

## Research article

# EPHEDRA USE IN A SELECT GROUP OF ADOLESCENT ATHLETES

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### ABSTRACT

Ephedra-containing dietary supplements are consumed to improve sports performance, but may carry risks of cardiac and neurological adverse events. Little is known of their use by young athletes. Our aim was to determine the prevalence and patterns of ephedra use among high school athletes. An anonymous survey was performed in Rochester, Minnesota on high school athletes who participated in fall sports during 2003-04. Parental consent was obtained for athletes under age 18 years. Surveys were distributed at preparticipation examinations and in-school survey stations. The response rate to the survey was 68.2%, or 311 respondents out of a possible 456 with consent (or 26% of all 1197 athletes eligible prior to the consent process). Seven of 311 (2.3%) respondents used dietary supplements containing ephedra. Only one of seven users (14.3%) knew that the supplements they used contained ephedra. Ephedra use was more common in boys (five) than girls (two). Ephedra use was only found in 17 and 18-year-olds. The most common sports among ephedra users were football, track and field, and weightlifting. This study suggests that Ephedra use was infrequent among the young athletes in this population. However, ephedra users were generally unaware that the dietary supplements they consumed contained ephedra. Users were more likely to participate in football, track and field, and weightlifting. Ephedra users were likely to obtain supplements from their peers, and were largely uninformed of the content of their supplements.

**KEY WORDS:** Ephedrine, sports, supplements, performance enhancement, ergogenic.

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### INTRODUCTION

Ephedra-containing dietary supplements were thought to be gaining popularity in the United States until the Food and Drug Administration (FDA) announced the ban on their sale in December of 2003 (FDA, 2004; Knight 2004). The ban went into effect in April of 2004, but just one year later was over-ruled by a federal court (Thiessen, 2005). As of December 2005, ephedra has yet to return to the retail market in the U.S., but internet sales have started again. In addition, athletes may also be able to purchase ephedra in other countries, or in the form of traditional Eastern medicines, which were

not covered in the ban. Little evidence exists on the use of ephedra by adolescent athletes, but they are known to be regular consumers of ergogenic aids and nutritional supplements of all kinds (Massad, 1995; Ray et al., 2001; Smith and Dahm, 2000; McGuine et al., 2001; Sobal and Marquart, 1994).

Ephedra alkaloid stimulants are derived from the plant genus *ephedra* (also known as ma huang). The ergogenic effects of ephedra are similar to ephedrine, and include increased energy, time to exhaustion, power output, running speed, and weight loss (Bell et al., 2002; Hardy et al., 2003; Jacobs et al., 2003; Shekelle, 2003; Pittler and Ernst, 2004). Adverse effects, however, may include nervousness,

**Table 1.** Supplements in Survey \*.

Creatine	ETA Stack	Xenadrine
Protein: powder, mix, or pill	Exandra Lean	Herbal Ecstasy
Ephedra	Excel	Metabolife Ephedra
Ephedrine	Extreme Ripped Fuel	Ripped Force
Ma Huang	GH Fule	Ripped Fuel
3-Andro Xtreme	Herba Fuel	Thermadrene
Adipokinetix	Herbalife	ThermaPro
Amphedra Lean	Herbal Phen-Fen	ThermiCore CRT
Animal Cuts	Herbal PF Stage	Thermogenic Power
Beta Lean	Hydroxycut	TheroPlex
Clenbutrx	LipoKinetix	Thermo Speed
Diet Boost	Mag Pro Basopro	Trim Fast
Diet Fuel	Metacuts	Ultimate Energizer
Diet Pep	Metabolean	Ultimate Orange
Diet Phen	Metabolife 365	Ultra Chromaslim
Diur Lena	Metabolift	UltraCuts
Dyna-Burn Xtreme	Metabomax	Xenadrine
Dymetadrine Xtreme	Natural Trim	Xenadrine RFA-1
Energel	Turbotrim Plus	Yellow Jacket
Esclation	Up Your Gas	Other:

\* All supplements listed except creatine and protein contained ephedra or ephedrine

nervousness, tachycardia, insomnia, psychosis, nephrolithiasis, hypertension, seizures, myocardial infarction, stroke, and death (Andraws et al., 2005; Battig, 1993; Maglione et al., 2005). A growing number of case reports of these adverse effects are appearing in the medical literature (Bent et al., 2003; Chen et al., 2004; Myers et al., 1999; Theoharides, 1997). The relative incidence of adverse events is unknown, but is suspected to be higher than currently documented due to underreporting (Haller and Benowitz, 2000; Perotta, 1996). Considerable debate continues on the safety of ephedra.

