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**L'Utilité du Questionnaire CAGE pour le  
Dépistage de l'Alcoolisme dans la Santé Publique**

Thèse

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de l'Université de Genève  
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# **L'Utilité du Questionnaire CAGE pour le Dépistage de l'Alcoolisme dans la Santé Publique**

## **RESUME**

### **Objectif**

1. Décrire les problèmes liés à l'alcool dans la population générale genevoise en utilisant comme indicateur le questionnaire CAGE
2. Evaluer l'utilité et les caractéristiques du CAGE comme outil de dépistage
  - dans la population générale
  - dans la culture franco-suisse
  - dans la médecine préventive

### **Méthodes**

Analyse secondaire de données tirées d'une enquête sur la consommation de tabac et d'alcool réalisée à Genève. Un questionnaire a été envoyé à un échantillon représentatif de 1000 personnes âgées de 18 à 70 ans. Le taux de réponse montait à 67.5%.

### **Le CAGE**

Le questionnaire de CAGE a pour but de dépister des personnes souffrant de l'alcoolisme. Il comporte quatre questions avec réponse oui/non.

- C Avez-vous déjà ressenti le besoin d'arrêter de boire de l'alcool ?
- A Avez-vous déjà été ennuyé par des critiques de vos proches concernant votre consommation d'alcool
- G Avez-vous déjà ressenti un sentiment de culpabilité vis-à-vis de votre consommation d'alcool ?

E Avez-vous déjà bu de l'alcool le matin pour mieux vous réveiller ? („eye-opener“)

Deux réponses affirmatives ou plus sont considérées une forte indication que le sujet soit présentement un alcoolique ou le fut.

### **Autres questions posées**

On a comparé les personnes ayant répondu d'une manière affirmative aux questions de CAGE avec ceux dont les réponses étaient négatives, par rapport à la consommation d'alcool et les effets néfastes de la consommation alcoolique. Ces comparaisons étaient faites pour chacune des questions séparées et pour des seuils différents de détection. Selon la consommation et les problèmes liés à l'alcool on a identifié des groupes de buveurs avec une consommation qui à long terme nuit la santé („hazardous drinkers“) et de buveurs avec une consommation problématique („harmful drinkers“). La capacité du CAGE à détecter ces individus a été évaluée.

Toutes les paramètres de cette analyse ont fait l'objet d'une comparaison entre les sexes.

### **Résultats**

Avec le seuil de détection le plus utilisé, soit 2 réponses positives ou plus, 11% des participants ont un CAGE positif, (17% des hommes et 6.1% des femmes). La consommation moyenne d'alcool rapportée est à 9.5 verres par semaine (à environ 12g d'alcool) pour les hommes et 3.6 pour les femmes. 11.9% des hommes et 5.5% des femmes ont une consommation alcoolique qui nuit à la santé. 10% de la population (10.9/9.1%) avoue avoir connu des problèmes liés à l'abus de l'alcool (familiales, professionnels, etc.)

Une réponse positive à une des quatre questions est associée à une probabilité d'être buveur à consommation dangereuse ou problématique 3 à 6 fois supérieure par rapport au groupe avec des réponses négatives. Seule la question „eye-opener“ diffère des trois autres et permet d'identifier moins bien les personnes qui ont des problèmes liés à l'abus d'alcool.

Dans le groupe avec deux ou plus de réponses positives (seuil de détection standard pour

le CAGE) les individus montrant des habitudes suggérant des problèmes liés à leur consommation d'alcool sont nettement plus nombreux que dans le groupe avec un CAGE négatif. Les «odds-ratios» se situent entre 4 et 50. Les analyses avec un seuil de détection baissé à 1 donnent des chiffres légèrement plus bas.

Pour ce qui concerne le dépistage des buveurs à consommation qui nuit la santé, les performances du CAGE (avec un seuil à 2) sont néanmoins faibles, avec une sensibilité de 0.57 et un spécificité de 0.79. Le même vaut pour les buveurs problématiques avec sensibilité et spécificité de 0.52 et 0.78 respectivement. Baisser le seuil à 1 ne donne pas des résultats plus satisfaisants.

## **Conclusion**

Les scores de CAGE obtenus dans cette enquête correspondent aux résultats d'autres études similaires ce qui suggère une certaine reproductibilité. Le fait que 11% des personnes interrogées aient un test de CAGE positif (seuil à 2) de même que les réponses aux questions liées à la problématique de l'alcool sont inquiétants. Supposant que le déni reste un facteur majeur, la problématique de l'alcoolisme semble très étendue dans la population.

Le CAGE paraît un bon indicateur pour l'évaluation de l'alcoolisme dans une population générale. Tous les critères suggérant un problème alcoolique montrent une bonne corrélation avec le CAGE. La question „Eye-opener“ paraît trop directe pour la population étudiée. Sa suppression ne change guère les résultats.

Mais le CAGE a ses limites. Il ne paraît pas assez sensible pour le dépistage de l'alcoolisme à symptômes bas („hazardous and harmful drinkers“). Puisque ces individus profiteraient d'avantage d'une intervention précoce, le CAGE ne semble pas le meilleur choix pour la prévention de l'alcoolisme.

# Utility of the CAGE-Test as a Screening Tool for Alcoholism in Public Health

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# 1 INTRODUCTION

## **1.1 Definition of Alcoholism**

Alcoholism is a very heterogeneous illness and its definition is still in progress. ICD-10 classifies two different types of alcoholism: Dependence and harmful drinking (1).

### **Alcohol Dependence (ICD-10)**

- Strong desire or sense of compulsion to take the substance
- Impaired capacity to control substance taking behavior in terms of onset, termination, or levels of use
- Physiological withdrawal state when substance use is reduced or stopped or use of the substance to relieve or avoid withdrawal symptoms
- Evidence of tolerance to the effects of the substance
- Other pleasures or interests being given up or reduced because of the substance use
- Persistent substance use despite clear evidence of harmful consequences  
(at least three items required for diagnosis)

### **Harmful Alcohol Use (ICD-10)**

- Clear evidence that the substance use is responsible for (or is substantially contributing to) physical or psychological harm
- The nature of the harm is clearly identifiable and specified
- The pattern of use has persisted for at least one month or has occurred repeatedly with the twelve month period
- The subject does not fulfill criteria for alcohol dependence

DSM-IV (2) criteria are similar. However for „Harmful use“ the expression of „Alcohol abuse“ is preferred.

A third widely accepted problem is hazardous drinking (3-7) which classifies people without alcohol-related problems but an amount of alcohol intake that is likely to lead to problems in the future. Unfortunately its definition is quite difficult because health

risks related to alcohol consumption increase gradually with the amount of alcohol intake and a cut-point is therefore artificial. A limit of 1 drink/day for women and 2 drinks/day for men above which consumption is considered hazardous, is suggested by the U.S. Dep. of Health (6). These are the levels of consumption at which the demonstrated risk for alcohol-associated diseases such as hypertension (7) and breast cancer (7) exceed the potential benefits derived. Similar limits were put by the Health Education Authority in U.K. and the Royal College of Psychiatrists (8,9).

## **1.2 The impact of Alcoholism on Public Health**

Alcohol consumption and alcohol related medical and psychosocial morbidity remain a major concern in Public health. In the USA incidence and prevalence of alcoholism ( diagnosed by DSM-IV criteria) in the general population is estimated 4.4% and 13.3% respectively (10). In Switzerland there is an estimated average consumption of 13 liters of pure alcohol per year and person (age 15 and older) as calculated from the overall alcohol sold in the country (9.6 liters for the U.S.A.) (11). There are an estimated 2.5% of alcoholics (4), a number probably highly optimistic. Apart of the immense amount of personal suffering, the socioeconomic impact is considerable. In Canada the economic cost of alcohol abuse was estimated at more than \$7.5 billion per year, representing 40.8% of the total cost of substance abuse (12). In Switzerland 20% of all hospital admissions are related to alcohol, ranging up to 50% in the group of 40-50 years old (4).

## **1.3 Prevention**

There is no doubt about the necessity of effective prevention to fight this major health problem. Whereas primary prevention tries to inform and support people before they get into any alcohol related troubles, the aim of secondary prevention is to help people already experiencing any kind of negative consequences due to their alcohol intake. This is done with the goal to decrease or even stop their harmful alcohol consumption and to minimize further social or physical health damage. Secondary prevention is a widely used practice in clinical medicine, but primary prevention is often neglected . The reasons therefore are manifold. Apart from lack of time and focus, difficulty to prove effectiveness seems a major constraint (1,2,4,26).

