



Research Article

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Risk factors for drowsy drivers at the wheel and its contribution on traffic accident in Madagascar

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Abstract

Purpose: The aim of this study was to detect in Malagasy drivers the risk factors for drowsiness at the wheel often cited as causes of traffic accidents and to propose preventive measures. **Methods:** This descriptive and analytical prospective study, from November 1, 2016 to March 31, 2017, was conducted to detect sleep disorders in drivers coming for a driving ability medical visit in two major cities of Madagascar. **Results:** 546 drivers were registered, represented by men in 96.9%, aged 30 to 49 in 61%, as light car drivers (49.8%), public transport (30.6%) and heavy goods vehicles and machinery (19.6%). Epworth Sleepiness Scale showed moderate risk in 46.9% and very high in 18.9%. The main factors identified were alcoholism (56.4%), lack of sleep (50.5%) and snoring in 37.5% with 29.5% family disposition and 7.9% overweight. An Epworth scale of 10 was associated with snoring [OR 5.69 (3.60-9.00)], drowsiness at the wheel [OR 35.15 (12.77-96.76)] and an accident [OR 10.54 (4.52-24.59)]. High blood pressure, diabete, dyslipidemia and smoking were not correlated with drowsiness at the wheel. **Conclusion:** Driver awareness of compliance with regulations, screening for pathologies causing sleep disorders are necessary during driving ability visits, especially among professional drivers, in order to reduce the risk of accidents common cause of death in Madagascar.

Keywords: Traffic accident, Drowsiness, Risk factors, Drivers, Ability visit.

INTRODUCTION

Traffic accidents related to reduced driver performance and inattention are responsible for serious injuries and significant property damage. Sleep disorders are often cited as causes of excessive daytime drowsiness and associated cognitive impairment [1,2]. Obstructive obstructive sleep apnea syndrome (OSAS) affecting about 4-5% of the general population is one of the known risk factors for sleep disorders, causing as much as alcohol, lack of sleep and certain sedative medications drowsiness at the wheel with the risk of an accident [1-3]. The diagnosis and treatment of underlying pathologies of sleep disorders would allow drivers to better control driving and reduce the number of road accident victims [2]. We conducted this study to find out the factors related to drivers' sleep disorders and their reports of accident risk in Madagascar.

MATERIALS AND METHODS

The study was carried out in two major cities, Mahajanga and Antananarivo. Our choice focused on these sites on the one hand according to geographical, practical and demographic considerations but also linked to the level of urban traffic in Antananarivo the capital.

Antananarivo is one of Madagascar's most populous cities with the densest car fleet in the entire island.

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We conducted a descriptive and analytical prospective study from November 1, 2016 to March 31, 2017, representing a 5-month period. The investigation took place at the Institute of the Medical Hygiene Office of Antananarivo and the Mahajanga I Public Health District Service, place of medical visit for driving ability. Drivers were employees in companies, in public transport, working as individuals or individuals who owned a pleasure vehicle. We have included all drivers with a driver's licence of all categories, able to answer questionnaires and views on medical visits. We excluded those who refused to respond to our questionnaire as well as those who responded incompletely.

We used a pre-established questionnaire, written in Malagasy or French, communicated orally to drivers in the form of a simple verbal interview whose answers were collected by the investigator during the consultation. Each interview lasted between 20 and 30 minutes.

The questionnaire included seven topics whose items were identified from studies of sleep disorders and their impacts on driving [4.5] consistent with the country's contexts:

- 1- The civil status of the driver: age, gender, marital status, socio-economic level.
- 2- Occupation: type of vehicle, driver status, history of accident and driver liability in that accident.
- 3- Anthropometric parameters: BMI (body mass index), ANC (adjusted neck circumference).
- 4- Daytime symptoms and nocturnal signs of sleep disturbances.
- 5- An assessment of daytime hypersomnolence by Epworth's Sleepiness Scale.
- 6- Risk factors associated with drowsiness at the wheel.
- 7- Comorbidities.

