as the case drivers were killed or injured. That would be almost impossible in practice. In more general terms drivers within a certain area and time period may be considered a population which is the basis for the road accidents occurring within the same area and time period. Thus, a sample of drivers representative for the area and time period, should be acceptable as controls for the injured or killed drivers within the same area and period.

The unweighted control sample cannot be considered to be representative of all drivers who participated in road traffic in the Oslo and Bergen areas at all days of the week and all times of the day, since the sample distribution over different times and days was not equal to the distribution of traffic volumes. The police were given plans for controls where time of day and weekday were picked at random. However, the police had other duties than collecting samples for this project, and would have to adjust the plans. So, in order to make the control sample representative, it had to be weighted, based on traffic flow distribution over the various days of the week and times of the day. The weights are shown in **Table 2.4**.

2.2.6 Comparability of the cases and controls samples

To obtain a sufficiently large number of injured drivers in the case sample, choosing the largest population centres in Norway, the Oslo and Bergen areas, was necessary, even though the Police directorate said from the beginning, that including the Oslo police in the project might be difficult. In practice the Oslo police did not participate, but the mobile police force did some sample collection on the major highways in Oslo. The Oslo hospitals get patients from surrounding counties, where the mobile police force also collected specimens. The Bergen police collected specimens during spring, summer and fall 2003, until the police officer in charge of the project quit for another job. As the Bergen university hospital would not continue the collection of samples from injured drivers after the pilot, the Bergen police force was not asked to keep up the specimen collection from general drivers on the road. Later on data on fatally injured drivers were included in the cases sample, and more controls data from the Bergen area would have been useful after all.

Table 2.5 shows the data collection periods for cases and controls within the different locations. For practical reasons the collection of data for all locations was not possible for the whole period planned.

Originally the data collection period was planned to be the 12 months from July 2003 through June 2004 with pilots in May 2003. However, getting started took longer than expected. Moreover, collecting information about 10-15 injured drivers as pilots in the hospitals took much longer than expected. Consequently, the data collection periods varied quite a bit within a total of 14 months from May 2003 through June 2004.

Table 2.5: Data collection periods for killed, injured and regular drivers by area

Months and year	Killed drivers		Injured drivers		General drivers	
	Oslo area	Bergen area	Oslo area	Bergen area	Oslo area	Bergen area
May 2003		■			■	■
June 2003	■	■				■
July 2003	■	■		■		■
August 2003	■	■	■	■		■
September 2003	■	■	■	■	■	■
October 2003	■	■	■	■		■
November 2003	■	■	■			■
December 2003	■	■	■			
January 2004	■	■	■			
February 2004	■	■	■		■	
March 2004	■	■	■		■	
April 2004	■				■	
May 2004	■					
June 2004	■				■	
N	46	12	19	10	327	75
	58		29		438*	

* including 36 drivers with no information about area. Source: TØI report 805/2005

Table 2.6: Number of killed, injured and general drivers by counties and areas.

	Killed drivers		Injured drivers		General drivers	
Counties	Oslo area	Bergen area	Oslo area	Bergen area	Oslo area	Bergen area
Østfold	11				81	
Akershus	10		11		186	
Oslo	3		7		60	
Hedmark	4					
Oppland	2					
Buskerud	7					
Vestfold	1		1			
Telemark	8					
Hordaland		9		10		75
Rogaland		2				
Sogn og Fjordane		1				
N	46	12	19	10	327	75
	58		29		438*	

* including 36 drivers with no information about area. Source: TØI report 805/2005

Table 2.6 shows that the cases are obtained from a larger number of counties than the controls. However, 61 out of 87 cases, or 70 per cent of the cases come from the same counties as the controls. The four counties covered by the controls make up 36.8 per cent of the population of Norway (Official Statistics of Norway 1999). Even if the cases and control data do not match completely as to time and area, all data are used to keep the number of cases and controls as high as possible, although a reduction in generalizabilty and representativity had to be accepted.

2.3 Analysis of body fluids

For the cases, the killed and injured drivers, blood samples were used. For the general drivers oral fluid specimens were used for practical reasons.

2.3.1 Blood analysis

The blood samples from the injured drivers were screened and analyzed at the Ullevål University in Oslo, and some of the confirmatory analyses were carried at the National Institute of Public Health, Division of Forensic Toxicology. The results of the fatally injured drivers were obtained from the forensic institutes at the university hospitals in Oslo and Bergen.