Therefore screening general population to follow the impact of primary prevention is fundamental. However the utility of screening instruments such as the CAGE questionnaire for primary prevention has only recently become part of investigation. The requirement for a screening tool in primary prevention differ from secondary. Most often the general population has to be screened and there is a need to detect a population at risk rather than people already suffering from illness. Moreover, even if a test is not very specific, it may be useful as a parameter to detect time trends as long as reliability is accurate.

#### **1.4 Alcohol screening tests**

Alcoholism is difficult to diagnose. There are no objective biologic tests that are reliable indicators of alcohol problems. Mean cell volume of red blood cells,  $\gamma$ -GT of the liver and a few others are often altered in excessive drinking but their sensitivity and specificity are insufficient (3). Therefore, in most of the cases diagnosis requires subjective information of the patient or his surrounding. Unfortunately, alcohol problems are associated with social stigma and patients are not eager to have the condition discovered at any stage. For this reason patients may not be truthful with themselves or others regarding the extent of consumption or negative consequences resulting from its use. The combination of subjective diagnostic criteria and denial creates a major barrier for physicians in the screening and diagnosis of alcohol problems. To overcome this problem, multiple alcohol screening questionnaires have been developed. Their common goal is to provide physicians and health care workers with a good tool to diagnose alcoholism. Therefore they needed to be short, easy to use, and overcome denial, which was achieved by using questions that are answered positively by alcoholics even though they denied any excessive drinking.

The following is a short overview of the most used and well established alcohol screening questionnaires:

##### **1. CAGE-Test**

One of the oldest and best investigated screening tests (4,13)



2. MAST (Michigan alcoholism screening test)

25 Questions, wide variety. Slightly better performance than the CAGE but much longer (14)

3. B-MAST

Reduction of the MAST to 10 Questions (15), shows a high correlation with the full MAST ( $r=0.95$ ). It's performance is comparable to the CAGE (16).

4. S-MAST

Reduction of the MAST to 13 questions with high correlation to the MAST (17).

5. AUDIT

10 Questions, including questions similar to the CAGE and questions about alcohol consumption. It was developed to identify problem drinkers in primary care settings. It seems to detect a broad range of alcohol related problems, including hazardous drinking (5).

6. TWEAK

5 Questions, including some questions of the CAGE, others from the MAST, and a question about the quantity of alcohol consumed. It was initially designed to detect „at risk“ drinkers. There is some evidence that it performs better in detecting heavy drinking than the CAGE (18).

Findings from studies that compared all or some of the tests are heterogeneous (5,14,16,18,19,20) and probably due to methodological differences. In summary, apart from the MAST that is much longer than the others, the tests seem to perform equally well in detecting alcoholism with some minor individual advantages in different populations (sex, age) (21).

There are some other, less known questionnaires, such as the VAST, SWAG, NET, T-ACE(14,21,22).

### **1.5 The CAGE Questionnaire**

The CAGE Questionnaire is a widely used tool to screen for alcoholism. It was developed by Ewing and Rouse in 1970 (13) to detect alcoholics in general hospitals. A patient sample, including clinically diagnosed alcoholics, answered a large number

of alcohol related questions. Next, researchers looked for the minimum number of questions that would usefully divide the responders into alcoholics and non-alcoholics. Four questions performed well and were placed in a new order to permit the use of the mnemonic CAGE. In 1974 Mayfield et al. published the first validation study (23). Since then, reliability and validity have been well documented in hospital (13,16,18,24,25,) and general practice (10,14,21,26-30) settings. The CAGE has gained remarkable popularity because it is short, simple to use, and allows to detect more alcoholics than blunt questions on drinking habits (13,23). Two or more positive answers on this 4-question-test is the common cut-off for detecting alcoholism (13,23). The sensitivity and specificity of this test by DSM-III-R criteria for alcohol dependence as a goldstandard are 75-85% and 85-95% respectively (21).

### **1.6 The CAGE and gender differences**

In every evaluation of alcohol related disorders it seems useful to investigate men and women separately. The CAGE performance seems to be worse in women than in men(12,16,20,22). Not only are women three times less likely to have a positive test result, which may reflect the fact that alcoholism is less common in the female population but some studies show less sensitivity in women (16,31). The increased stigma associated with heavy drinking in women (32) might lead women to underreport alcohol consumption and alcohol related problems more often than men. Also, in many social groups women are less likely than men to experience overt social consequences of heavy drinking such as employment, economic, or legal difficulties (33,34). On the other hand, women suffer from adverse consequences of drinking at lower levels of consumption than men (6-9,35).

### **1.7 The CAGE in General Populations**

The validity of the CAGE questionnaire in general population samples was subject of recent investigations (12,16,18,31,36-39). The general population differs in many ways from hospital and general practice settings:

1. Usually the prevalence of alcoholism (pre-test probability) is lower than in general practice or hospital settings. Mainly because alcoholics are more likely to

experience health problems and contact the medical system than the average population (3,16).

2. Alcoholics in the general population have less severe symptoms than alcoholics seeking medical care(3,16). It seems that alcoholics are much more likely to contact health care providers once they are seriously ill, which is usually in a later and more severe stage of their alcohol disease (3,16).
3. In the general population the risk for denial is higher than in hospital and general practice settings (3,16). People who are seeking a physicians help are often aware of their problem and more likely to talk about their alcohol consumption. And even people initially denying any relation between their medical problem and alcohol consumption often start accepting the facts after continuous conversations and treatment (3,16).

Changes in pre-test probability should not affect the sensibility and specificity of a test. However the positive predictive value is lower in samples with low pre-test probabilities such as the general population.

The other two points represent new conditions that may alter the CAGE's performance (sensitivity and specificity). For example, if denial is more common, then sensitivity is expected to be lower.

The different characteristics of general populations compared to hospital and general practice samples explain the need to test the performance of the CAGE under these conditions. A task that is complicated by the fact that proper goldstandards are more difficult to obtain in general populations. It is often very difficult to get access to preexisting clinical records and the time healthy individuals are ready to invest in surveys is often limited. This makes it difficult to obtain further information to validate and administer the CAGE questionnaire, especially longtime psychiatric interviews and clinical tests. Only two American studies compared the CAGE to DSM-III-R criteria in a general population, reporting sensitivity of 0.56/0.77 and specificity of 0.95/0.85 (16,39). In all the other applications of the CAGE to the general population proper gold standards are missing.

Finally, most of the mentioned studies used the English version of the CAGE in

Anglo-Saxon cultures. However, for the use in general populations proper validation of the French version and its use in European cultures is still lacking (36).

### **1.8 The CAGE in Public Health**

Especially in public health the CAGE is often administered in a different way (phone interviews or posted questionnaires) and for different reasons (population surveys and prevention rather than treatment). That is why further validation of the CAGE under these special conditions could be valuable.

Whereas the CAGE's ability to detect alcohol dependence are well documented there are still some doubts about its ability to detect harmful and especially hazardous drinking (3,12). The CAGE was not initially designed to detect lower symptomatic alcoholism (13). However, as the definition of alcoholism progressed (16) and the importance of hazardous drinking started to be recognized (3) the question raised whether the CAGE would be able to detect these conditions(3,16).

One could argue that in public health screening for harmful and hazardous drinking is more important than screening for dependence because it seems often an earlier stage in alcohol disease, is more effective to treat and covers the greatest part of alcohol related suffering and costs due to its high prevalence (3,4).

### **1.9 Goals of the study**

Paying attention to these aspects this study addresses to the following questions:

1. Utility of the CAGE as a screening tool in population surveys
2. Ability of the CAGE in detecting low symptomatic alcoholism
3. Analysis of the validity of the CAGE in general population samples
4. Performance of different cut-offs
5. Gender differences in the CAGE performance
6. Analysis of the validity of the French version of the CAGE

## 7. Characteristics of the CAGE administered to the Swiss-French culture

## 2 METHODS

### **2.1 *Setting and population***

In February 1996, J.-F. Etter et al. mailed a questionnaire to a representative sample of the population living in the canton of Geneva aged from 18 to 70. The sample is a random selection of 1000 persons based on the official file of Geneva residents (400'000 inhabitants). Four reminders were sent to the non-responders, and a response-rate of 68.4% (675 / 987) was obtained after exclusion of 13 ineligible persons.

This dissertation is a secondary analysis of these previously published datas (46).