Our objective was to examine patterns and prevalence of ephedra usage by high school aged athletes in Rochester, Minnesota. All three public high schools in Rochester, Minnesota were surveyed. Their combined enrollment for grades 9-12 was 5,557 students in 2004, with a graduation rate of 90%. The community is a mid-sized city of approximately 100,000 residents, and is 120 km from the nearest large city (Minneapolis). The population served by the public schools is primarily suburban, with a small percentage (less than 20%) of rural and urban children.

This is, to the best of our knowledge, the first epidemiological study of ephedra use in a population of adolescent athletes. We hypothesized that ephedra would be used by small numbers of athletes. Due to its purported ergogenic effects, we suspected that it would be used more commonly in sports requiring high levels of sustained energy expenditure (running, swimming, soccer), and those in which weight loss is emphasized (wrestling or gymnastics).

## METHODS

This study was an anonymous survey of high school athletes who participated in the fall sports season in 2003. The study was approved by the Institutional Review Board of our institution, who mandated parental consent in this study. The surveys were first distributed at our sports medicine center's annual preparticipation examinations (PPEs) in August of 2003, and subsequently distributed directly to athletes during the 2003-2004 school years at the area public high schools. Parental consent was obtained (for athletes under age 18) in person for the PPEs, and by mail otherwise. Parents who did not respond to the initial mailing were sent a second request. To minimize possible biases, athletes and coaches were not informed in advance of the plans for the survey. Athletes gave personal written assent at the time of the survey.

Surveys were administered in the schools by two of the study investigators. At the first two schools, announcements were made for the students to report to the survey area during their free periods for a mandatory meeting with researchers. The third school had more strict rules for student's freedom to roam through the school; therefore surveys were distributed directly to the students' desks during their free periods. In all cases, students were separated from school personnel and coaches, and were given the right to decline the survey. Responses were collected anonymously in sealed boxes. Due to the anonymous nature of the study, we could not determine which students completed the

**Table 2.** Ephedra use demographics.

	Users	Nonusers	Total Group
<b>Number</b>	7	304	311
<b>Total %</b>	2.3	97.7	100
<b>Male (No.)</b>	5	164	169
<b>Female (No.)</b>	2	140	142
<b>Male/Female</b>	2.5	1.16	1.19
<b>Mean (<math>\pm</math>SD)Age</b>	17.5 (.53) *	16.3 (1.5)	16.4 (1.5)

\*  $p = 0.069$ .

survey. No identifying marks were allowed on the survey instrument, and we were not permitted to record which athletes declined the survey, therefore a second attempt to reach missing athletes was not possible.

### **Survey instrument**

Athletes provided demographics, including all sports they played. They reviewed a list of supplements, including all ephedra-containing products available at local vendors and many other sources (Table 1). The selection items “creatine”, “protein”, “ephedra”, “ephedrine”, and “other” were also included on the list, without additional “brand names”. Athletes were instructed to select those supplements used in the past 12 months (this time period was prior to the FDA ban). For each supplement, they were asked to provide the following information: average frequency of use (rarely =less than once per week, weekly, daily), dosage (if known), source of information (magazine, online, friends, coach, other) and place of supply (gym, store, online, friends, coach, other). They were also asked if they perceived a benefit or had side effects from the supplement. In a separate question, they were asked if any of the supplements they used contained ephedra.

### **Data analysis**

Survey answers were managed with a standard statistical spreadsheet program. When a supplement was written into the “other” category, its content was verified prior to categorization. Differences between the median ages for the groups were evaluated using the Wilcoxon Rank Sum test. For determination of gender differences, the Fisher’s Exact Test was applied. For analysis of patterns of use, and sports played, descriptive statistics alone were used.

