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Nicotine in Sport: Use or Abuse

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## **NICOTINE IN SPORT: USE OR ABUSE ?**

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### **Abstract**

Small doses of nicotine produce a stimulation of the respiratory system and can increase the activity of the skeletal muscles. The answer of the body to nicotine is known to be very rapid and powerful. Although the absorption of this alkaloid by the classical way (smoking cigarettes) is contradictory with sport performance, non-official reports indicate that chewing special tobacco preparation (snus) is now the current practice of some athletes. The main effects expected by the users are the increase of alertness and the decrease of stress. Nicotine is a very toxic alkaloid and oral intake produces similar health problems as smoked nicotine.

The distribution of nicotine users was established in the athlete population through a portion of the 2'000 urines analysed in our laboratory for doping controls during 1996. Secondly, the route of administration of nicotine was tentatively determined by using metabolisation indicators.

Results show that in team sports, mainly in ice hockey, football and basketball, the percentage of nicotine positive urines was higher than in other sports.

Our laboratory still investigates this problem further in order to establish whether or not nicotine should be considered as a doping agent in sport. In that case, rules similar to caffeine, with a maximum urinary concentration or a specific ratio (nicotine to cotinine), could be applied.

### **Introduction**

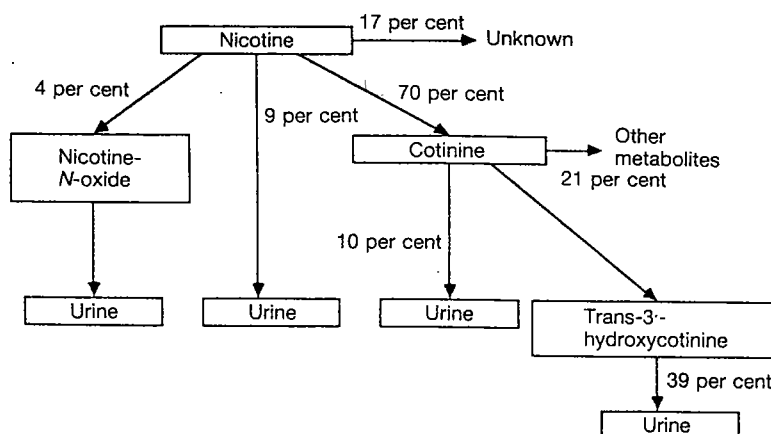
By analysing athletes' urines for official swiss antidoping controls, nicotine was frequently found, sometimes even in high concentrations. It was already shown that athletes intook nicotine to increase some performances and that they not only smoked but used other form as gum, patch or nasal spray [1-2].

Nicotine, a major alkaloid of tobacco, has numerous psycho-active properties, because it fixes on the cerebral nicotinic receptors: the main effects (sought after by the users) are [1-3]:

- Increase of concentration, vigilance and alertness.
- Increase of blood pressure and the cardiac rythm.
- Inhibition of hungry feeling, with increase of calorific expenses.
- Increase of the anti-diuretic hormone production.
- Rapidity of the effect of nicotine: at each breath, a quarter of the nicotine inhaled reach the brain in 7 seconds (14 seconds for heroin).
- Reduction of anxiety and increase of pleasure.
- Improvement of motor capacity.

All these properties explain that nicotine can be used in some skill sports by reducing anxiety, increasing concentration, vigilance and reflex rapidity. The supply in nicotine is two to four times more important for products with nicotine which are not smoked: chews, pinch of snuff,...[4]

Nicotine (half life: 2h) is eliminated by the kidneys as such or metabolized (nicotine-N-oxide, minor metabolite and cotinine) (Figure 1). Cotinine (half life: 20h) is extensively metabolized with only about 17% excreted unchanged in the urine [4].



**Figure 1:** Excretion of nicotine and its metabolites in urine [4].

### Aim of the study

The aims of this study were:

- 1) To list nicotine and cotinine positive urines from the database of the laboratory (1st January 96 to 31th December 1996) and to quantify nicotine.
- 2) To compare the population of the athletes with a population of regular smokers in order to verify if the rate of nicotine was similar or different, and to see if the nicotine found in urines could come from nicotine preparations other than cigarettes.

## **Material and methods**

### ***Volunteers group***

13 smokers (10 women and 3 men between 20 and 60 years old ): 12 were regular smokers and one occasional. They smoked between 11 and 38 cigarettes a day. Each volunteer had to collect his/her urine during 24 hours and to report how many cigarettes he/she smoked (trade and dose of nicotine on the pack are used to calculate the amount of nicotine ingested).