### **2.2 *Content of the Questionnaire***

The Questionnaire was in French and contained a section on personality, smoking and on alcohol. The alcohol section consisted of the CAGE-Questionnaire and questions about drinking habits, alcohol-related problems and other questions related to alcohol and personal health.

**The part of the Questionnaire used for this study (translated from its French version)**

<p>1. How frequently have you been drinking alcohol in the past twelve months.....</p>	<ul style="list-style-type: none"> <li>- 6-7 days / week</li> <li>- 3-5 days / week</li> <li>- 1-2 days / week</li> <li>- 1-3 days / month</li> <li>- Less than once a month</li> <li>- Never</li> </ul>
<p>2. How many drinks on average did you take on the days you've been drinking alcohol?</p>	<p>___ drinks / day</p>
<p>3. How many times in the last twelve months have you driven a car with the impression of having drunk too much?</p>	<p>___ times</p>
<p>4. Have you met any of the following problems related to alcohol abuse?</p>	<ul style="list-style-type: none"> <li>- Drivers license suspension</li> <li>- Difficulties in the family</li> <li>- Difficulties in the job</li> <li>- Difficulties with friends, neighbors, etc.</li> </ul>
<p>5. Have you ever tried to get help for a problem related to alcohol use ?</p>	<ul style="list-style-type: none"> <li>- from a doctor (except psychiatrists)</li> <li>- from a psychiatrist or psychologist</li> <li>- from social workers</li> </ul>

6. In general, do you consider that your health is.....	<ul style="list-style-type: none"> <li>- Excellent</li> <li>- Very good</li> <li>- Good</li> <li>- fair</li> <li>- poor</li> </ul>
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### 2.3 Measures

The CAGE is an acronym of the four questions:

Have you ever felt you ought to cut down on your drinking? (yes/no)

Have people annoyed you by criticizing your drinking? (yes/no)

Have you ever felt bad or guilty about your drinking? (yes/no)

Have you ever had a drink first thing in the morning to steady your nerves or get rid of a hangover (eye-opener)? (yes/no)

The original CAGE was designed to detect current alcoholics (13). However, because people who had only experienced alcoholism far in the past could also answer positively to the questions it was suspected that the CAGE may detect lifetime prevalence of alcoholism rather than only current alcoholics. That is why the past-year CAGE was developed to detect only the actual alcoholics (prevalence) . In this study we used a French translation of the questionnaire in the version that screens for life long prevalence of alcoholism.

#### Validation Criteria

Cronbach  $\alpha$  was used to assess reliability. For criterion validation we used the following hypothesis: If the four CAGE questions are good tools to detect people who have a problem with their alcohol intake, the following hypothesis should be true for the individuals giving an affirmative answer to one of the four question compared to the ones that responded negatively :

1. People with one or more positive answers to the CAGE questions have a higher average alcohol intake than participants with no positive answers.
2. People with one or more positive answers to the CAGE questions are more likely to be hazardous and heavy drinkers.

As mentioned, hazardous alcohol intake is difficult to define. We set the limit at an average daily alcohol intake of 1 drink/day for women and 2 drinks/day for men on above which consumption is considered hazardous, as suggested by the U.S. Dep. of Health (6). These are the levels of consumption at which the demonstrated risk for alcohol-associated diseases such as hypertension (7) and alcohol related cancer (7,40) exceed the potential benefits derived. Similar limits were set by the Health Education Authority in U.K. and the Royal College of Psychiatrists (8,9).

The chosen limits are the lower end of all suggestions found in the literature and are therefore subject to criticism. So we added the criteria "heavy drinking" for an average daily alcohol intake of more than 3 drinks for women and more than 4 drinks for men. These levels are slightly above to most optimistic estimation of harmful alcohol consumption in the literature (40g pure alcohol per day for women and 60g for men at a standard drink of 12g of pure alcohol)(11) and therefore above this limit there are hardly any doubts about the serious risks for physical and psychosocial health.

3. People with one or more positive answers to the CAGE questions are more likely to have experienced problems related to their alcohol intake.

„Harmful drinking“ was defined as reporting problems related to alcohol intake in at least one of the different areas. This doesn't completely correlate with the ICD-10 diagnosis for harmful drinking that suggests that the pattern of alcohol use leading to problems must persist for at least one month or has to be present repeatedly.

4. People with one or more positive answers to the CAGE questions are more likely to report repeated driving while intoxicated .

Individuals who answered the question "How many times have you been driving a car with the impression of having had too much alcohol" were considered positive



for "Driving while intoxicated" if they reported five or more such episodes. The repetitiveness of a behavior that exposes the person to a serious risk regarding its health and conflicts with law (41) is a good sign for the abuse of alcohol (DSM IV) and an increased risk for dependence (3). Unfortunately, DSM does not specify the meaning of repetitive but a cut at five times a year seems reasonable.

5. People with one or more positive answers to the CAGE questions are more likely to report having sought professional help for their drinking.

This includes all people having ever contacted a doctor, psychiatrist or social assistance to face a problem related to their alcohol intake.

6. People with one or more positive answers to the CAGE questions have a worse health status than those with negative answers.

Alcohol dependence and hazardous drinking is related to an alcohol consumption that harms the individuals health if persistent. CAGE positive individuals should therefore report an overall poorer health state than the CAGE negative. To get a dichotomic variable we separated the individuals who considered their health being excellent, very good or good from the ones reporting fair or poor health.

Each of the four CAGE questions was tested against those criteria. In addition we compared the population with two or more positive answers, the recommended threshold for the CAGE 2 to detect alcoholism (13,23), to the population with one or no positive answers.

In some studies a cut-off of one is discussed (16,18,29,42), especially for screening tests in which sensitivity is supposed to be high. The aim is to keep negative predictive value as low as possible. Therefore a high sensitivity is needed. This can only be achieved with a low threshold. The consequence is often a decrease in specificity and positive predictive value. But this is secondary for a screening test who aims not a final diagnosis but rather detecting a population at risk. The definitive diagnosis can then be evaluated with further tests.

Moreover, in general population samples where symptoms are often mild, too many false negative are said to be lost with a threshold of two(16). That is why we compared the performance of the CAGE at the different thresholds.

As mentioned, hazardous, harmful and heavy drinking should be detected by a screening test, especially in public health. We measured the performance of the CAGE in detecting these individuals. Again we compared thresholds of two and one. The clinician who is confronted with a patient, however, is more interested in the meaning of the individual score rather than a threshold. That's why we added the probability of having one of those conditions for the different CAGE scores.

For the statistical calculations we used the SPSS8.0 program (SPSS Inc., Chicago). We did group comparison accompanied with p-values calculated with chi-squares for categorical variables. Differences associated with a p-value  $\leq 0.05$  were considered statistically significant. To validate the different CAGE questions we further used Pearson chi square, relative values (bench marking of Pearson chi squares of the four CAGE questions) and odds ratios.

### 3 Results

#### 3.1 CAGE results at the threshold of 2

The total sample was 675, 322 men (48%), 350 women (52%). Of those 9.7 % were non-drinkers. This low number is characteristic for the Swiss-French population (43,11).

The results of the CAGE at the common used cut-off point of two are shown in table 1.

**Table 1 CAGE-Test (In %, n=675=100%)**

	All	men	female
Have you ever felt you need to Cut down on you drinking?	17.3	23.9*	11.2*
Have you ever felt Annoyed by criticism of your drinking?	9.0	14.5*	4.3*

Have you ever felt <b>Guilty</b> about your drinking?	13.7	18.9*	8.6*
Have you ever felt you needed a drink first thing in the morning? ( <b>Eye-opener</b> )	2.3	4.4*	0.3*
“CAGE” Positive (2 or more positive answers with “eye-opener excluded)	11.0	16.6	6.1
<b>CAGE Positive</b> (2 or more positive answers)	<b>11.3</b>	<b>17.0*</b>	<b>6.1*</b>

\* Difference between men and women  $p < 0.05$

11.3% of the population has a positive CAGE result. Men are 2.8 times more likely to have a positive test result than women (17.0 vs 6.1) are. Almost one out of five people or 17.3% of the population have already felt that they need to cut down their drinking. On the other hand, only 2.3% respond affirmatively to the "eye-opener". The exclusion of this question would hardly change the number of positive CAGE results. The shown percentages are based on the total sample, including the non-drinkers. Even though in many other studies CAGE results are calculated excluding the non-drinkers, including non-drinkers seems more appropriate. It gives a better estimation of the number of problem-drinkers in the general population and allows comparing the results in different populations. Moreover to validate the CAGE, including self-reported non-drinkers seems important because this group may contain an important percentage of alcoholics in denial. They may be detected in the process of validation.