Blood specimens were analyzed by the Division of Forensic Toxicology and Drug Abuse, Norwegian Institute of Public Health. Screening for opiates and cannabis

in blood was performed by EMIT® Enzyme ImmunoAssay, which is based on competition for drug antibody binding sites. The cut-offs used were 9 ng/ml for cannabis, 85 ng/ml for opiates, 90 ng/ml for cocaine and 50 ng/ml for amphetamines. Positive EMIT® screening results were confirmed and quantified using GC/MS (gas chromatography/mass spectrometry).

Screening for the other drugs was performed by LC/MS (liquid chromatography/ mass spectrometry) after precipitation of blood cells, confirmation and quantification were performed by LC/MS (using additional ions) Analytical cut-offs (quantification limits) were applied; see **Table 2.7**.

Table 2.7: Components and cut-off limits after GC/MS or LC/MS analyses in blood samples

Component	**Cut-off limit** (ng/ml)
Cocaine:	
Cocaine	60
Benzoylecgonine	60
Amphetamines:	
Amphetamine	40
Methamphetamine	45
MDMA	55
(MDEA included, but never found in Norway)	55
MDA	50
Opiates:	
Morphine	9
6-MAM (heroin)	8
Codeine	9
Cannabis	
THC	0,3 ng/ml
Benzodiazepines:	
Alprazolam	10
Bromazepam (not in Norway)	
Brotizolam «	
Chlordiazepoxide «	
Clobazam «	
Dealkyl flurazepam «	
Desmethyl diazepam	55
Diazepam	60
Flunitrazepam	1,6
Clonazepam	10
Loprazolam (not in Norway)	
Lorazepam “	
Lormetazepam „	
Midazolam	65
Nitrazepam	14
Oxazepam	280
7-aminoflunitrazepam	6
7-aminonitrazepam	13
7-aminoklonazepam	30
Zolpidem	19
Zoplicon	19

Source: Christophersen, Norwegian Institute of Public Health, 2005.

2.3.2 Oral fluid analyses

Oral fluid or "Oral Mucosal Transudate ***OMT*** is a serous rich fluid. It is NOT saliva and, unlike saliva, it contains substances that mirror what is found in blood serum." (Altrix Healthcare). Altrix refers to Cordeiro et al (1992) and Malamud (1997) for this statement. However, more recent information (Clarke 2005) indicates that no comparison studies of oral fluid and blood from the same test persons exist for the drugs that are relevant in this project.

The oral fluid specimens were shipped right after the collection to Altrix Healthcare, UK, for screening and confirmatory analysis. **Table 2.8** indicates the cut-off values used.

Table 2.8: Cut-off values used by Altrix healthcare for analyses of oral fluid.

Drug Class	Cut-Off Calibrator Level (ng/ml) for Immunoassay
Amphetamines	100
Cocaine	5
Marijuana	1
Opiates	10
PCP	1
Methadone	5
Methamphetamine	40
Benzodiazepines	1
Buprenorphine	1
Propoxyphene	10
Barbiturates	20

Source: Clarke 2005

2.4 Statistical analysis

For statistical analysis, it was assumed that the sample of seriously injured drivers (cases) admitted to the two hospitals and the fatally injured drivers at the two forensic institutes were a representative sample of all drivers seriously injured in road accidents in the Oslo and Bergen areas. As explained earlier, however, very few of the admitted drivers were included in the sample. But as no one refused to participate, the other causes for exclusion from the sample may be considered as having random influence on the sample. Autopsy of fatally injured drivers is carried out on the request of the police. An estimated percentage of 60-70 per cent of all fatally injured drivers is admitted for autopsy (Arnestad 2004). One reason for this request may be suspicion of drugs or alcohol. Consequently the prevalence of drug use among fatally injured drivers admitted for autopsy may be higher than for other fatally injured drivers (**see Section 2.1**).

The relative risk of drivers who used one or more of the psychoactive substances involved in the study, was determined by comparing the prevalence of these substances in the control sample and the case sample. Subjects who had used one particular substance or a combination of different substances were related to subjects who had used none of these substances. 95% confidence intervals will be used for significance.

3 Results of the hospital survey

3.1 Prevalence of psychoactive substances among killed and seriously injured drivers

Table 3.1 gives a detailed picture of the prevalence of psychoactive substances in the killed and seriously injured drivers admitted to the emergency rooms of the Ullevål and Bergen University hospitals and the forensic institutes in Oslo and Bergen.

Table 3.1: Psychoactive substances among case drivers, by gender. Per cent.