### ***Athletes group***

Urines were analysed in Lausanne from the Swiss official anti-doping controls: 1763 athletes of 61 different sports were controlled from 1.1 96 to 31.12.96 (77% men). 337 urines were positive for nicotine.

### ***Quantification of nicotine***

- In the study with the volunteers, nicotine was quantified with a calibration curve ranging from: 0.4 to 20 µg/ml of nicotine.
- In the study with the athletes, nicotine was semi-quantified with the controls used in the screening procedure I (control urine spiked with nicotine at 2 µg/ml).
- Cotinine was not quantified but only reported when it was detected in the urine. The method used was the screening procedure I for stimulants with analysis on GC-NPD.

### ***GC-NPD parameters***

GC-NPD: HP 5890/HP7673 (Hewlett Packard).

Column: HP Ultra 2, WCOT crosslinked 5 % phenyl methyl silicone, 25m, 0.2 mm i.d., 0.33 µm film thickness.

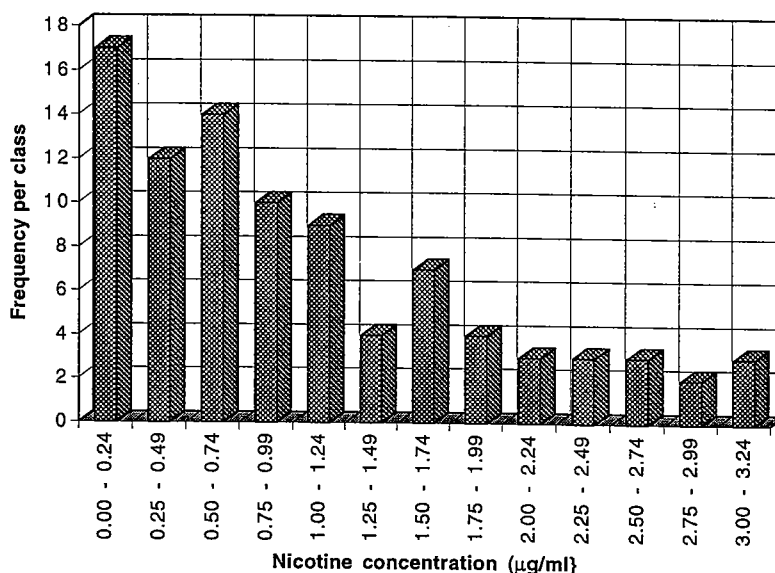
Carrier gas: helium, head pressure; 25 psi, splitless.

Temperature program: 100°C, 0.5 min, 20° C per min to 320°C, 8.5 min.

## Results and discussion

### *Volunteers group*

Nicotine was detected in each urine of all the smokers. The range obtained was from 0.04  $\mu\text{g/ml}$  to 3.18  $\mu\text{g/ml}$  with a mean at 0.95  $\mu\text{g/ml}$  (Figure 2). Cotinine was not quantified but only reported and it was detected in all urines of the regular smokers. For one occasional smoker, cotinine was detected only in the last miction (18h45 after the first cigarette).