### **3.2 Alcohol and alcohol related problems**

The average alcohol consumption was 6.4 glasses/week (table 2) that is 77 g of pure alcohol (one standard drink = 12g pure alcohol (11)). Men consume almost three times more than women. 8.6% of the population are hazardous and 3.8% heavy drinkers. These data are quite similar to the ones obtained by Gmel (11) who used similar cut-offs in the Swiss-French population (9.1% and 3.9% respectively).

**Table 2 Alcohol consumption and Alcohol related problems****(n=100%=675)**

	Total	Male	Female
<b>Hazardous drinking</b>	8.6%	11.9%*	5.5%*
<b>Heavy drinking</b>	3.8%	6.7%*	1.2%*
<b>Harmful drinking</b>	10%	10.9%	9.1%
- Confiscated driving license	3.8%	6.0%	1.5%
- Family problems	6.0%	6.0%	6.1%
- Professional problems	2.9%	3.1%	2.6%
- other social problems	4.2%	3.1%	5.2%
<b>Intoxicated while driving (&gt;= 5 times in last twelve months)</b>	4.3%	8.1%*	0.9%*
<b>Tried to get help for alcohol-related problems</b>	2.5%	3.2%	1.8%
<b>Fair or poor health status</b>	6.8%	6.7%	7%
<b>drinks/week</b>	6.4	9.5*	3.6*

\* Difference between male and female p&lt;0.05

10% of the population reports having experienced problems related to alcohol consumption in at least one of the screened areas and are therefore classified harmful drinkers. Interestingly there is no significant difference between man and women, as one would expect if the hypothesis of lower consumption and higher denial in females were true. This could be due to women reporting problems related to the alcohol consumption of close ones rather than their own. Whereas the number of men

reporting five or more times intoxicated driving in the last twelve month is alarmingly high (8.1%), the number of people seeking professional help for their drinking is deceptively low. In the latter , there is no difference between sexes.

### 3.3 Reliability

Cronbach-alpha was 0.70 (table 3), a result also found in other studies of the French and English version of the CAGE (36), suggesting good internal consistency.

Additionally, we tested Cronbach-alpha for the CAGE excluding questions one by one. By excluding the "eye-opener" question Cronbach-alpha raised to 0.73. All other exclusions decreased internal consistency of the CAGE.

**Table 3 Cronbach alpha for the total CAGE and partial, excluding each of the four questions**

CAGE	AGE	CGE	CAE	CAG
0.70	0.61	0.61	0.55	0.73

### 3.4 Validation of content

As shown in table 4 , the CAGE does not cover all of the criterias indicating alcohol dependency as suggested by ICD-10. Especially the criterion “giving up other activities” seems not to be covered by any of the four CAGE questions.

**Table 4 Content validation of the CAGE regarding ICD-10 criteria**

ICD-10	Cut down	Annoyed	Guilty	Eye-opener
Compulsion				
Lack of control				
Withdrawal				
Tolerance				
Other activities given up				
Use despite harmful				

### 3.5 Characteristics of the different CAGE questions

To test the properties of the CAGE we compared its four questions to the different indicators for alcohol problems (table 5a). Every single question shows good discrimination power in tests. A positive answer in any of the four questions is associated with a four to five times higher probability for being a hazardous or harmful drinker. A positive answer increases the alcohol consumption 2.6 to 3 times.

**Table 5a Prevalence of each validation criterion in the different CAGE groups in %**

CAGE question	Cut-down*		Annoyed*		guilty*		eye-opener*	
	Yes	no	Yes	No	yes	No	yes	No
answer								
n=	116	517	61	573	91	534	15	625
Hazardous drinking	25.7	5.5	33.9	6.4	27.3	6.1	30.8	8.5
Heavy drinking	11.7	2.3	16.7	2.7	11.2	2.8	14.3	3.7
Harmful drinking	24.3	7.0	40.0	7.0	27.8	7.3	53.3	9.1
Intoxicated while driving	9.4	3.4	18.5	3.1	16.5	2.5	23.1	3.9
Professional Help	12.3	0.4	16.7	1.0	9.0	1.5	28.6	1.9
Fair or poor health status	13.2	5.7	20.3	5.7	16.9	5.3	15.4	6.8
drinks/week	13.4	5.2	16.3	5.7	13.8	5.6	18.6	6.3

\*All  $p < 0.05$

By far the best discrimination is obtained for the group seeking professional help. People with a positive answer in any of the questions are 6 to 30 times more likely to have contacted professional help than the ones with negative answers. This group is considered the one with the highest probability of alcohol dependence and the high discrimination power of the CAGE questions is therefore of great significance. Finally the groups answering affirmatively report a poorer health status than the negative, as one would expect.

The calculated chi-squares and relative validity (table 5b) show that the „Annoyed“-question performs best in all criteria except in „driving while intoxicated“. „Cut-down“ and „Guilty“ are of equal value with some differences. Whereas the first does excellent in „Professional Help“ the second performs better in „Driving while

intoxicated“. Again the "eye-opener" has a somewhat special position. Its discrimination power is pretty poor compared to other items.

**Table 5b Pearson Chi-Squares and Relative Validity**

CAGE Question	cut-down		Annoyed		Guilty		eye-opener	
	chi	rv	Chi	rv	Chi	rv	chi	rv
Hazardous drinking	44.5	<b>0.91</b>	49	<b>1.00</b>	40.5	<b>0.83</b>	7.8	<b>0.16</b>
Heavy drinking	20.9	<b>0.75</b>	27.8	<b>1.00</b>	13.8	<b>0.5</b>	4.0	<b>0.14*</b>
Harmful drinking	31	<b>0.48</b>	65.2	<b>1.00</b>	35.1	<b>0.54</b>	31.3	<b>0.48</b>
Driving w. intox.	7.4	<b>0.27</b>	27.4	<b>0.84</b>	32.6	<b>1.00</b>	11.5	<b>0.35</b>
Professional help	53.2	<b>0.99</b>	53.8	<b>1.00</b>	17.1	<b>0.32</b>	39.7	<b>0.74</b>
Poor health	7.9	<b>0.49</b>	17.6	<b>1.00</b>	15.6	<b>0.89</b>	1.4	<b>0.09*</b>

\* p>0.05

### **3.6 Validation of the CAGE at a threshold of 2**

The Characteristics of the CAGE positive population at a CAGE threshold of 2 are shown in table 6a. All tested factors that indicate problems with alcohol consumption are far more common in the CAGE positive group of the sample. Alcohol consumption in the positive group is three times higher than in the negative. One third are hazardous (33.3%) or harmful drinkers (33.8%) compared to 5.7% and 7.1% respectively. A previous study (12) supports the good discrimination factor for harmful drinking (4.8 and 7 respectively). Heavy drinkers are six times more common (15.1 vs 2.5). However, it is surprising that heavy drinking is not better separated than hazardous drinking (6 vs 5.8).

**Table 6a Characteristics of the CAGE positive (>=2) vs CAGE negative population in %**

CAGE score	Total*		male*		female*	
	>=2	<2	>=2	<2	>=2	<2
Hazardous drinking	33.3	5.7	29.4	8.9	42.9	3.2
Heavy drinking	15.1	2.5	15.4	5.2	14.3	0.3
Harmful drinking	33.8	7.1	34.0	6.3	33.3	7.7
Driving w. intox.	14.5	3.1	18.4	6.3	5.0+	0.7+

Professional Help	14.9	0.9	16.7	0.4	10.0	1.3
Health status	19.2	5.3	13.2	5.6	35.0	5.1
drinks/week	15.7	5.4	17.1	8.2	12.2	3.2

\* all  $p < 0.05$

+ not significant

The most impressive performance is detected in the people seeking professional help for their alcohol consumption. They are 15 times more common in the positive group (14.9 vs 0.9). It is interesting to see that the CAGE has in all areas an equal or higher distinction power in women.

To highlight the discrimination power in the different criterions we additionally calculated the odds ratios (table 6b).