	Gender		
Psychoactive substance use	*Male*	*Female*	*All drivers*
Negative for all seven drugs	63.6	80.9	67.8
Positive for one drug (any of seven)	21.2	19.0	20.7
Positive for two drugs (any of seven)	10.6	0.0	8.0
Positive for three drugs (any of seven)	4.5	0.0	3.4
Total	**99.9**	**99.9**	**99.9**
Single drugs			
Alcohol 0.2-1.3 g/l, alone	4.5	0.0	3.4
Alcohol >1.3 g/l, alone	7.6	4.8	6.9
Amphetamine alone	3.0	4.8	3.4
Benzodiazepines alone	1.5	9.5	3.4
Cannabis alone	1.5	0.0	1.1
Cocaine alone	0.0	0.0	0.0
Ecstasy alone	0.0	0.0	0.0
Opiates alone	3.0	0.0	2.3
Total: Single drugs including alcohol alone	21.1	19.1	20.5
Combination of drugs			
Alcohol > 0.2 + 1 drug	3.0	0.0	2.3
Alcohol > 0.2 + 2 drugs	3.0	0.0	2.3
No alcohol, 2 or 3 other drugs	9.1	0.0	6.9
Total: Combination of drugs	**15.1**	**0.0**	**11.5**
N = Number of case drivers	**66**	**21**	**87**

Source: TØI report 805/2005

Table 3.1 shows that a total of almost 68 per cent of the killed and injured drivers were negative for the seven drugs included in the study. 32 per cent were positive

for one or more of these drugs. Alcohol was the most frequently used drug by the killed and injured drivers. A total of almost 15 per cent had alcohol above the legal limit of 0.2 g/l in their blood. The sample of killed and injured drivers is small, a total of 87 drivers, and a further subdivision of the prevalence of psychoactive substances, e.g. by gender *and* age, was considered as not useful.

Alcohol was the most frequently used substance of the seven substances included in the study, and benzodiazepines were the second most frequent, as shown in **Table 3.2**. No driver was positive for cocaine.

Table 3.2: Prevalence of substances in case drivers. Confirmed substances used alone or in combination with other substances.

Substance	Per cent	N
Alcohol	14.9	13
Amphetamine	9.2	8
Benzodiazepines	11.5	10
Cannabis	2.3	2
Cocaine	0.0	0
Ecstasy	1.1	1
Opiates	8.0	7
N = number of case drivers	-	87
Positive drivers	32.2	28

Source: TØI report 805/2005

4 Results of the roadside survey

4.1 Prevalence of psychoactive substances in control drivers

Table 4.1 shows the prevalence of psychoactive substances by gender in the control driver sample. 99.2 per cent of all control drivers were negative for all drugs tested, including alcohol. Benzodiazepines, cannabis and opiates were found. Alcohol, amphetamine, cocaine and ecstasy were not found in any of the control drivers. The prevalence is so low that difference between genders or any other road user category is hardly meaningful. Consequently, further analysis of prevalence is not carried out.

Prevalence studies of the general driving population in Norway have only been carried out for alcohol, and that was in 1981/82. Glad (1985) found that 0.27 per cent of the kms driven in Norway was done by drivers with a blood alcohol concentration above 0.5 g/l, the legal limit at that time. Even though more recent data on drinking and driving do not exist for Norway, the general impression is that the prevalence of alcohol among Norwegian drivers has not changed very much since the early 1980's. If that is so, about one drunk driver could be expected in a sample of 410 drivers.

Table 4.1: Psychoactive substances among control drivers by gender. Weighted by traffic flow. Per cent

	Gender		
Psychoactive substance use	*Male*	*Female*	*All drivers*
Negative for all seven drugs (any of seven)	99.3	99.1	99.0
Positive for one drug (any of seven)	0.7	0.9	1.0
Positive for two or more drugs (any of seven)	0.0	0.0	0.0
Total	**100.0 %**	**100.0 %**	**100.0 %**
Single drugs			
Alcohol > 0.2 g/l	0.0	0.0	0.0
Amphetamine alone	0.0	0.0	0.0
Benzodiazepines alone	0.0	0.9	0.2
Cocaine alone	0.0	0.0	0.0
Cannabis alone	0.7	0.0	0.5
Ecstasy alone	0.0	0.0	0.0
Opiates alone	0.0	0.6	0.2
N (unweighted)	**286**	**114**	**410***

*including 10 persons with gender unknown. Source: TØI report 805/2005

As no control driver was positive for two drugs or more, the prevalence of the drugs can be seen from **Table 4.1**. Because of the small sample and the extremely low prevalence in the general driver sample, there is no reason to comment further upon prevalence.