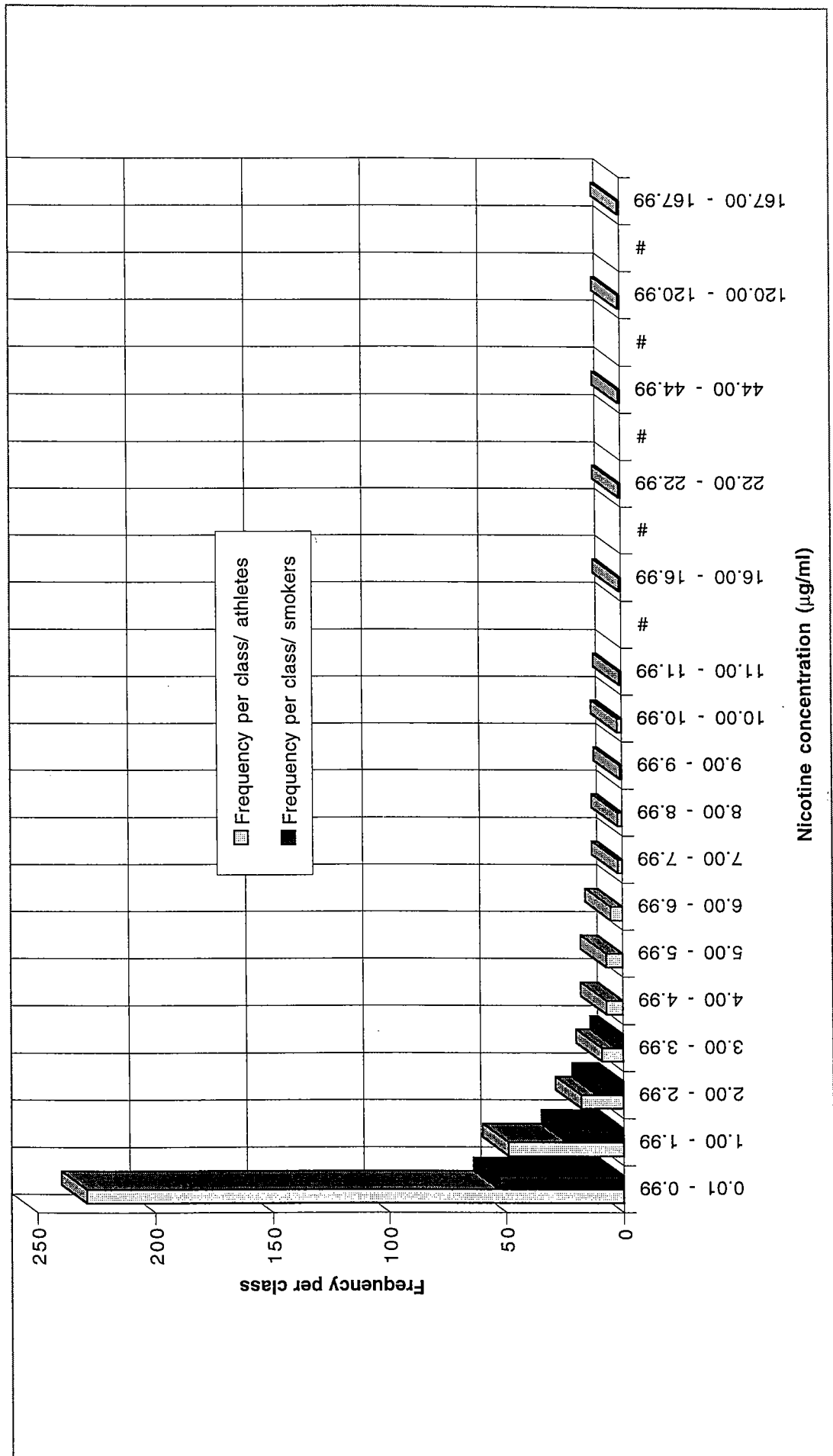
**Figure 2:** Nicotine concentration repartition of 13 smokers (91 urines).

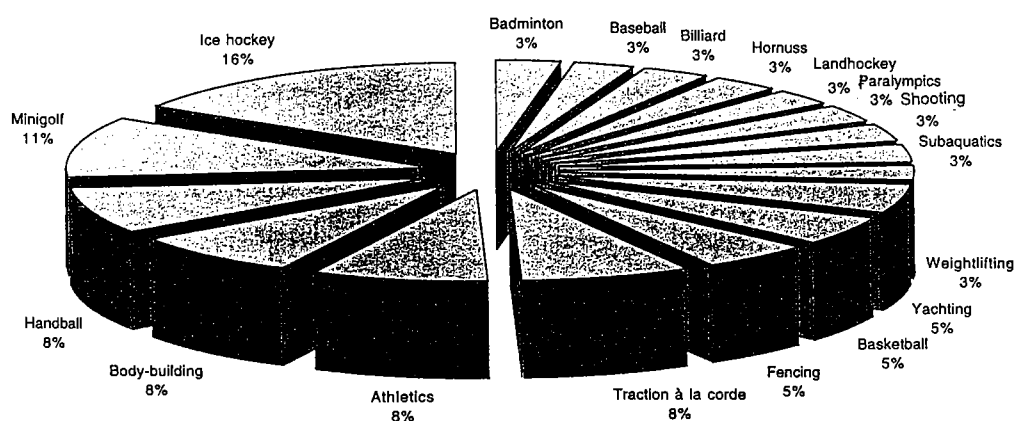
### *Athletes group*

The Table 1 showed that high percentages of nicotine were found in ice hockey (71%), handball (41%), football (35%), fencing (30%) and basketball (26%). On average 20% of the athletes had nicotine in their urines.

The repartition of the athletes was represented with the one of the smokers condensed (Figure 3). The majority of the athletes (90%) were in the range of the smokers (0.01 to 4.0  $\mu\text{g/ml}$ ); but it is obvious that some athletes showed higher nicotine concentration (5 of them with very high nicotine from 16 to 167  $\mu\text{g/ml}$ ), which cannot be attributed to normal cigarette use. These five results were not characteristic by the sport. The samples with the concentration over 3.24  $\mu\text{g/ml}$  were represented in 20 different sports with ice-hockey as dominant. (Figure 4).