Drowsiness is the more or less irresistible propensity to fall asleep if you are not stimulated. The Epworth Sleepiness Scale (ESS) is a measurement method used to assess subjective drowsiness, normally correlated with objective results collected by sleep records. The score ranges from 0 to 24. The value above 10 was considered abnormal [6].

From an ethical point of view, this study has been approved by ethics committee of the University hospital, interviews with drivers were

Table 1: Symptoms and results of objective assessments

		frequency	%
Daytime signs			
Morning headache	Yes	23	4,2
Memory disorder	Yes	12	2,2
Difficulty concentrating / depressive syndrome	Yes	2	0,4
Libido disorder / impotence	Yes	3	0,5
Excessive fatigue at sunrise	Yes	27	4,9
Nocturnal signs			
Snoring*	Yes	203	37,2
	No	218	39,9
	Don't know	125	22,9
Sleep apnea	Every day	5	0,9
	Never	534	97,8
	Sometime	7	1,3
Agitated sleep	Yes	14	2,6
Startle awakening with feeling of suffocation	Yes	1	0,2
Nycturia	Yes	8	1,5
Night sweat	Yes	2	0,4
Nocturnal paroxysmal dyspnea	Yes	1	0,2

*Intensity : weak 61 (30,05%), moderate 125 (61,58%), strong 17 (8,37%)

conducted in a confidential manner after information on the purpose of the study with their signed consent.

Regarding the limitations of the study, the screening for OSAS was not carried out due to lack of resources.

The data was entered and analyzed with SPSS 20.0 for Windows software. For qualitative values, the chi square test (95% confidence interval, $p < 0.05$) was used, or Fischer's exact test when the numbers were low.

RESULTS

In the present study, 546 subjects were participated, including 273 for Mahajanga and 273 for Antananarivo. The drivers were between the ages of 18 and 72. The average age was 42.05-12.38 years. The 30-55 age groups were the highest in 61%. Male gender was predominant (96.9%), compared to female gender (3.1%) with a sex ratio of 31.1. Eighty-eight percent subjects were married and 11.2% single. Our sample consisted of a low level of study in 56.8% (from illiterate to secondary level) and 40.5% with a university level. The average working year was 11.5 years with extremes ranging from 1 to 25 years. The types of vehicles used were in 49.8% a light car, in 30.6% a public transport (minibus, coach) and 19.4% a heavy goods vehicles. Vehicle owners accounted for 53.5% and employees 46.5%.

One hundred and sixty individuals (29.3%) reported drowsiness at the wheel, which was significantly found in the 40-55 age group ($p < 0.001$). We found that 99 subjects (18.1%) had already had a traffic accident with property damage in 81.9%. The 75.5% of these 99 drivers admitted responsibility for the accident.

For the anthropometric characteristics of individuals, BMI of less than 25 kg/m² was predominant in 88.1%, with an average BMI of 21.57 kg/m². The average ANC was 39.71cm, with a minimum of 31cm and a maximum of 53cm. The majority of subjects had ANC of less than 43 cm (low risk of having OSAS) with a rate of 79.5%; 16.3% had a ANC between 43-48 cm (moderate risk of OSAS) and 4.2% at high risk of OSAS with a circumference of more than 48 cm.

Some drivers complained of diurnal symptoms such as excessive fatigue at sunrise for 4.9% or morning headaches for 4.2%. Nocturnal signs were dominated by snoring in 37.2% followed by restless sleep in 2.6% (Table 1).

