Dietary Supplement and Drug Use and Doping Knowledge and Attitudes in Italian Young Elite Cyclists

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Objective: To explore use and attitudes toward drugs and dietary supplements (DS) and knowledge concerning doping in cycling.

Design: Retrospective cross-sectional study.

Setting: Professional cycling.

Participants: Elite under-23 male cyclists.

Intervention: Anonymous semistructured questionnaire administered during race periods.

Main Outcome Measures: Use and attitudes toward DS and drugs, and doping knowledge.

Results: Forty cyclists aged 19 to 23 years and practicing for 14 to 30 h/wk were interviewed. Previous use (last 3 months) of drugs or DS occurred in 33 of 40 (82.5%) and 39 of 40 (97.5%) cyclists, respectively. Almost all the subjects named at least 1 doping agent (range, 1-10). Within a fixed list of 18 substances (among which only 14 were doping agents), participants recognized 3 to 18 of them as doping agents. They recognized tramadol and sildenafil as doping agents, which are not doping agents, and failed to recognize probenecid and albumin, which actually are. Doping knowledge correlated with drug use ($r^2 = 0.1614$; $P = 0.01$). Participants deemed doping prevalence high among cyclists in general but not in their own team ($P < 0.0001$).

Conclusions: Use of prescription drugs and DS was a common occurrence. Doping knowledge was poor and biased, and its relationship with drug use deserves consideration. Educational interventions are needed to improve knowledge and awareness about prescription drugs and DS use, as well as about doping.

Key Words: dietary supplements, doping, cycling, sport, young elite athletes

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INTRODUCTION

Doping use seems to be a common practice among professional cyclists, and it has been described as endemic.[1–3] Besides improving physical performance, the use of banned substances may contribute to team cohesion and identity,[4] although a switch in doping practice has been recently reported, from a team habit toward an individual use.[1] Doping use is influenced by both personal attitude and the social environment (doctors, coaches, teammates, friends, etc),[1] and therefore, it can be considered not just as a sport issue but as a social phenomenon. In particular, young cyclists wishing to become professionals are exposed to a high pressure and often seek the advice of more experienced athletes, who had likely used illicit substances during their careers.[1] Despite that doping likely occurs early in the career of potential top cyclists, knowledge and attitudes toward doping among young cyclists remains a quite unexplored issue.

Consumption of dietary supplements (DS) is common in sport, with an estimated prevalence among elite athletes ranging from 57% to as high as 94%.[5–8] The pattern of DS use is largely sport dependent, the highest use occurring in sports that involve continuous endurance-type activity, such as cycling, athletics, and rowing.[7,9] Despite the beneficial claims in advertising, there is to date little evidence to support these contentions, and the advantage of supplementation on sporting performance is still controversial.[10–12] Among athletes with a balanced diet, the risk of vitamin or mineral deficiency is rare; therefore, dietary supplementation is usually unnecessary.[13] Moreover, DS use may be associated to the risk of a positive doping result due to the presence of prohibited substances not declared on the label.[14–16] In addition, DS intake may increase the likelihood of subsequent use of doping substances and may be, therefore, considered as a risk factor for doping.[5,10,17,18]

Although young and generally healthy, athletes often use a wide variety of medication to treat illness, cure injuries, and obtain a competitive edge. Drug consumption may also represent an indirect marker of disease serious enough to require medical treatment, and in some cases, represent a clue of doping if considering, for instance, those used to counteract typical doping adverse reactions, that is, antibiotic cream for acne in androgenic steroids users.[19] Nevertheless, the legal use of medication by young athletes has so far received little attention, even if some studies reported prevalence around 44% to 61%.[7,20]

Effective doping prevention strategies should be planned taking into account doping awareness and attitudes, and the possible relationship with frequency and patterns of

use of medications and DS, and educational measures should also aim at reducing the improper use of these latter substances. Therefore, the aim of the present investigation was to gain insight into the use of drugs and DS and into knowledge and attitudes toward doping among Italian young elite cyclists. For this purpose, DS and drug use were surveyed within the sample. Doping knowledge, including substances, benefits and risks, and diffusion together with any factors potentially associated, such as sociodemographic characteristics, time devoted to physical activity, use of drugs or DS, were investigated.