Figure 3: Nicotine concentrations repartition of smokers and athletes





**Figure 4:** Nicotine concentration repartition by sport (> 3.24 µg/ml).

### *Cotinine*

Of the 1763 athletes, 337 athletes were found positive for nicotine and 107 of them were positive for cotinine (32%). The detection of cotinine depends on the time necessary to transform nicotine to cotinine and on the dosis of nicotine intake. So the 107 athletes with cotinine had probably taken one dosis of nicotine 70-72 hours before the urine was taken or were regularly consumer of nicotine.

The percentages of cotinine found in ice hockey and in handball were low (Table 1: percentage in relation to the presence of nicotine). On the contrary in fencing, cotinine was widely present. The lack of cotinine in some sports could be related to an occasional use of nicotine.

Is then the ratio nicotine to cotinine significant?

**Table 2:** Ratio nicotine/cotinine for the sports with more than 30% urine positive for nicotine.

Categories	Nicotine/Cotinine
Smokers	1.0
Fencing	1.7
Football	2.4
Handball	2.6
Ice Hockey	6.1

This ratio (Table 2) may be used to characterize the intake of nicotine: more elevated is the ratio, higher is the probability, that we are confronted to an irregularly consumption of nicotine.

## Conclusions

- 10% of the athletes concentration of the urinary nicotine were above the concentration found in the urines of the smokers.
- 70% of the ice hockey samples were from consumers of nicotine (confirmed in 1997; data not shown).
- Cotinine was detectable in all the smokers' urines, but only 32% of the athletes' ones presented cotinine.
- For all the others (68%), the intake of nicotine could occur just before the competition, when cotinine was not detected.
- A detailed pharmacokinetic study will be implemented to improve our comprehension of elimination rate of nicotine, cotinine and other metabolites in the sport context. Some alkaloids (anabasine, anatabine or normicotine) can be used as markers to show a better discrimination between cigarette smokers and smokeless tobacco users [5].
- Collaborative study should be done with the most exposed sportive federations to focus on athlete's habits and the related health risks.

## Acknowledgements

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## References

1. Lagrue G., Cormier S., Lebargy F. La nicotine: une substance psychoactive, un produit dopant ? *La presse Médicale* 25:761-2; 1996.
2. De Mondenard JP. *Dictionnaire des substances dopantes*. Masson, pp.173-6;1991.
3. Lagrue G., Branellec A., Lebargy F. La toxicologie du tabac. *Rev. Prat (Paris)*; 43 (10): 1203-7; 1993.
4. Benowitz N.L., Porchet H., Jacob P. III. Pharmacokinetics, metabolism, and pharmacodynamics of nicotine. In: S. Wonnacott, M.A.H. Russell, I.P. Stolerman (eds). *Nicotine Psychopharmacology*, Oxford University Press (Oxford, New York, Tokyo); pp.112-57, 1990.



5. Jacob P. III, Yu L., Liang G., Shulgin A.T., Benowitz N.L. Gas chromatographic-mass spectrometric method for determination of anabasine, anatabine and other tobacco alkaloids in urine of smokers and smokeless tobacco users. *Journal of Chromatography*, 619; 49-61; 1993.

**Table 1:** Percentage of athletes positive to nicotine and cotinine by sport (1.1.96-31.12.96)

Sports	N total	Nicotine +	% Nicot+	Cotinine +	% Coti+ (v. nicotine)	Ratio Nicot/Cot
Athletics	173	21	12	6	29	3.5
Rowing	32	1	3	1	100	1
<b>Basketball</b>	80	21	<b>26</b>	3	<b>14</b>	<b>7</b>
Bobsleigh	23	1	4	0	0	-
Bodybuilding	22	5	23	2	40	2.5
Ski cross contry	22	0	0	0	0	0
Curling	8	1	13	0	0	-
Cycling	234	12	5	2	17	6
<b>Dance</b>	29	8	<b>28</b>	1	<b>13</b>	<b>8</b>
<b>Fencing</b>	33	10	<b>30</b>	6	60	1.7
<b>Football</b>	114	40	<b>35</b>	17	43	2.4
Gymnatics	20	3	15	1	33	3
<b>Handball</b>	64	26	<b>41</b>	10	39	2.6
<b>Ice hockey</b>	86	61	<b>71</b>	10	<b>16</b>	<b>6.1</b>
Judo	29	1	3	0	0	-
Swimming	46	2	4	2	100	1
Figure skating	6	1	17	1	100	1
Skating	18	2	11	0	0	-
Ski	22	6	27	3	50	2
Tennis	313	34	11	6	18	<b>5.7</b>
Shooting	24	1	4	1	100	1
Archery	6	2	<b>33</b>	2	100	1
Volleyball	22	2	9	0	0	-