## **RESULTS**

### **Parental and athlete consent**

At the PPE, 100 athletes presented with parents, of which 49 agreed to give consent (49%). For in-school surveys, consent forms were sent for all fall sports athletes ( $n = 1197$ ). A total of 397 (33.2%)

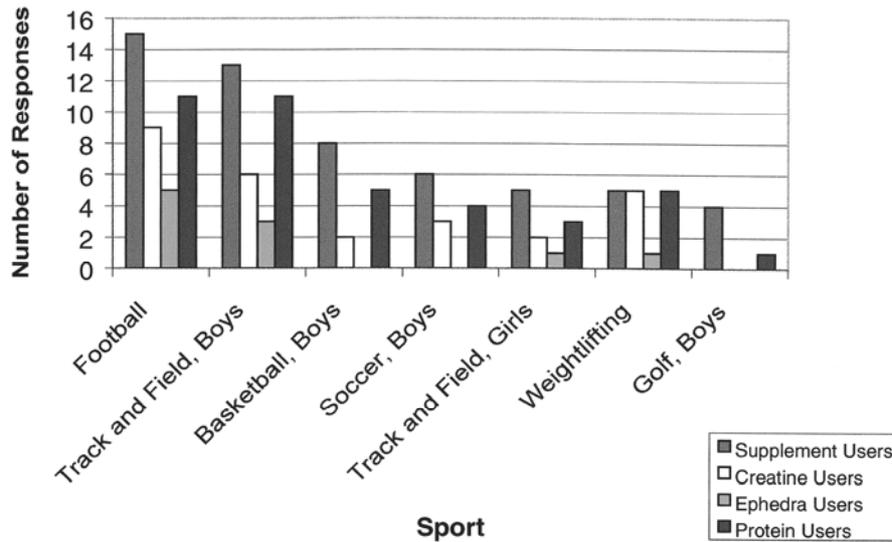
parental responses were received in the two mailings, with 307 (77.3%) consents given. At the time of the survey in the schools, 100 athletes 18 years or older were surveyed. No athlete refused personal consent.

### **Subjects and supplements used**

The total number of athletes eligible for survey at the time of school survey was 456 (49 from PPE, 307 minors with mailed parental consent, and 100 students age 18 and over). Of these, a total of 316 eligible participants completed the questionnaire. The remaining athletes were unable to be located at the time of survey. Five individuals failed to provide demographic information and therefore were excluded. None of these five athletes reported ephedra use. A total of 311 subjects (169 males (54.3%) and 142 females (45.7%)) completed the study yielding a 68.2% response rate (or 26% of the 1197 eligible athletes prior to the consent process). (see demographics - Table 2). A total of 34 athletes (10.9%) used supplements of any kind. Ephedra was used by 7 (2.3%) athletes: 5 males and 2 females. The average age of ephedra users appeared higher than nonusers (17.5 vs. 16.4 years), but the difference was not quite statistically significant ( $p = 0.069$ ). However, all ephedra users were age 17 ( $n = 4$ , or 6.9% of 17-yr-olds) or 18 ( $n = 3$ , or 3.3% of 18-yr-olds). Protein supplements were used by 26 athletes (8.4%). Creatine was used by 14 (4.5%), including 12 males and 2 females. Four athletes took both creatine and ephedra. All four were male American football players.

### **Patterns of ephedra use**

Although seven athletes reported taking dietary supplement products that contained ephedra, only one identified the supplement as an ephedra-containing product. The others identified the supplement by brand name, but concomitantly indicated that they had *not* taken ephedra when asked directly on the questionnaire. Supplements (in general) were used in 21 different sports. The seven sports with the highest usage rates are shown in Figures 1 and 2. These include all sports in which ephedra was used. The type of “weight lifting” done



**Figure 1.** Supplement usage by sport. Only the seven most commonly played sports by supplement users are shown. The number of supplement users in some sports is larger than the combined total of supplements listed, because some athletes reported using carbohydrate-containing sports drinks and energy bars as supplements.

by athletes was not specified. This is not a school-sponsored sport, but was reported a sport “also played” by the athletes. There was no way to verify which type of weight lifting (i.e. power lifting, “Olympic” lifting, or body-building) was done.