METHODS

Subjects

The investigation was conducted from July to August 2009, during race periods, among professional elite under-23 cyclists. Five teams were involved, all from northern Italy: 2 from Lombardy, 2 from Piedmont, and 1 from Veneto.

Procedures and Outcome Measures

A semistructured, anonymous questionnaire with multiple choice, closed and open answers was designed to gather data on (1) sociodemographical characteristics: age, education, place of living, anthropometrical data (height, weight), (2) cycling training and experience: time devoted because many years it had been practiced and if it was a full-time activity, (3) the use of drugs within the past 3 months: reason for using and sources for information/prescribing, (4) the use of DS within the past 3 months: reason, frequency of use, expected and obtained benefits, and sources for information, and (5) knowledge of doping agents: ability to name doping agents and to recognize them among a fixed list of substances, opinion concerning the use and diffusion in cycling in general, among elite under-23 team and in their own team, reasons for using doping, related risks, and sources for information.

Data Analysis

Collected data were inserted into a digital archive and analyzed through a descriptive approach. Data were presented as mean ± SD or percentage where appropriate. Anthropometric data, height and weight, were expressed as body mass index (kilograms/square meter). Prescribed drugs were coded according to the World Health Organization's Anatomical Therapeutic Chemical (ATC) classification system (http://www.whocc.no/atc/structure_and_principles/). Knowledge about doping was measured as either the number of doping agents spontaneously named or the number of substances within a fixed list correctly identified as doping or nondoping agents. Correlation between doping knowledge and sociodemographic and anthropometric data, as well as with the number of drugs and DS used, was assessed by the χ^2 test, the unpaired *t* test, analysis of variance, or Pearson correlation test, as appropriate. Statistical significance of the differences in the opinions about doping prevalence was assessed by the χ^2 test. Calculations were performed by the use of GraphPad StatMate for Windows (GraphPad Software, La Jolla, California).

Ethical Considerations

Informed consent was obtained from all participants, and the survey was conducted in accordance with ethical research guidelines.

RESULTS

Subjects

Forty elite under-23 cyclists, all of them male, were interviewed. Anthropometric and sociodemographic features are presented in Table 1.

Prescription Drugs

Thirty subjects (75.0%) used 84 drugs (2.8 ± 1.0 drugs/person; range, 1-5) in the past 3 months. In addition, 6 DS and 1 homeopathic product (*damiana compositum*) were included by mistake by 4 subjects among prescription drug. The complete list of drugs grouped according to ATC is shown in Table 2. The most common ATC group was group B "blood and blood-forming organs." Among active principles, the most common was V03AB32 glutathione, followed by the antianemic preparation B03BA01 cyanocobalamin. The most common class of drugs was nonsteroidal anti-inflammatory drugs (NSAIDs) (M01A and N02B).

Reasons for using drugs were provided by 96.4% of the subjects and included "vitamin deficiency" (27 drugs, 32.1%), "energy recovery" (18, 21.4%), "detox" (12, 14.3%), "fever/influence" (7, 8.3%), "unease" (5, 6.0%), "anemia" (5, 6.0%), "pain" (4, 4.8%), "to maintain hematocrit" (4, 4.8%), "allergy" (2, 2.4%), and "fitness maintenance" (1, 1.2%).

Dietary Supplements

Thirty-nine participants (97.5%) declared the use of DS in the past 3 months. A total of 108 DS (2.8 ± 1.3 DS/person; range, 1-5) were used cyclically (47, 43.5%), daily (37, 34.3%), on demand (17, 15.7%), or during race (5, 4.6%), and the most frequently used were amino acids. In Table 3, the complete list of DS used is presented. A homeopathic product (*damiana compositum*) was listed among DS.