**Table 6b Odds ratios with 95% confidence interval for an individual with a CAGE score  $\geq 2$**

	Total		Male		Female	
	odds ratio	Interval	odds ratio	Interval	odds ratio	interval
Hazardous drinking	<b>8.2</b>	4.5/15.1	<b>4.2</b>	2.0/9.0	<b>22.6</b>	7.8-66
Heavy drinking	<b>7</b>	3.0/16.0	<b>3.3</b>	1.3/8.5	<b>52.0</b>	5.1/525
Harmful drinking	<b>6.7</b>	3.7/12.0	<b>7.7</b>	3.6/16.4	<b>6.0</b>	2.2/16.3
Driving w. intox.	<b>5.3</b>	2.3/12.0	<b>3.8</b>	1.4/8.3	<b>8.0</b>	0.7/92*
Professional help	<b>19.6</b>	6.6/58.2	<b>50.4</b>	6.2/407	<b>8.5</b>	1.5/50
Poor health status	<b>4.2</b>	2.1/8.4	<b>2.6</b>	1.0/6.7	<b>9.9</b>	3.4/28

\*not significant

In this view, the outstanding performance of the CAGE in detecting people who got professional help for their alcohol use is even more evident, especially in men. In women hazardous and heavy drinking is best detected.

### **3.7 Threshold at 1**

With a CAGE at a threshold of one 24.1% of the sample have a positive CAGE (34.5% of men, 16.3 % of women). In this case the CAGE positive group shows slightly lower frequencies for all factors (table 7). On the other hand, the CAGE negative group shows only little decrease of the criterion frequencies.



Especially in "Professional help" the CAGE performance is still outstanding, and in female even better than at a threshold of two.

**Table 7a Characteristics of the CAGE positive (>=1) vs CAGE negative population in %**

	Total*		male*		female*	
	pos	neg	pos	neg	pos	neg
CAGE >=1						
Hazardous drinking	20.9	5.0	21.2	8.0	20.4	2.9
Heavy drinking	9.6	2.1	11.8	4.5	5.5	0.4
Harmful drinking	21.1	6.5	21.7	5.5	20.0	7.2
Driving w. intox.	11.4	2.1	15.5	4.7	3.8+	0.4+
Professional help	8.8	0.4	9.4	0.0	7.5	0.7
Poor health status	10.6	5.7	8.5	6.1	14.8	5.4
Drinks/week	12.3	4.8	14.5	7.4	8.2	2.9

\* all p<0.05

+ not significant

**Table 7b Odds ratios with 95%confidence interval for an individual with a CAGE score >=2**

	Total		Male		Female	
	odds ratio	Interval	odds ratio	Interval	odds ratio	interval
Hazardous drinking	<b>5</b>	2.8/8.8	<b>3.1</b>	1.5/6.2	<b>8.7</b>	3.3/22.8
Heavy drinking	<b>5</b>	2.2/8.8	<b>2.8</b>	1.1/7	<b>16</b>	1.6/157
Harmful drinking	<b>3.9</b>	2.5/6.6	<b>4.8</b>	2.2/10.3	<b>3.3</b>	1.4/7.2
Driving w. intox.	<b>5.9</b>	2.6/13.1	<b>3.7</b>	1.5/8.8	<b>11*</b>	0.9/122
Professional help	<b>23.1</b>	5/103	<b>n/a</b>		<b>11.4</b>	2/63
Poor health status	<b>2</b>	1.1/3.7	<b>1.*4</b>	0.6/3.5	<b>3</b>	1.2/7.6

\* not significant

### **3.8 CAGE performance in detecting low symptomatic alcoholism**

Of the 56 individuals who were positive for hazardous drinking 42.9% had a positive CAGE (table6), of the harmful drinkers only 38.5%.

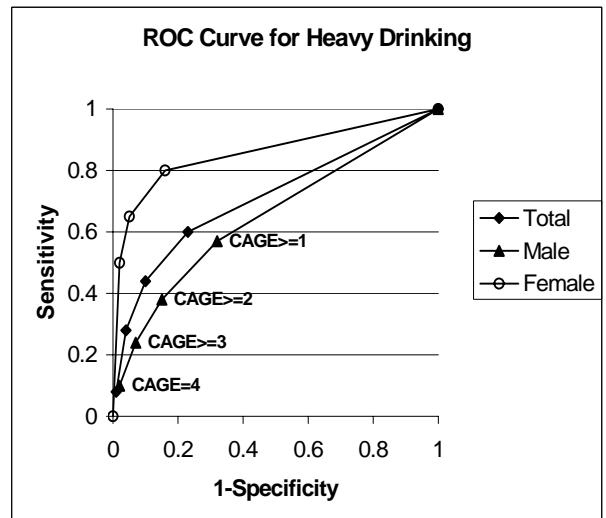
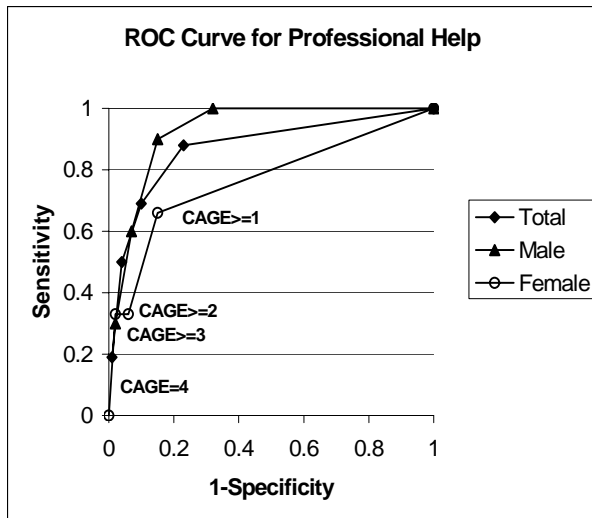
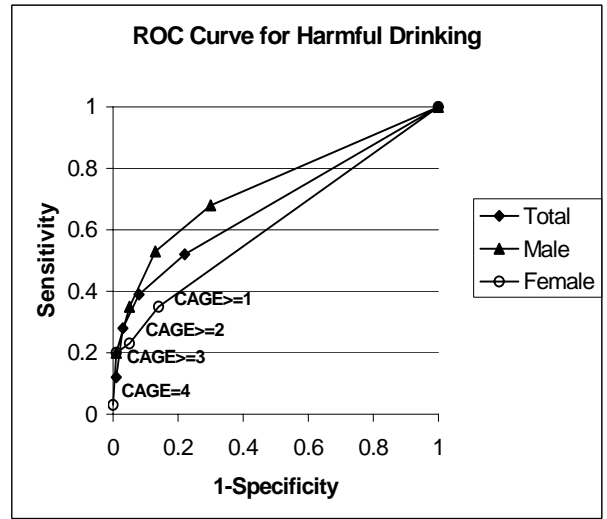
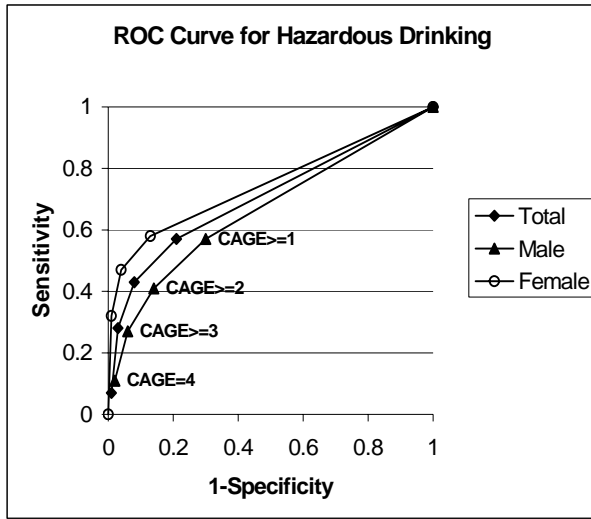
**Table 8 Performance of the CAGE in detecting hazardous or harmful drinking at different thresholds**

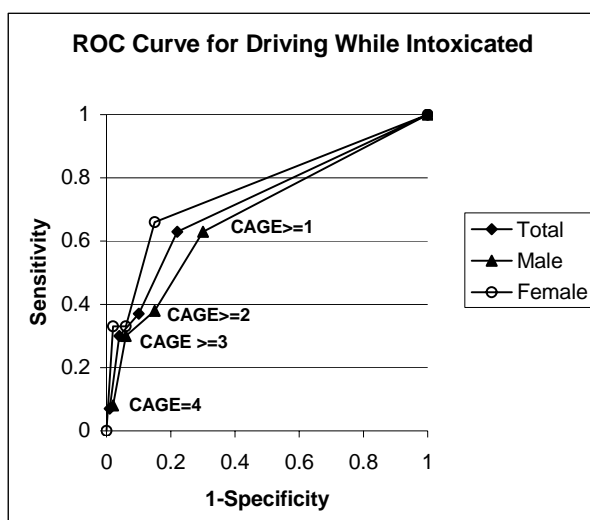
CAGE thres- hold	N=	Hazardous drinking			Heavy drinking			Harmful drinking		
		total	male	female	total	male	female	total	male	female
		56	37	19	25	21	4	65	34	31
>=1	Sens	0.57	0.57	0.58	0.60	0.57	0.75	0.52	0.68	0.36
	Spec	0.79	0.70	0.86	0.77	0.68	0.84	0.78	0.70	0.86
>=2	Sens	0.43	0.41	0.47	0.44	0.38	0.75	0.39	0.53	0.23
	Spec	0.92	0.86	0.96	0.90	0.84	0.95	0.92	0.87	0.96

Of the heavy drinkers 54% have a negative CAGE. At the lower the threshold of one, sensibility in detecting hazardous and harmful drinking raises to 0.57 and 0.60 respectively. If it comes to compare sexes, hazardous or heavy drinking is better detected in female, sensibility and specificity being higher. Not so in harmful drinking. Only 23% of the females reporting problems related to their alcohol intake have a positive CAGE at a threshold of two (vs 53% in men). With a cut-off at one, sensitivity raises to 36%. As mentioned there is the same number of female harmful drinker as male. However 75% of them are CAGE negative.