5 Calculation of relative risk and odds ratios

The relative risk of using one or more of the psychoactive substances involved in the study, is determined by comparing the prevalence of these substances among case and control drivers. Subjects who used one particular substance or a combination of different substances are related to subjects who used none of these substances. 95% confidence intervals are used for statistical significance. The results are shown in **Tables 5.1, 5.2**, 5.**3** and **5.4**.

Table 5.1: Prevalence percentages of psychoactive substances among case and control drivers and relative risk.

Psychoactive substances	Cases	Controls (weighted)	Relative risk
Negative for seven drugs	67.8	99.0	0.7
Single drugs			
Cannabis alone	1.1	0.5	2.2
Amphetamine alone	3.4	0.0	Undefined
Ecstasy alone	0.0	0.0	Undefined
Cocaine alone	0.0	0.0	Undefined
Opiates alone	2.3	0.2	11.5
Benzodiazepines alone	3.4	0.2	17.0
Alcohol 0.2-1.3 g/l	3.4	0.0	Undefined
Alcohol ≥ 1.3 g/l	6.9	0.0	Undefined
Total: One drug (any of seven)	**20.7**	**1.0**	**20.7**
Combination of drugs			
Two drugs (any of seven)	8.0	0.0	Undefined
Three drugs (any of seven)	3.4	0.0	Undefined
Alcohol > 0.2 + drug(s)	4.6	0.0	Undefined
No alcohol, one or more other drugs	17.2	1.0	17.2
Total positives	**32.1**	**1.0**	**32.1**
N (unweighted)	**87**	**410**	

Source: TØI report 805/2005

Relative risk in **Table 5.1** is calculated as the prevalence percentage among cases divided by prevalence percentage among controls. As prevalence is 0.0 for eight drugs or drug combinations, relative risk is undefined for those. For the categories having a defined relative risk, the relative risk is highest for "one or more drugs", i.e. positive for at least one of the seven drugs included in the study. The lowest relative risk is for cannabis alone.

Table 5.2 shows the odds ratios for the same drugs. The odds ratio formula used for the calculations in **Table 5.2** is:

Odds ratio = (P1/N1) / (P2/N2), where

P1 = number of cases, positive for a certain drug or drug combination
N1= number of cases, negative for all drugs
P2 = number of controls, positive for a certain drug or drug combination
N2 = number of controls, negative for all drugs

Table 5.2: Number of negatives and positives among case and control drivers, odds ratios and confidence intervals for drugs and combinations of drugs.

Psychoactive substances	**Cases**	Controls (weighted)	Odds ratio	95% confidence interval
Negative for seven drugs	59	406	1	
Single drugs				
Cannabis alone	1	2	3.4	0.3 -38.5
Amphetamine alone	3	0	Undefined	
Ecstasy alone	0	0	Undefined	
Cocaine alone	0	0	Undefined	
Opiates alone	2	1	13.8	1.2 – 154.2
Benzodiazepines alone	3	1	20.6	2.1 – 201.8
Alcohol 0.2-1.3 g/l	3	0	Undefined	
Alcohol ≥ 1.3 g/l	6	0	Undefined	
Total: One drug (any of seven)	**18**	**4**	**31.0**	**10.1 – 94.7**
Combination of drugs				
Two drugs	7	0	Undefined	
Three drugs	3	0	Undefined	
Alcohol > 0.2 g/l + drug(s)	4	0	Undefined	
No alcohol, one or two other drugs	15	4	25.8	8.3 – 80.4
Total positives	**28**	**4**	**48.2**	**16.3 – 142.2**
N (unweighted)	**87**	**410**		

Source: TØI report 805/2005

The odds ratio of the negatives is one by definition. Of the five substances having a defined value in **Table 5.2**, cannabis alone has the lowest odds ratio. The confidence interval goes down to 0.3, i.e. it is not significantly different from one, meaning that the risk of drivers who have cannabis in their blood is not different from drivers having no drug in their blood. This finding corresponds to the finding concerning cannabis in the Dutch part of the study (Mathijssen & Houwing 2005, p. 17 and 23).

All other drugs or combinations of drugs have confidence intervals above one, meaning that the risks are higher than for negatives. "Total positives" has the highest odds ratio in **Table 5.3**, i.e. among the drugs which have at least one positive among the controls. This is the same result as for relative risk.

Table 5.3: Number of negatives and positives and odds ratios for drugs and combinations of drugs.