Table 2: Distribution of drivers according to risk factors

		Frequency	%
Alcohol	Yes	308	56,4
Smoking	Yes	136	24,9
Snoring in the family	Yes	161	29,5
Drinking before bed	Yes	10	1,8
Position during sleep	Back	267	48,9
	Belly	78	14,3
	On the side	201	36,8
Menopause	Yes	1	0,2
Gastroesophageal reflux	Yes	29	5,3
Late and variables bedtime	Yes	276	50,5
ENT anomalie	Without abnormality	542	99,3
	Abnormal	4	0,7
Asthma	Yes	11	2,0

Table 3: Epworth Sleepiness Score and risk factors (n=546)

		≤10 n = 187	>10 n = 359	OR (IC 95%)	p-value
Age (year)	18-29	49 (8,9%)	55 (10%)		
	30-39	65 (11,9%)	102 (18,7%)		
	40-49	36 (6,6%)	130 (23,8%)		0,001
	50-59	25 (4,6%)	43 (7,9%)		
	>60	12 (2,2%)	29 (5,3%)		
BMI	<25Kg/m ²	186 (34%)	295 (54%)	0,42 (0,25- 0,71)	<0,001
	>25Kg/m ²	1 (0,2%)	64 (11,7%)		
CCA	<48cm	186 (34,1%)	337(61,7%)	ND	<0,001
	≥48cm	1 (0,2%)	22 (4%)		
Snoring (n=203)	Oui	28 (13,8%)	175 (86,2%)	5,69 (3,60-9,00)	<0,001
Drowsiness at the wheel (n=160)	Oui	8 (5%)	152 (95%)	35,15 (12,77-96,76)	<0,001
Road crashes (n=99)	Oui	6 (6%)	93 (94%)	10,54(4,52-24,59)	<0,001

Table 4: Reported drowsy at the wheel (n=160) and risk factors

		Yes n (%)	No declare n(%)	OR (IC 95%)	p-value
Age	18-29 ans	12	92		
	30-39 ans	41	126		
	40-49 ans	67	99		<0,001
	50-59 ans	23	45		
	>60 ans	17	24		
BMI	>25Kg/m ²	43 (7,9)	22 (4)	0,30(0,14-0,65)	<0,001
	≤25Kg/m ²	117 (21,4)	364 (66,7)		
Lack of sleep	Yes	95 (17,4)	181 (33,2)	1,65(1,13-2,40)	0,008
	No	65 (11,9)	205 (37,5)		
Alcohol	Yes	105 (19,2)	203 (37,2)	2,00(1,36-2,95)	<0,001
	No	55 (10)	183 (33,5)		
Snoring	Yes	108 (19,8)	95 (17,4)	7,90(5,22-11,96)	<0,001
	No	52 (9,5)	291 (54)		
Smoking	Yes	45 (8,2)	91 (16,7)	1,26(0,83-1,92)	0,13

	No	115 (21,1)	295 (54)		
Comorbidity	HTA	48 (8,9)	26 (4,8)		
	AIT	6 (1,1)	10 (1,8)		0,57
	Diabete	22 (4)	5 (0,9)		
	Dyslipidemia	23 (4,2)	2 (0,4)		
Vehicle	Light car	54 (9,9)	218 (39,9)	1	-
	Public transport	61 (11,2)	106 (19,4)	2,32 (1,50-3,58)	<0,001
	Heavy GV	44 (8)	62 (11,4)	2,85 (1,75-4,66)	<0,001
	Engin	1 (0,2)	0		
Traffic accident	Yes	81 (14,8)	18 (3,3)	19,31(11,08-33,66)	<0,001
	No	79 (14,5)	367 (67,2)		

ESS showed that 34.2% had no sleep debt (score 10), 46.9% had moderate daytime drowsiness (score 10 to 16) and 18.7% had high-degrees drowsiness (score 17 to 24). The average score was 12.46 with extremes ranging from 5 to 24.

Among the risk factors for sleep disorder (Tables 1 and 2), the top three factors identified were alcoholism (56.4%) ($p < 0,001$), lack of sleep (50.5%) ($p = 0,008$), and snoring in 37.5% ($p < 0,001$) with 29.5% family disposition and 7.9% overweight (Table 3). However, only 19.2% of those who consumed alcohol reported drowsiness at the wheel and 19.8% of snorers.