Reasons for DS use were reported by 92.6% of participants and included "to integrate a dietary deficiency"

TABLE 1. Anthropometric and Sociodemographic Features of the Sample Population (n = 40)

	Total, Mean ± SD (Range)
Age, y	20.7 ± 1.3 (19-23)
Body mass index, kg/m^2	21.1 ± 1.0 (19.5-22.9)
Hours/week	21.8 ± 4.3 (14-30)
Started cycling, y	11.1 ± 3.2 (4-17)
Education, n (%)	
Primary school	1 (2.5)
Secondary school	38 (95.0)
Bachelor	1 (2.5)
Nonstudents	24 (60.0)
Students	16 (40.0)

TABLE 2. List of Drugs Used According to the ATC Classification System

ATC	Drug	Users, n (%)
B		22 (73.3)
B03BA01	Cyanocobalamin	11 (36.6)
B03AA07	Ferrous sulfate	7 (23.3)
B03BA51	Cyanocobalamin combinations	7 (23.3)
B03BB01	Folic acid	4 (13.3)
B03AB19	Sodium ferric gluconate	2 (6.7)
V		20 (66.7)
V03AB32	Glutathione	19 (63.3)
V03AF04	Calcium levofolinate	4 (13.4)
A		9 (30.0)
A11JA*	Combinations of vitamins	5 (16.7)
A11DB*	Group B vitamin	4 (13.3)
A11AA*	Multivitamins with minerals	1 (3.3)
A11GA01	Vitamin C	1 (3.3)
M		8 (26.7)
M01AE03	Ketoprofen	5 (16.7)
M01AX17	Nimesulide	3 (10.0)
N		7 (23.3)
N02BA01	Acetylsalicylic acid	5 (16.7)
N02AX02	Tramadol	1 (3.3)
N02BE01	Paracetamol	1 (3.3)
R		2 (6.7)
R03CC02	Salbutamol	1 (3.3)
R05CB01	Acetylcysteine	1 (3.3)
R06AE09	Levocetirizine	1 (3.3)
J*		1 (3.3)
J01*	Antibacterials for systemic use	1 (3.3)
Total	—	30 (100.0)

*Information provided by responders did not allow the identification of individual drugs.

(53 DS, 49.1%), "better recovery" (38, 35.2%), "wellness" (5, 4.6%), and "better reactions" (4, 3.7%).

Benefits were reported by 27 users (69.2%) and were represented by "better recovery" (16, 59.3%), "wellness" (6, 22.2%), "more strength" (4, 14.8%), and cramp prevention (1, 3.7%).

Doping

Thirty-eight subjects (95.0%) were able to name at least 1 agent considered as doping (3.2 ± 2.0 doping agents/person; range, 1-10), for a total of 16 different substances (Table 4). In 3 cases, nondoping agents were also mentioned.

Subjects were also asked to identify substances they knew within a fixed list and to discriminate whether they were doping or not (Table 5). The list included 18 agents, among which 14 of them were doping according the 2009 World Anti-Doping Agency (WADA) list. Surveyed subjects recognized a mean of 10.6 ± 3.7 substances (range, 3-18), among which 7.6 ± 2.7 (range, 3-14) were properly identified as doping agents. Among the most frequently recognized (by more than 75% of respondents), growth hormone and testosterone were correctly considered doping agents in 100% of the cases, amphetamine and ephedrine in 94.8% and 93.8% of the cases, respectively, and cocaine in only 84.8%. Within doping agents, probenecid, albumin, and Hematide were identified as doping by only 40.0%, 52.9%, and 71.4% of respondents who indicated they knew these substances. Phenmetrazine was the less recognized doping substance because it was known by only 2 participants (5.0%) who nonetheless both correctly identified it as doping. Among nondoping agents, tramadol was wrongly considered as doping in 6 of 25 cases (24.0%).

According to the majority of subjects (38, 95.0%), doping agents are globally dangerous with potentially serious consequences, whereas for 2 of them (5.0%), only erythropoietin, continuous erythropoietin receptor activator, erythropoietic agents, and psychotropic agents are actually unsafe.