Psychoactive substances	Cases	Controls (weighted)	Odds ratio	95% C.I.
Negative	59.5*	406.5*	1	
Single drugs				
Cannabis alone	1	2	3.4	0.3 -38.5
Amphetamine alone	3.5*	0.5*	47.8	2.4 – 937.5
Ecstasy alone	0	0	Undefined	
Cocaine alone	0	0	Undefined	
Opiates alone	2	1	13.8	1.2 – 154.2
Benzodiazepines alone	3	1	20.6	2.11 – 201.8
Alcohol 0.2-1.3 g/l	3.5*	0.5*	47.8	2.4 – 937.5
Alcohol ≥ 1.3 g/l	6.5*	0.5*	88.8	4.9 – 1597.0
Total: One drug (any of seven)	**18**	**4**	**31.0**	**10.1 – 94.7**
Combination of drugs				
Two drugs	7.5*	0.5*	102.5	5.8 – 1817.7
Three drugs	3.5*	0.5*	47.8	2.4 – 937.5
Alcohol > 0.2 g/l+ drug(s)	4.5*	0.5*	61.5	3.3 – 156.6
No alcohol, one or two other drugs	15	4	25.8	8.3 -80.4
Total positives	**28**	**4**	**48.2**	**16.3 - 142.2**
N (unweighted)	**87**	**410**		

* 0.5 is added to the cases and the controls to make calculations possible for drugs which have no positive controls. For the substances which have positives in the controls computations the figures are the same as in Table 5.2.
Source: TØI report 805/2005

Five of the drugs or drug combinations have undefined relative risk and odds ratios because the number of positive controls is zero. To be able to calculate relative risk and odds ratio for these, 0.5 unit is added to positives and negatives among both cases and controls as shown in **Table 5.3**. Adding ½ unit is the traditional way to overcome the problem of zero counts, but this practice may be discussed. More sophisticated solutions such as sensitivity analysis are proposed by Sweeting, Sutton and Lambert (2004). A simple sensitivity analysis, i.e. adding 0.1 unit and 0.9 unit respectively in stead of 0.5 unit gives a rather wide range of results, e.g. an odds ratio varying from 29.6 to 221.8 for amphetamine alone. When the count is zero in a small sample such as 410 controls in this case, it is still reasonable to expect a low prevalence in a larger sample of 4100 or 41000. Consequently, high odds ratios should be expected when the count is zero in a small control sample. After adding 0.5 unit alcohol above 0.2 g/l BAC (with or without other drugs) comes out with the highest odds ratio, and two drugs (any two of seven) come out with the second highest. The lowest defined odds ratio is still for cannabis alone. However, because of small samples, the confidence intervals are wide and overlapping, a fact which means that nothing definite can be said about differences in risk between the substances.

5.1 Correction for possible bias among case drivers

As mentioned earlier 67 cases are fatally injured drivers. These fatally injured drivers are those for whom the police have requested autopsy, and the police are likely to request an autopsy when there is a suspicion e.g. of drug abuse. An estimated percentage of 60 – 70 per cent of all fatally injured drivers are submitted for autopsy. This means that the fatally injured drivers included in the cases may be biased towards drug use. To correct for this possible bias the number of fatally injured drivers should have been 30 – 40 per cent larger, and to be conservative these are presumably all negative for all drugs. In **Table 5.4**, 25 negative drivers have been added to the cases sample to compensate for the 30-40 per cent of fatally injured drivers who are not submitted for autopsy. (In the three-country report (deliverable D-R4.2; Assum et al 2005) 37 negatives were added, but 25 is the correct number. This error has been corrected in this report, but the results are only slightly changed.)

As expected all odds ratios become lower when another 25 negative cases are added. Nevertheless, most odds ratios are still rather high, and all except cannabis and opiates have confidence intervals different from one, the latter of which has changed after the addition of the extra 25 negative cases. Otherwise, this addition does not change the results significantly.

*Table 5.4: Number of negatives and positives and odds ratios for drugs and combinations of drugs. 25 negative drivers added to the cases sample**.*