Comorbidity such as hypertensive, TIA (transient ischemic accident), diabetes and dyslipidemia were not correlated with a risk of sleep disorder. Of those who had drowsiness at the wheel (29.3%), 50.3% had already an accident. Professional workers were the most at risk (Table 4).

DISCUSSION

Prevalence of drowsiness in drivers at risk of accident

Of the 546 drivers surveyed in our study, the ESS showed that 65.8% had a risk of drowsiness with 46.9% of moderate drowsiness and 18.9% of drowsiness at very high degree. The occurrence of road accidents due to drowsiness has been widely documented. In the United States about 1 to 3% of accidents were due to sleep disturbances while driving [7]. Mayock *et al.* demonstrated the involvement of fatigue and drowsiness in 7% of drivers [4], 10% for Philip and *al* in France [8]. Carter *et al.* [9] in Sweden reported this correlation in 36.6% among professional drivers and 32.5% in the general population, Horne *et al.* [10] found a rate of 10% for driving on national roads and 20% on motorways. Few data have been identified on risk factor research in developing countries. In Madagascar, for example, Rakotoarison *et al.* recorded 23 collective accidents, 18 of which occurred on national roads, the implication of drowsiness at the wheel for night and late-day driving as risk factors for accidents remained hypothetical.

We used this validated and reliable subjective scale for its simplicity in measuring sleep disorder [6,12,13], but it is demonstrated not to measure the correlation of drowsiness and the severity of an obstructive sleep apnea [14, 15]. Real-world driving simulator setting is the gold standard for the detection of sleep disorder in the driver [2], this test is not yet available in Madagascar.

Socio-demographic profile of drivers

In the present study, the majority of drivers were aged 30-49 (61%) with an average age of 42.05 - 12.38 years. A Japanese study during the visit for the granting of a driver's license found a result close to ours with a predominant age between 26 and 45 years in 53.58% of cases [16]. Similarly in the United Kingdom Mayacok *et al.* also showed an average age closer to ours of 47.7-17.1 years [4]. Laraqui *et al.* found

an average age of 39.3 - 7.7 years and an age group of 30 to 50 years (69.3%) among professional drivers. Pérez-Chada *et al.* in Argentina [17] recorded a lower average age of 38.1-11 years among truckers.

In this study, male gender was the majority (96.9%) with a sex ratio of 31.1. This corroborates the study conducted by Karl *et al.* [18] and El fourth *et al.* [19] which recorded 93.5% and 91.6% of men respectively.

Risk factors

In this study, one hundred and sixty individuals (29.3%) reported that they had been drowsy at the wheel, this finding is similar to that of a Norwegian study showing a rate of 27% [20]. Laraqui and *al* scored an abnormally high Epworth Sleepiness Score in 36.3% among professional HGV drivers [5]. Sleep debt related to the probability of accident affects mainly men, especially professional drivers [9]. Professional drivers reported having had 2.32 times sleep behind the wheel for public transport and 2.85 times for HGV drivers (Table 4).

Compared to age and gender, 42.5% of drivers aged 30 to 49 were more likely to be drowsy with an Epworth-10 score. According to Lyzinski *et al.* [7], it is rather young people under the age of 25 who are at greater risk of sleep-related accidents in 55% of cases, mainly involving the male gender. Similarly Mc Connel *et al.* reported that the 15-24 age group was the most affected, with 44.5% of cases of sleep-related accidents while driving often related to alcohol [21]. According to Sagherb *et al.*, women were 2.5 times less at risk than men [20].