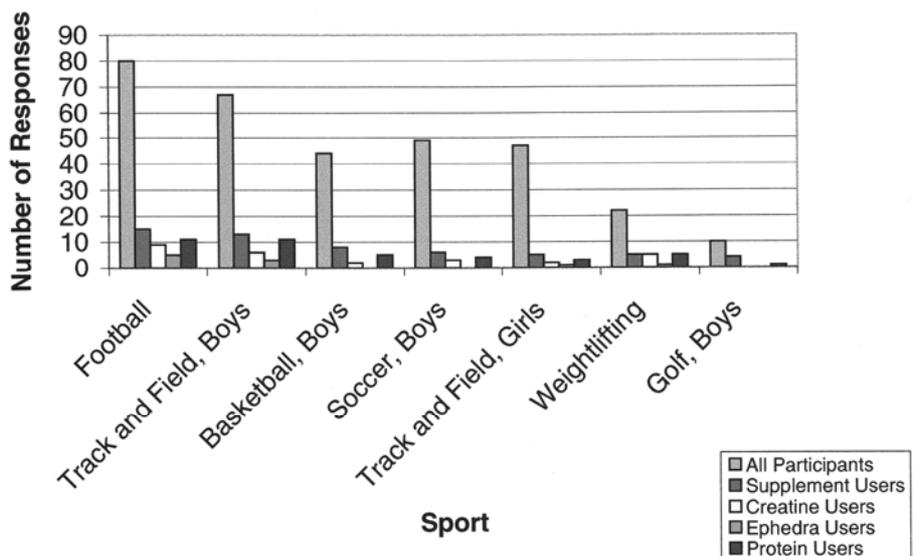
Patterns of use and beliefs about ephedra are shown in Table 3. Ephedra was used most

commonly in American football (5 users), and boys track and field (3 users). One female weightlifter and one girls track and field athlete used ephedra. Four of seven ephedra users thought that it improved their

performance. Only one user claimed a side effect from the supplement, but did not report what the side effect was. Ephedra tended to be used on a rare basis (less than once per week; 5 of 7 users) or weekly basis (2 of 7). Creatine, for comparison, was used on a daily basis by forty three percent of its users.

**Acquisition of ephedra**

Sources of information about supplements are shown in Table 4. Because some athletes had more than one source, the number of responses was



**Figure 2.** Participation rate versus supplement usage for the seven sports most commonly played by supplement users. The number of sports reported with ephedra use is larger than the number of users due to the responses of multi-sport athletes.

**Table 3.** Patterns of use and beliefs among ephedra and creatine users.

Question	Ephedra (n = 7)		Creatine (n = 14)	
	No. of users	No. of users (%)	No. of users	No. of users (%)
<b>Frequency of use</b>	7		14	
Rarely		5 (71)		5 (36)
Weekly		2 (29)		3 (21)
Daily		0 (0)		6 (43)
<b>Know dosage?</b>	7		14	
Yes		1 (14)		6 (43)
No		6 (86)		8 (57)
<b>Improves performance?</b>	7		14	
Yes		4 (57)		11 (79)
No		3 (43)		3 (21)
<b>Experienced side effects</b>	7		14	
Yes		1 (8)		2 (14)
No		6 (92)		12 (86)

\*All participants did not respond to each question.

sometimes greater than the number of athletes who used each supplement. All results are reported as number of athletes who obtained information from each source, however. The most common source of information about supplements was friends of the athletes for both ephedra and creatine by a large margin (86% and 93% respectively). The internet was listed as a source of information more commonly for ephedra than for creatine (19% vs. 11%). Ephedra-containing supplements were most commonly obtained from friends (47% of responses). The source of creatine supply, for comparison, was a retail store (73% of responses). Ephedra-containing supplements were also purchased from the internet more commonly than creatine (27% vs. 7%).

## DISCUSSION

This report represents the first epidemiological study of ephedra usage in a population of adolescent athletes. Our most notable finding was that only one in seven users of ephedra acknowledged that their dietary supplements actually contained ephedra. This information has many potential implications: 1) there may be an increased safety risk if any substance is taken unknowingly, or in inappropriate dosages. Coaches, parents, athletes, and medical staff should read labels or seek product information to learn the content of any supplements used, 2) In drug testing of athletes, adolescents may be more at risk to test “positive” accidentally due to unknowingly taking a banned substance, and 3) In

**Table 4.** Acquisition of ephedra and creatine.

Question	Ephedra (n = 7)		Creatine (n = 14)	
	No. Users	No. of users (%)	No. responding	No. of users (%)
<b>How did you learn about the supplement?</b>	7*		14*	
Magazine		1 (14)**		2 (14)**
Friends		6 (86)		13 (93)
Online		1 (14)		2 (14)
Coach		0 (0)		2 (14)
Other		1 (14)		0 (0)
<b>Where did you purchase the supplement?</b>	7		14*	
Gym		0 (0)**		1 (7)**
Online		1 (14)		1 (7)
Store		1 (14)		11 (79)
Friends		4 (57)		2 (14)
Coach		0 (0)		0 (0)
Other***		1 (14)		0 (0)

\*Some participants had multiple sources of acquisition.