Psychoactive substances	Cases	Controls (weighted)	Odds ratio	95% C.I.
Negative	84.5*	406.5*	1	
Single drugs				
Cannabis alone	1	2	2.4	0.2 -26.8
Amphetamine alone	3.5*	0.5*	33.6	1.7 – 658.0
Ecstasy alone	0	0	Undefined	
Cocaine alone	0	0	Undefined	
Opiates alone	2	1	9.6	0.9 – 107.3
Benzodiazepines alone	3	1	14.4	1.3 – 122.8
Alcohol 0.2-1.3 g/l	3.5*	0.5*	33.7	1.7 – 658.0
Alcohol $\geq$ 1.3 g/l	6.5*	0.5*	62.5	3.5 – 1120.8
Total: One drug (any of seven)	**18**	**4**	**21.6**	**7.1 – 65.6**
Combination of drugs				
Two drugs	7.5*	0.5*	72.2	4.1 – 1275.7
Three drugs	3.5*	0.5*	33.7	1.7 – 658.0
Alcohol > 0.2 g/l+ drug(s)	4.5*	0.5*	43.2	2.3 – 811.8
No alcohol, one or two other drugs	15	4	18.0	5.8 – 55.7
Total positives	**28**	**4**	**33.7**	**11.5 – 98.5**
N (unweighted)	**112**	**410**		

* 0.5 is added to the cases and the controls to make calculations possible for drugs which have no positive controls. ** In the three-country report (deliverable D-R4.2; Assum et al 2005) 37 negatives were added, but 25 is the correct number. This error has been corrected in this report, but the results are only slightly changed.

Source: TØI report 805/2005

6 Summary and discussion

The relative risk of road trauma associated with psychoactive substance use, was determined by comparing the prevalence of these substances between a sample of killed and seriously injured drivers (cases sample) and a sample of the general driving population (control sample). Both samples were taken more or less in the same time periods and the same areas, i.e. the catchment areas of the two hospitals that collected the hospital sample. Results of analyses of blood specimens from killed and injured drivers were compared with results of oral fluid specimens from general drivers. The oral fluid is said to "mirror what is found in blood serum", but to what degree the results will be identical cannot be said without oral fluid and blood specimens taken from the same persons at the same time.

The collection of data on injured drivers and the general driving population turned out to be much more difficult than expected, and the sample numbers are consequently much smaller than planned. The small sizes of the samples and the differences in time, area and specimen medium limit the conclusions that can be made from the data. Nevertheless, the prevalence of five of the seven drugs studied is higher among the killed and injured drivers than among the general drivers. Two drugs, ecstasy and cocaine, were not found, neither among the killed and injured nor among the general drivers. Some of the drugs or drug combinations have considerably higher prevalence among the killed and injured drivers than among the general drivers. Among the killed and injured drivers 32 per cent had taken at least one of the seven drugs studied, whereas only one per cent of the general drivers had taken one or more of these drugs. This is an indication that these drugs cause high accident risk in road traffic. Because the number of cases and controls are small, the drugs are not divided into concentration categories, and the comparisons between the cases and the controls are consequently quite rough.

6.1 Drug and alcohol use in the general driving population and among killed and injured drivers

6.1.1 General driving population

99 per cent of the weighted general driving population were negative for all seven drugs included in the survey. Benzodiazepines, cannabis and opiates were found among the drivers in the sample. However, a much larger sample would be needed to survey the prevalence of drugs among the general driving population of Norway.

6.1.2 Killed and injured drivers

Slightly less than 68 per cent of the killed and injured drivers included in the cases sample were negative for the seven drugs included, and 32 per cent were positive for one or more of the seven drugs. Alcohol was the most frequently used drug among the drivers who were confirmed positive.

6.2 Relative risk of drug and alcohol use

6.2.1 Odds ratios

Calculation of relative risk and odds ratios for specific drugs was difficult, because only three different drugs were found among the controls. Relative risk or odds ratios cannot be defined when there is zero positive among the controls. To be able to calculate odds ratios when there is no positive among the controls, 0.5 was added to all cases and controls, except when both cases and controls had zero positive. After these calculations the highest odds ratio for any specific drug was for alcohol above 0.13 per cent BAC, whereas any combination of two drugs came out with the highest odds ratio of all drugs or combinations. Cannabis had the lowest relative risk and odds ratio, and the risk of drivers using cannabis was not significantly different from that of drivers using none of the drugs studied. Relative risk and odds ratios could not be calculated for ecstasy and cocaine which were not found in either group.

However, as the samples are small and the number of positives is even smaller, definite conclusions cannot be made concerning the risk of each drug. The results are quite robust to the addition of another 37 negative cases to compensate for a possible bias in the selection of fatally injured drivers for autopsy.

6.2.2 Are the results comparable?

The cases and controls samples were taken from the most densely populated areas of Norway, the Oslo and Bergen areas. The counties covered by the controls samples make up 36.8 per cent of the population of Norway. The main question for a case control study is, however, whether the cases sample and the controls sample are representative of the same population. As shown in **Section 2.2.6** the two samples do not match completely as to time and area. The match could be made more complete by excluding cases or controls, which do not match by time or area. However, as the samples sizes are small, reducing the samples is considered a greater problem than imperfection in match between the two samples. Even though the match between the two samples could have been better, both samples are collected within the same two areas and within the same 14-month period, a fact, which should make comparison possible.