We noted that BMI over 25kg/m² was correlated with an abnormal ESS in 11.7% of drivers, 95% of whom reported drowsiness at the wheel (Table 3). According to Takashi *et al.*, overweight drivers have 1.59 times the risk of falling asleep at the wheel [16], same report for Chen *et al.* [22]. On the other hand, an ESS of 10 was associated with a ANC over 48cm in only 4% of drivers in our study probably consistent with a moderate to severe OSAS with a significant risk of drowsiness (Table 3), however the presence of OSAS could not be verified due to lack of means. Indeed, Chen *et al.* [22] noted that even for a ANC of 41.8-3cm, 37.7% of drivers had a severe risk of OSAS and a lower average ANC of 40.2-3cm was associated with a moderate risk of OSAS (16.5%). In the present study, 61.8% of those with ANC 48 had a sleep disorder with an ESS above 10. These same authors found a risk of moderate OSAS associated with an ESS of 10.4-4.6 and a score of 13-5 for severe OSAS [22]. Thus those with a low ESS were not without risks, our results showed a 5% rate of complaints of drowsiness at the wheel in this category of patient (Table 3). It is known that obesity is a risk factor for OSAS, diagnostic circumstances are represented primarily by the presence of snoring, respiratory arrests perceived during sleep and daytime drowsiness [1].

Snoring is a major factor in drowsiness at the wheel, with 37.2% of our population suffering from it. Kim *et al.* [23] found that the intensity of snoring above 50dB correlated with the intensity of OSAS. The noisy resumption of breathing after apnea corresponds to the reappearance of snoring due to the resumption of ventilation. Complaint of subjective drowsiness is common among apneics [1]. In our study, the intensity of snoring was strong in 8.4% of cases (Table 1); those who snored were nine times more likely to have an ESS above ten (Table 3). Lee *et al.* [24] found that there was a significant correlation between a high BMI, snoring, and a pathological ESS ($p=0.034$). Adewole *et al.* in Nigeria [25] found that the risks of snoring were related to age, male gender, BMI-30kg/m³, smoking, daytime hypersomnolence with high ESS. A Japanese study noted that the risk of snoring was three times higher in an overweight population [26]. Sleep recording, especially among professional drivers with high risk factors, is necessary in Madagascar.

Compared to lack of sleep, 50.5% of drivers reported having a habit of going to bed at late and variable hours (Table 1). According to El Ftouh *et al.* [19], one of the risk factors for falling asleep at the wheel was sleep duration of less than seven hours; but still, the risk was multiplied sixfold when this duration was less than five hours of sleep per night. In a large study from 1994 to 1996, McConnell *et al.* claimed that 3.27% of accidents were due to lack of sleep that caused serious injury or death [21].

Alcohol intake was a significant factor with a figure of 56.4%; sleep deprivation and moderate alcohol intake impair driving abilities in apneic patients much more than in control subjects [1]. Laraqui and al [5] reported that there was a significant relationship between drowsiness at the wheel and alcohol consumption ($p<0,0001$).

For comorbidity, in our study hypertensive, diabetes and dyslipidemia were not significantly associated with a notion of drowsiness at the wheel (Table 4). Yet Chen *et al.* [22] reported a significant association of hypertensive and increasing severity of OSAS. Karl *et al.* stated that the presence of chronic diseases such as hypertensive, high cholesterol, obesity, and physical inactivity had risk factors to be considered in long distance truck drivers [18].

This survey found that 18.1% of participants had already an accident, most (75%) drivers acknowledged their responsibility. The 29.3% reported drowsiness at the wheel with an ESS greater than ten increasing the risk of an accident by 10 (Table 3). According to Carter *et al.* [9], the occurrence of an accident among drivers is related to an ESS greater than ten associated with a lack of sleep. Pérez-Chada *et al.* in Argentina found the risk of an accident three times higher for an ESS >10 [17]. In a multi-variable analysis taking into account the existence of snoring, the presence of drowsiness at the wheel and the car's belonging to a company, significativity became more important [4]. Sleep at the wheel would result in a driving abnormality with 40% overtaking the right limit and 4% collision or exit from the road [20].

CONCLUSION

Through this study in vehicle drivers in Madagascar, risk factors for drowsiness were identified mainly alcohol intake and snoring both personal and family often associated with overweight. During driving ability medical visit, especially among professional drivers, driver awareness of compliance with working and rest regulations, health education and screening of the pathology that cause sleep disorders must be considered in order to reduce the risk of accidents.

Conflicts of Interest

There was no conflict of interest in the study.

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