Reasons given to explain doping use by other athletes were "advantages in terms of physical performance" (23 subjects, 57.5%), "results achieved in a short time" (16, 40.0%), "good results during the competition" (15, 37.5%), "because it's a common habit" (3, 7.5%), "because you're not worth for what you are, but for what you achieve" in 1 case (2.5%), and generically "other" in another one (2.5%).

TABLE 3. List of DS Used

	Users, n (%)
Amino acids	28 (71.8)
Hydro saline supplement	28 (71.8)
Vitamins	19 (48.7)
Iron	6 (15.4)
Caffeine	5 (12.8)
Proteins	2 (5.1)
Ergogenic products	1 (2.6)
Total	39 (100.0)

TABLE 4. List of Substances Spontaneously Mentioned as Doping Agents

Substance	Respondents, n (%)
Erythropoietin	32 (84.2)
CERA	26 (42.1)
Growth hormone	23 (60.5)
Amphetamine	10 (26.3)
Testosterone	10 (26.3)
Gonadotropin	5 (13.2)
Nandrolone	5 (13.2)
Ephedrine	4 (10.5)
Insulin	3 (7.9)
Anabolic steroids	2 (5.3)
Corticosteroids	2 (5.3)
Tramadol*	2 (5.3)
Cocaine	1 (2.6)
Corticotropin	1 (2.6)
Methamphetamine	1 (2.6)
Sildenafil*	1 (2.6)

*Nondoping agents.
CERA, continuous erythropoietin receptor activator.

TABLE 5. List of Substances to Be Recognized and Discriminated as Doping or Nondoping (Defined According to the WADA List 2009)

Agents	Recognized, n (%)	Considered as Doping, n (%)
Doping agents		
Growth hormone	39 (97.5)	39 (100.0)
Testosterone	39 (97.5)	39 (100.0)
Amphetamine	39 (97.5)	37 (94.9)
Cocaine	33 (82.5)	28 (84.8)
Ephedrine	32 (80.0)	30 (93.8)
Human chorionic gonadotropin	28 (70.0)	27 (96.4)
Nandrolone	24 (60.0)	24 (100.0)
Salbutamol	23 (57.5)	21 (91.3)
Methadone	19 (47.5)	16 (84.2)
Albumin	17 (42.5)	9 (52.9)
Corticotropin	7 (17.5)	7 (100.0)
Hematide	7 (17.5)	5 (71.4)
Probenecid	5 (12.5)	2 (40.0)
Phenmetrazine	2 (5.0)	2 (100.0)
Nondoping agents		
Paracetamol	37 (92.5)	0 (0.0)
Nimesulide	29 (72.5)	0 (0.0)
Tramadol	25 (62.5)	6 (24.0)
Pseudoephedrine/ cetirizine	20 (50.0)	1 (5.0)

Pseudoephedrine, included in the monitoring program in 2009, has been considered doping agent by WADA since 2010.

The majority of subjects believed that doping occurs "a lot" among cyclists and among nonprofessional cyclists, and 3 subjects even indicated that among cyclists in general "every one uses it." However, only a few subjects answered about their own team and indicated that doping occurs (Table 6).

Sources of Information

As presented in Table 7, sources of information were similar for drugs and DS and were mainly represented by a specialized doctor, general practitioner (GP), and the Internet. Sources of information for doping were significantly different from those for drugs and DS and were mainly the Internet, newspapers/radio/television, and relatives/friends, whereas specialized doctor and GP were mentioned only in a few cases. The trainer was never considered a major source of information.

Correlations

No relationships were found between sociodemographic or anthropometric profile and drug or DS use, or with doping knowledge (not shown). However, doping knowledge showed a low but significant correlation with the number of drugs ($r^2 = 0.1614$; $P = 0.01$) but not with the number of DS ($r^2 = 0.0068$; $P = 0.61$).