The following ROC curves help to visualize the effect of different CAGE cut-offs on hazardous -, harmful drinking and some others of the used criterions.

**Table 9 ROC Curves for the different criteria**





The only satisfying curve is obtained in "Professional help" All other curves are less impressive. Even by sacrificing specificity, sensitivity is only slowly increasing.

The ability of the CAGE in detecting individuals with harmful or hazardous drinking or both is shown in table 10.

**Table 10 Performance of the CAGE in detecting individuals with hazardous and/ or harmful drinking at different thresholds**

CAGE Threshold	hazardous and/or harmful drinking n=108					
	Sensibility			specificity		
	total	Male	Female	total	male	female
>=1	0.51	0.60	0.39	0.81	0.74	0.87
>=2	0.36	0.44	0.25	0.94	0.90	0.97
	pos pred value			neg pred value		
	total	Male	Female	total	male	female
>=1	0.36	0.38	0.32	0.11	0.13	0.10
>=2	0.54	0.55	0.53	0.12	0.15	0.11

At a cut-off at two the positive predictive value is 0.54. That means a person with a positive test has a 54% chance of having at least one of the two conditions. However

sensibility is very poor (36.1%). 2/3 of the harmful and/ or hazardous drinkers has a negative CAGE and is therefore not detected. Even at a threshold of 1 that lowers the specificity from 93.7 to 81%, sensibility is not much more than 50% and the positive predictive value falls to 0.36.

Whereas there is a higher sensibility in men, specificity is better in women. The higher the specificity, the higher is the positive predictive value. The similar results for both sexes are a result of the deeper prevalence (pre-test probability) in women.

### **3.9 Characteristics of the individual CAGE scores**

Alcohol consumption and related problems increase continuously with CAGE scores (table 11) and any threshold seems therefore artificial. That's why it is often proposed to judge after individual scores rather than by cut-points (29). One third of the persons with a CAGE score of two has either hazardous or/and harmful drinking. With a score of three this probability is 0.65, raising to a 100% for a score of 4.

**Table 11 Hazardous and harmful drinking in different CAGE scores in %**

<b>CAGE-Score</b>	<b>0</b>	<b>1</b>	<b>2</b>	<b>3</b>	<b>4</b>
n=	478	81	38	24	10
Hazardous drinking	5.0	9.9	21.1	50.0	40.0
Harmful drinking	6.5	10.3	17.9	40.0	80.0
Hazardous and/or Harmful drinking	11.2	19.5	35.9	65.2	100.0
Drinks/week	4.8	9.2	12.4	17.7	23.1

## **4 DISCUSSION**

### **4.1 Validation of a the CAGE in a French version administered to a general population sample**

The percentage of positive answers for the different CAGE-questions is similar to other studies in the Swiss-French (43) and even other European populations with the same prevalence of a positive CAGE (38,43). These findings suggest good reproducibility for the CAGE in the studied population. Internal consistency is

reported being around 0.7 in different studies (36).

. The content validation of the CAGE is not complete regarding ICD-10. This is not surprising considering that the CAGE is more than 25 years old and the ICD classification changed significantly over the years. However since only 3 out of the 6 criterions of ICD-10 are necessary for the diagnosis of alcohol dependency and the CAGE covers five of them, content validation may be regarded as satisfying.

The discrimination power of the different CAGE questions and of the common threshold of two for all tested criterions shows good construct validity, for men as well as for women. This supports its reputation of being a valid tool for detecting problem drinking, also in its French version and administered to the Swiss-French population.

It seems worthy to emphasize the good performance of the CAGE in people having sought professional help for their alcohol use. This group probably contains a high number of alcoholics. And it is a good sign to see that the CAGE is able to detect this group. However, people seeking help are more likely to confess their alcohol problems and therefore the good CAGE result in this group does not permit to comment on its performance towards denial.

The association between a positive CAGE and reported problems due to alcohol consumption supports the findings in other studies (12,36). Unfortunately again, individuals in denial may respond negatively to both, the CAGE and the questions about alcohol related problems.

The low number of positive “eye-openers” compared to results found in American studies is a common finding in the Swiss (43) and other European cultures (31,37). This question seems too blunt for a culture where drinking in the morning is socially unaccepted. People admitting it are considered alcoholics in the public opinion and this seems the reason that denial to this question is high. It is therefore not surprising that this question shows a very poor sensibility throughout all the performed tests. Cronbach-alpha increased by suppressing the "eye-opener" which further raises the question of its use in the studied population.

#### **4.2 Performance of different cut-offs**

At a threshold of one the CAGE's discrimination power for the studied criterions hardly changes. In this case the CAGE positive group shows slightly lower frequencies for all factors and specificity of the test could therefore be lower (table 5). On the other hand, the CAGE negative group shows only little decrease of the criterion frequencies. This suggests that a threshold of one does not remarkably improve negative predictive value. This questions a threshold of one in samples where a high sensitivity is needed.

The different ROC curves support the hypothesis that a threshold of one lowers specificity without remarkable improving of sensibility. However we must admit that this statement bases on our criterions and not on diagnosed alcoholism.

#### **4.3 Ability of the CAGE in detecting low symptomatic alcoholism**

The CAGEs performance in detecting hazardous or harmful drinking is pretty poorly (table 7). Of the 56 individuals who were positive for hazardous drinking 42.9% had a positive CAGE ( $\geq 2$ ), of the harmful drinkers only 38.5%. For hazardous drinking, an average of more than one glass for women and more than two for men was set. This low levels of alcohol consumption may not be considered low symptomatic alcoholism by anyone because they are very close to the suggested daily alcohol intake of 1 to 2 glasses to decrease cardiovascular risks.

The modest performance of the CAGE in detecting harmful drinking raises more concerns and correlates with results of other studies where sensitivity was 0.38 and 0.48 (44). Because we used lower criteria for harmful drinking than the DSM-III-R, sensitivity may be higher if DSM-III-R is used. Even of the heavy drinkers 54% are missed. It is surprising that the CAGE does not perform better in heavy than in hazardous drinkers. This is somehow in contrast to reported correlation of CAGE scores to alcohol consumption, saying the higher the alcohol consumption, the higher the average CAGE score (12,31,37). Being confronted with the poor CAGE performance in detecting lower symptomatic alcoholism one is tempted to lower the threshold to one. By this sensibility in detecting hazardous and harmful drinking raises by factor 1.3 and 1.6 to 57% and 60% respectively, still quite modest. If it

comes to compare sexes, it is surprising to see that the CAGE performs better in women than in men in detecting hazardous or heavy drinking. Even though definitions in these categories are not the same for men and women, this finding suggests that the CAGE detects unhealthy alcohol consumption better in women than in men. Not so in harmful drinking, where the performance in women is disastrous. Only 23% of the females reporting problems related to alcohol intake have a positive CAGE at a threshold of two. Even with the cut-off at one no satisfying sensitivity is obtained (36%). As mentioned there is the same number of female harmful drinker as male. However 75% of them are CAGE negative. One explanation for this findings is the possibility that many women reported having problems because of alcohol abuse of their husbands or other close ones rather than because of own drinking. The CAGE seems to be a weak tool to screen for low symptomatic or early stages of alcoholism, such as hazardous and harmful drinking. Here, lowering the cut-off to one does not remarkably increase its performance. It seems as if the CAGE is not able to differentiate between occasional harmless drinking and low symptom alcoholism.