\*\*Percentages greater or less than 100% because of rounding or multiple sources of information.

future research, inquiries regarding the use of supplements should include brand name products, not just the ingredient in question.

Limitations of the study are as follows: 1) Athletes from only one city were surveyed. It is possible that usage may vary from city to city or state to state, depending on local trends or access to supplements. Although numbers were small, we saw no apparent differences among the three schools surveyed. 2) The overall response rate 26% of all eligible athletes is somewhat low, due in large part to the parental consent mandate (see below). Of the eligible athletes with parental consent or personal assent, however, the response rate was good (68%), and a large number of athletes age 18 and over was able to give personal assent. 3) No comparison was made between athletes and non-athletes, or those students participating in non-school sponsored sports. While this was not the aim of our research, this does raise questions of the true prevalence of ephedra usage. 4) There is a possibility of false positive and false negative responses to this survey, as there was no measure to verify content and validity. To its credit, however, the survey was designed with the assistance of our survey research center, and included clear, plainly written instructions to the participants. 5) No data was collected regarding the sport-specific positions or events played by ephedra users. In track and field, for instance, runners may be more likely to use ephedra for energy gains, while throwing athletes may use creatine for strength enhancement.

### ***Ephedra usage by young athletes***

Ephedra usage in this population is not surprising, as it has been reported in older populations of older athletes. For example, the NCAA has detected ephedrine/ephedra in a number of athletes during routine screenings, and has noted an increase in the frequency of detection, with eight of 60 (13.3%) of positive test results attributed to ephedra or ephedrine (NCAA News Staff, 1999). Based on previous research, use of supplements in collegiate athletes raises the question of use at a younger age (LaBotz and Smith, 1999). We also noted that most users learned about their supplement from their peers. This highlights the potential usefulness of in-school or peer-based educational programs about the topic. Finally, a small percentage of users obtained information about or purchased their supplement from the internet. This source should be considered in any future regulation or intervention measures, especially considering its increasing popularity.

### ***Potential underestimation***

Although the rate of ephedra use in our study appears to be low (2.3% overall, 6.9% of 17-year-olds), we are concerned that this may be an underestimation of its usage. In particular, as the rate of creatine usage has been reported to be higher in other high school populations, we suspect that ephedra use may be more common as well. The study by McGuine et al. (2001) for example, identified creatine use in 30% (405/1349) of high school football players in the nearby State of Wisconsin while our rate was 11.3%. It is also possible that fewer athletes used ephedra after recent deaths of professional athletes rumored to be associated with the supplement. It is likely that ephedra use has declined since the FDA ban. This does not diminish the importance of our study, however, as ephedra appears to be returning to the U. S. market, and our findings may be applicable to other supplements. Finally, even our extensive list of ephedra-containing supplements may be incomplete. If athletes taking other ephedra-containing supplements didn't recognize the ingredients (as was the case in six out of seven athletes in this study) then an under-reporting bias would be further introduced.

### ***Parental and athlete consent***

The requirement for parental consent in this study may have induced a selection bias. Other research suggests that mandating parental consent for epidemiological studies may result in an under-reporting of adverse behaviours (Pokorny, 2001). We did request waiver of parental consent, but were denied for a number of reasons, including our institutional review board's ruling that ephedra was a "dangerous" substance. In support of our findings, however, we were able to study a number of athletes in the population (age 18 years and older), without parental consent. We were also fortunate to have a 100% consent rate from the athletes who presented for the survey. Further study on the issue of parental consent for research in minor athletes would be worthwhile, as this continues to be controversial (Santelli, 1995).

## **CONCLUSIONS**

Ephedra was used by a small number of high school athletes in this select population. These athletes were unlikely to know that their supplements contained ephedra. Athletes typically obtain ephedra from peers, and are unlikely to know the dosage taken. Users tend to be older than non-users and are more likely to participate in American football, track and field, and weight lifting. Future study is warranted to determine the prevalence of use in the United States

after the over-ruling of the FDA ban, and its use in other athletic populations. Without such data, it will be difficult to estimate the frequency of adverse events, or to provide counseling regarding its use.

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## **KEY POINTS**

- Ephedra is an herbal stimulant used as an ergogenic aide.
- Adolescent ephedra users most commonly obtain it from their friends.
- Adolescent athletes are likely to take ephedra unknowingly.

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