6.3 Implications for drug driving policy and research

The prevalence of drugs is 32.1 per cent among the sample of cases and 1.0 per cent among the general driving population sample. Even if the two samples do not match completely as to time and area, the difference in prevalence is a clear indication that the seven drugs included in the project are important accident risk factors. Because sample sizes are small and the prevalence of each drug in the controls samples is extremely low, it is difficult to compute relative risk for each drug. However, from the computations made, the combination of any two of the seven drugs studied had the highest odds ratio and alcohol above 1.3 g/l BAC had the second highest.

However, the small sizes of the samples do not allow the use of different concentrations for other drugs than alcohol. It is possible that high concentrations of any drug would produce a relative risk in the same magnitude as high alcohol concentrations.

The high prevalence of drugs in the cases indicates that drugs are a risk factor. Further research will be necessary to differentiate between drugs and between concentrations of each drug. The requirement of the Medical Ethical committee that each injured driver should give his or her written consent to the use of their blood specimen was the main obstacle for obtaining a sufficient number of cases. If further knowledge about the accident risk of the drug use among drivers is wanted, this requirement should be reconsidered. The requirements of the Medical-Ethical committee are based on the World Medical Association's "Ethical Principles for Medical Research Involving Human Subjects" and the Declaration of Helsinki of 1964. Paragraphs 5 and 8 are relevant for the data needed in this kind of projects:

> *"5. In medical research on human subjects, considerations related to the well-being of the human subject should take precedence over the interests of science and society.*
>
> *8. Medical research is subject to ethical standards that promote respect for all human beings and protect their health and rights. Some research populations are vulnerable and need special protection. The particular needs of the economically and medically disadvantaged must be recognized. Special attention is also required for those who cannot give or refuse consent for themselves, for those who may be subject to giving consent under duress, for those who will not benefit personally from the research and for those for whom the research is combined with care" (The World Medical Association 2005)*

Whether an exemption from the requirement of written consent would be possible to obtain, is an open question.

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Appendix: Questionnaires

-1

Hospital questionnaire

ATTACH BARCODE HERE

2-21

Inquiry about injured drivers

1. Has the patient received pain killers or other medicines before arrival at hospital?

22

No ☐ 1 If no, go to question 2

Yes ☐ 2

If yes: What kind of medicine?

_____ 23-24

Dosis

_____ 25-27

Time when medicine was given: ☐☐☐☐ 28-31

32

2. Are you Man ☐ 1

Woman ☐ 2

3. How old are you? _____ years
33-34

35

4. Have you got a valid driver's licence? Yes ☐ 1

No ☐ 2

5. Where (in what county) did the accident occur?

36-37

Oslo	☐ 03	**Buskerud**	☐ 06
Akershus	☐ 02	**Vestfold**	☐ 07
Østfold	☐ 01	**Telemark**	☐ 08
Hedmark	☐ 04	**Aust-Agder**	☐ 09
Oppland	☐ 05	**Vest-Agder**	☐ 10

Municipality

_____ 38-41

Road/street name or no:

_____ 42-46

Would you please indicate more precisely where the accident occurred, e.g. intersection, how far from the closest built-up area etc?

_____

_____

_____

_____

_____

6 Time of accident

Date ☐☐ ☐☐ ☐☐ 47-52
Day Month Year

Hour ☐☐☐☐ 53-56
h h m m

57

7. Did the police arrive ? Yes ☐ 1

No ☐ 2

Don't know ☐ 3

58

8. How far do you drive annually?

1-8 000 km	☐ 1
8-12 000 km	☐ 2
12-16 000 km	☐ 3
16-20 000 km	☐ 4
More than 2 000 km	☐ 5