#### **4.4 Gender differences**

Men have three times more often a positive CAGE result than women. This is a common finding (27,30,38,43) and reflects to a certain degree the fact that alcoholism is more common in men. However it is suspected that the CAGE performance is worse in women, sensitivity being poorer (20). But a recent study (12) showed the same probability for a positive CAGE results in both groups if they have the same drinking amount and pattern. Unfortunately, an important reason for reported lower alcohol consumption in women is the higher rate of overall denial, explained by the fact that drinking in women is socially less accepted (34). Women report about the same amount of alcohol related problems as men. This is surprising because women are said to have less alcohol-related problems than men at the same drinking pattern (33,34). The reason therefore seems to be that they are often socially less exposed, especially housewives (34). Our findings suggest that either alcohol consumption in women are underestimated or women are more likely to admit problems caused by their alcohol intake. However, as mentioned the underlying assumption is that the reported problems are related to their own alcohol intake and not to the consumption of significant others.



Even in people who sought professional help for problems related to their alcohol consumption there is no difference in sexes even though a recent study shows that women with alcohol-related problems are only half as likely to have received any alcohol-related treatment (45). Again one could argue that alcoholism in females might be higher than indicated by the CAGE results.

Overall this data shows a possibility that alcoholism may be higher in women as shown by the CAGE. This would be compatible with findings in other studies that report lower sensitivity for the CAGE in women than in men (20).

#### ***4.5 Utility of the CAGE as a screening tool in Public health***

The advantages of the CAGE, its shortness, ease of use and to evaluate, would make it an interesting tool for the use in preventive medicine, especially in health questionnaires, and routine screening procedures. However its poor performance in detecting low symptomatic alcoholism raises some doubts. 54% of all the people reporting an alcohol intake higher than 4 drinks for men and 3 drinks for women every day are not detected. And of the individuals who admit having problems due to alcohol consumption, more than 60% are CAGE negative. The CAGE's utility in Preventive Medicine seems therefore questionable because the population that is most appropriate for preventive intervention is not properly detected. This supports the similar findings in other studies (16,22).

For better detection of low symptomatic alcoholism, especially hazardous drinking, questioning about drinking amounts seems to be justified (3). The AUDIT test that contains questions about drinking habits may be a better tool for alcohol screening in preventive medicine. However its reputation of being able to detect lower symptomatic alcoholism is weak (and still needs further validation (5)).

## **5 CONCLUSION**

Different applications to the Swiss French population show similar CAGE results. The investigated criterion validation indicates that the CAGE test is a good parameter to measure the extend of alcoholism in a general population, but it does not allow to detect low symptomatic alcoholics accurately. Further investigations are needed to

strengthen its validity in the European and French-speaking culture. A literature review showed that there is no study validating the CAGE against ICD or DSM criteria in a European or French-speaking setting.

How many of the 11% with a CAGE score  $\geq 2$  in our study are true alcoholics can not be answered. Therefore a goldstandard such as DSM criteria would have been necessary. In the U.S.A., in a recent study 15.6% of the general population met DSM-III-R lifetime criteria for alcoholism (16). The administered CAGE showed sensitivity of 56% and specificity of 95% at a cut-point of two. Another study in the American general population reports lifetime prevalence for alcoholism of 38% as diagnosed by the CAGE (39). It is very unlikely that alcoholism was twice as common in this group, both representing the average American people. Nevertheless the administered CAGE showed even better sensitivity and specificity compared to DSM-III-R than in the other study. Finally, in a recent study in the Canadian general population, where drinking habits are comparable to the American, only 4.3% had a positive CAGE score (12). This shows that CAGE results in general populations are highly variable and difficult to compare. Even though they seem to reflect the degree of alcoholism present, the influence of the characteristics of the studied population and the study itself are considerable.

To add to the confusion, only 60% of DSM-III-R alcoholics meet the new DSM-IV criteria for the same disorder (16). This shows that the definition of alcoholism is still in progress and it seems therefore that the question, whether the CAGE detects true alcoholics or not, is quite artificial.

Under these aspects one should not diagnose alcoholism by the CAGE result but rather take it as an indicator for a possible problem. The Clinician should evaluate patients considering their individual CAGE score rather than a threshold. Whereas a CAGE score of 3 or 4 justifies intensive further investigation, a score of 1 or 2 should be seen in the patients overall context. Every second person with a CAGE result of two reports either unhealthy alcohol consumption or problems related to alcohol intake and this is therefore an alarming sign. If suspicion for alcoholism is present, a CAGE score of one should be an indication for further investigation.

That seems even more justified considering the fact that reported problems and drinking are certainly lower than reality. The mean alcohol intake in this study (6.4

drinks/week) represents less than 40% of the expected amount calculated from alcohol sold to the population (11). Moreover only 4 of 321 women report an alcohol intake greater than three drinks/week, suggesting that heavy drinking female hardly ever admit their drinking.

As mentioned 32% of the primary chosen sample were non-respondents. This group may contain a higher number of alcoholics because they are less likely to fill out a questionnaire. Therefore we can not exclude a “selection-bias” and again alcoholism and related problems could be higher than reported by the questionnaire.

All these limitations further raise fears that alcoholism is a very common illness, often and largely underestimated.

## 6 LITERATURE REVIEW

### 6.1 CAGE Characteristics in different applications to general populations

	<b>AUTOR/ Location</b>	re f	<b>Sample</b>	<b>CAGE characteristics</b>	<b>Results</b>	<b>Validation</b>
1	Smart, R.G., Ontario, Canada		General population survey, 703 drinkers, 18 and older	English, lifetime, personal interview	m/f, CAGE by question, and cut point 2	Results compared with alcohol intake, psychometric properties
2	Alvarez, J., Castile, Spain		General population survey, 2500, 53% drinkers, 14 and older	Spanish, lifetime, personal interview	m/f, CAGE by question, and cut point 2	Results compared with alcohol intake
3	Poulin, C., Canada		General population survey, 10530, 73% drinkers, 15 and older	English, past-year, telephone interview	CAGE pos. cut-point 2, independent risk factors for a positive result	alcohol intake, alcohol related problems
4	Tempier, R.T., Quebec, Canada		General population survey, 19724, 79% drinker	French, lifetime, questionnaire	CAGE by question	alcohol related problems, psychometric properties
5	Crowe, R.R., Iowa, U.S.A		Community sample 795 vs high risk sample 3435, 18 and older	English, lifetime and past year, personal interview	m/f, CAGE sensitivity, specificity, pos. pred. value for different cut-points, high risk vs community, alcohol abuse and dependence	DSM-III-R
6	Perdrix, A., Lausanne, Switzerland		Community sample, 416, 16 and older	French, lifetime, personal interview	m/f, CAGE pos. cut-point 2	Physicians diagnosis
7	Lairson, D.R., Houston, U.S.A.		Community sample, 687	English, lifetime, questionnaire	m/f, CAGE pos., specificity, cut- point 2, demographic and behavior variables	Addiction severity index, blood tests
8	Magruder, K.,		Veteran outpatient-clinic,	English, lifetime CAGE,	m, CAGE sensitivity, specificity	DSM-III-R

	North Carolina, U.S.A.		915, only males	personal interview	for all cut-points lifetime vs current alcoholics, pos. pred. value	
9	Buchsbaum, D., Virginia, U.S.A.		Outpatient medical practice, 821, 18 and older	English, lifetime, personal interview	sensitivity and specificity for different CAGE scores, likelihood ratios, ROC	DSM-III-R
10	Moret, V., Lausanne, Switzerland		Outpatient medical clinic, 270, 18 and older	French, lifetime, personal interview	m/f, age, CAGE pos., cut-point 2, characteristics of pos. population	MAST
11	Nystroem, M., Helsinki, Finland		First year university students, 2370, mean age 22, non-drinkers excluded	Finnish, lifetime, questionnaire	m/f, drinking habits, CAGE by questions and different cut-points	Alcohol intake, problems related to alcohol
12	Saunders, W., Glasgow, U.K.		Community sample, 3607	English, lifetime, personal interview	CAGE Sensitivity	Hospital records
13	Chan, A.W., Pristach, E.A.		General population (993) and general practice (390) samples	American, lifetime and past year, personal interview	m/f, drinking habits, sensitivity, specificity and Pos. pred. val.	DSM-III-R

## 6.2 COMMENTS

### Ad 1.

The CAGE Test shows good psychometric properties and suggests an unidimensional scale.

	c>=2	C	A	G	E
Male	17.2	26.7	11.1	18.8	9.0
Female	4.5	11.0	4.2	6.3	2.3
Total	10.9	18.8	7.7	12.6	5.6

The rate of Cage positive drinkers (10.9 %) is similar to the percentage of drinkers who consume four or more standard drinks daily, derived from aggregate per capita consumption estimates. The authors conclude that this suggests that the CAGE cut-off of two positive answers identifies heavy drinkers consuming about four drinks a day. However, whether the two compared groups correlate with each other is not known.