Roadside questionnaire

Date Day Month Year 21-24

Time of day h h m m 25-28

Municipality _____ 29-32

Road no/name, intersection, other indication of location

_____

_____

_____

_____

_____ 33-37

Police unity _____ 38-41

Information about driver

1. Gender 42

Man ☐ 1

Woman ☐ 2

2. Age: _____ 43-44
(to be estimated if driver refuses to answer)

3. Valid licence? 45

Yes ☐ 1

No ☐ 2

4. How far do you drive annually ? 46

1 – 8 000 km ☐ 1

8 000 – 12 000 km ☐ 2

12 000 – 16 000 km ☐ 3

16 000 – 20 000 km ☐ 4

More than 20 000 km ☐ 5

5. Breath test result _____ 47-49

If no breath test, why? 50

Driver unable to breath ☐ 1

Driver refused for principle reasons ☐ 2

Driver refused because of shortage of time ☐ 3

Driver refused for other reasons ☐ 4

6. Oral fluid sample provided 51

Yes -> End ☐ 1

No -> 7 ☐ 2

7. Why not? 52

Driver unable to provide sample ☐ 1

Driver refused for principle reasons ☐ 2

Driver refused because of shortage of time ☐ 3

Driver refused for other reasons ☐ 4

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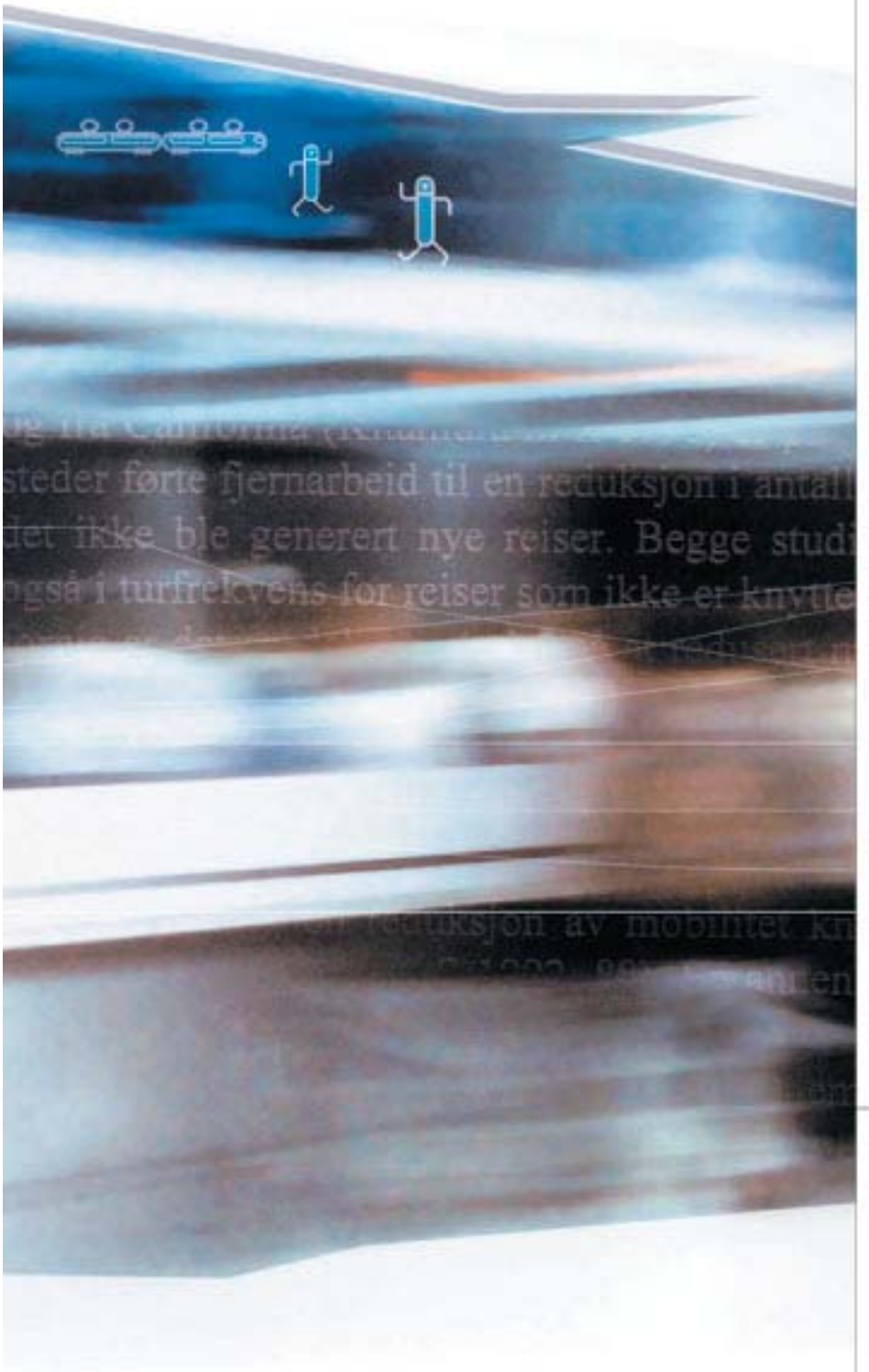

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