### Ad 2.

Only 51.3 % of the sample consumed alcohol at least once a week. Of those 10.6% are Cage positive (cut-off 2), that is 5.4 % of the total sample.

#### Weekly drinkers (51.3%)

	c>=2	C	A	G	E
Male	14.3	14.1	8.3	20.0	4.6
Female	3.6	3.2	3.4	6.3	0.7
Total	10.6	10.4	6.5	15.3	3.3

#### Total sample (100%)

	c>=2	C	A	G	E
Male	9.7	9.6	5.5	13.5	3.1
Female	1.3	1.1	1.2	2.2	0.2
Total	5.4	5.3	3.4	7.8	1.7

Groups with different Cage scores (0 to 4) are compared to the mean alcohol intake of its members which shows a positive correlation. CAGE positive people have a 1.8 times higher alcohol intake than CAGE negative.

4.2 % of the sample report alcohol consumption over 80 grams/day and are therefore considered heavy drinkers. This number is compared to the 5.4 % of CAGE positive. Once again, it is not known if the two groups are identical.

The low amount of CAGE positive people is questioned considering the high alcohol intake of the Spanish population. Spanish cultural background that favors denial is given as a possible explanation.

That 49% of the population drink less than once a week is quite surprising compared to studies in other countries.

### **Ad 3.**

73.3% of the sample are current drinkers. To 5994 the Cage was administered. Of those 5.8 % screened positive. Regarding the whole sample, 3.4% are CAGE positive at a cut-point of two.

The same questionnaire inquired about harmful consequences occurring in the 12 months before the survey, arising from the respondents own use of alcohol:

Proportion of current drinkers reporting specific alcohol-related problems:

Problem area	CAGE negative (% of respondents)	CAGE positive (% of respondents)
Spouse/partner	1.5	53.6
Physical health	5.3	47.4
Outlook on life	1.4	32.6
Friendships	2.3	32.4
Finances	3.4	29.3
Home life	1.1	26.2
Work/studies	1.2	17.3
<b>One or more areas</b>	<b>9.5</b>	<b>66.8</b>

The proportion of respondents reporting problems in one or more areas was 7 times greater among drinkers with a positive Cage result.

This study also shows that the higher the alcohol intake the more likely is a positive CAGE result. However it doesn't show the drinking habits of the Cage positive group. Moreover male drinkers are 1.7 times more likely to have a positive result than females. But when male and female drinkers who had the same drinking pattern and other demographic characteristics were compared, there were no significant differences.

**Ad 4.**

This study shows the good psychometric properties for the French version of the CAGE. Cronbach alpha is 0.70. Inter item correlation ranges from 0.23 to 0.49 (mean 0.37), the eye-opener question being responsible for the 0.23.

Additionally, questions about alcohol related problems are added which increases Cronbach alpha to 0.91.

The number of reported alcohol related problems are given but not compared to the CAGE.

Positive CAGE questions in % of total sample

C	A	G	E
11.5	9.5	14.5	4.9

**Ad 5.**

This study compared a high-risk sample (35% alcoholics) to a community sample that is similar to general population (15%).

CAGE results

Cut-point at 2	Lifetime	past year
high-risk sample	34.6	19.1
low-risk sample	15.6	9.0



The lifetime prevalence of the low-risk sample is compared to the National Comorbidity Survey reporting 14.1% of alcoholism.

From all the all the different cut-off points, 2 performed the best regarding sensitivity and specificity. However it is noted that a lower cut-off in the low risk group may be more accurate, even though it produces a lower specificity (78%), because it allows detection of 85% of all alcoholics (vs 56% at a cut-off point at 2 in which case almost half of the alcoholics are missed.)

CAGE cut-off 2		sensitivity	specificity	Pos. pred. value
low-risk sample	Total	0.56	0.95	0.66
	Male	0.59	0.93	0.70
	Female	0.47	0.97	0.54
high-risk sample	Total	0.80	0.92	0.84
	Male	0.82	0.88	0.89
	Female	0.77	0.94	0.78

It is noted that the CAGE shows better sensitivity in the high-risk sample, although those values should be unaffected by the base rate. The same is noted for males. Possibly, these findings reflect greater severity of alcoholism in the high-risk group and in men.

Regarding alcohol abuse (2.1% of the whole sample) the CAGE performs less well than for alcohol dependence. However at a cut-point of 1 68% of the individuals were detected. This is a welcome finding because alcoholism may be more treatable in its early stage.

Overall, the authors conclude that the CAGE is a good screening-tool for alcoholism in a low-risk sample (such as general population) performing slightly better in male than in female. A cut-off point at 1 is suggested to detect most of the alcoholics, accepting some loss of specificity.

**Ad 6.**

The results of the CAGE at a threshold of 2, administered by general practitioners were the follows:

Total	male	female
7.0%	11.6%	2.0%

This is surprisingly low for the studied population, especially in women. Moreover the group of alcoholics clinically diagnosed by the practitioners correlated weakly with the CAGE positive group.

**Ad 7.**

CAGE performance, threshold 2

total	male	female	specificity
8.6%	17.3%	3.8%	0.68

**Ad 8.**

This sample contains only males with a mean age of 54.4 years.

Performance of the CAGE for different cut-off points

Threshold	sensitivity	specificity
1	90.2	52.1
2	78.0	76.1
3	51.2	91.5
4	24.4	100

Positive predictive values are calculated for different prevalence rates on the basis of the sensibility and specificity found in this study. This is questionable because other studies have shown that sensitivity and specificity change with the prevalence of alcoholism in a sample.

The authors conclude that the CAGE is an excellent screening tool for general clinics. However, prevalence of alcoholism in the studied sample is around 4% (positive MAST-test). The calculated pos. pred. value for this prevalence is reported to be only 0.2.

**Ad 9.**

CAGE performance associated with specific CAGE scores:

Score	sensitivity	specificity	likelihood ratio
0			0.14
1	89	81	1.5
2	74	91	4.5
3	44	98	13
4	25	100	100

Calculated posterior probabilities of being an alcoholic according to prior probability:

CAGE Score	Prior probability				
	10%	15%	20%	36%	63%
0	2	2	3	7	19
1	14	21	27	46	72
2	33	44	53	72	88
3	59	70	76	88	96
4	92	95	96	98	99

The authors suggest the use of likelihood ratios for different CASGE scores to interpret a patients risk for an alcohol problem rather than thresholds. However this is only possible when prior probability can be accurately estimated.

**Ad 10.**

CAGE results at a threshold of 2:

Total	male	Female
21.6%	30%	12%

Good correlation between MAST and CAGE ( $\kappa=0.69$ ) is reported.

The relative high results compared to other studies on alcoholism in the Swiss population are explained by the higher prevalence of alcoholism in outpatient clinics in the French part of Switzerland, not comparable to general practices or general population samples.

**Ad 11.**

This Finnish study examines the drinking habits in first year university students.

CAGE result

Question	C	A	G	E	$\geq 2$
Male	23.2	6.5	21.4	3.2	15.5
Female	38.3	11.8	29.9	13.2	28.1

Furthermore the CAGE showed good correlation with reported drinking amount.

Its performance in detecting heavy drinking was sensitivity of 50% and specificity of 84%.

**Ad 12**

This study is very unusual because the CAGE was administered to a general population that was not informed of the real purpose of the study. Without their permission records of psychiatric hospital in the studied region were compared to the test answers. Only 46% of the alcoholics in the studied sample as identified by their psychiatric treatments had a positive CAGE test. This performance is even more deceptive because it is known that 50% of hospital-treated alcoholics admitted to doorstep interviewer that they had psychiatric histories.

**Ad 13.**

This study in the American general population compared the CAGE to DSM-III-R criteria.

38.3% of the population had a positive lifetime CAGE at a cut-off of two. 19.2% had a positive past-year CAGE.

Sensitivity and specificity are 77% and 85% respectively. Positive predictive value is 77.5. It concludes that the CAGE is a useful tool to screen for alcoholism or problem drinking in the general population.

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