DISCUSSION

Prescription Drugs and Dietary Supplements

To our best knowledge, this is the first study investigating the use of DS and medicines in young elite cyclists and its relationship with knowledge and attitudes toward doping. Participants were all young (age range, 19-23 years), healthy, and with good instruction levels (97.5% with at least a secondary school degree), an observation which raises even more concern on our results, which show limited knowledge about doping and the occurrence of extremely high use of prescription drugs and of DS.

Indeed, 75% of our subjects used at least 1 drug (up to 5) in the past 3 months, with a mean of almost 3 drugs/subject. Drug use reported in the literature is in the range of 44% to 61%.[7,20] Our findings show considerably high drug use even if compared with data from the Italian Observatory on the Use of Medicines, which indicate that around 50% of the general Italian male population between 15 and 24 years used at least 1 drug per year.[21]

As regards specific classes of drugs, our results confirm previous observations about the high prevalence of use of drugs such as iron-containing preparations and NSAIDs.[7] Nonetheless, the use pattern is considerably different from that of the general population. As an example, drugs for blood (ATC group B) were used by nearly 3 of 4 subjects in our sample, whereas in the general population, their prevalence is less than 5%.[21] Additional concern comes from the high proportion of nonmedical reasons for the use of prescription drugs, which may result in inappropriate and excessive use of medications, in turn increasing the risk for adverse drug events and interactions.[5]

Increased risk of interactions also stems from the frequent use of DS. In this regard, our data showing that almost all surveyed subjects (98%) used at least 1 DS in the

TABLE 6. Opinion About the Use and Diffusion of Doping in Cycling

Does Doping Occurs in…	Cyclists in General? (A), n (%)	Nonprofessional Cyclists? (B), n (%)	Your Team? (C), n (%)	*P*		
				A vs B	A vs C	B vs C
				0.08	<0.0001	<0.0001
Respondents (% of participants)	40 (100.0)	39 (97.5)	7 (17.5)	—	—	—
A few	0 (0.0)	0 (0.0)	6 (85.7)	—	—	—
Somewhat	14 (35.0)	21 (53.8)	1 (14.3)	—	—	—
A lot	23 (57.5)	18 (46.2)	0 (0.0)	—	—	—
Every one use it	3 (7.5)	0 (0.0)	0 (0.0)	—	—	—

TABLE 7. Sources of Information for Drug Use, DS, and Doping

Sources	Drugs (A), %	DS (B), %	Doping (C), %	*P*		
				A vs C	B vs C	A vs B
				<0.0001	<0.0001	0.47
Trainer	6.7	15.4	15.0	—	—	—
Pharmacist	3.3	12.8	5.0	—	—	—
Newspapers/radio/television	3.3	7.7	60.0	—	—	—
Internet	13.3	15.4	82.5	—	—	—
GP	23.3	15.4	10.0	—	—	—
Specialized doctor	90.0	74.4	20.0	—	—	—
Relatives/friends	6.7	15.4	35.0	—	—	—

past 3 months are similar to previous works suggesting that, on average, 75% to 90% of elite athletes consume DS.[5,10] However, although vitamins and minerals are the most commonly used DS in sports (50%-63%),[5,7,22–24] in our sample of elite cyclists, amino acids were the preferred substances, being used by 34% of the subjects.

In the present study, DS were mainly used with a cyclical pattern, principally for a dietetic integration and 60% of the users perceived some benefits. This finding is in agreement with previous studies, which showed that performance enhancement, extra energy supply, maximized recovery, nutritional deficiency, prevention of illness, and health maintenance are major reasons offered to justify DS use.[7,10,23]

Our results underline the widespread perception of DS as substitutes to normal, well-balanced diet and of the significant benefits subjectively associated with dietary supplementation, as almost 70% of our sample was satisfied by DS use. However, DS may present unwanted side effects, for example, due to the micronutrient levels exceeding the safe upper level or due to possible interactions with concomitant medications.[13] In addition, DS can be a source of unintentional doping because some may contain unlabelled substances included in the WADA List of Prohibited Substances.[14–16] The risk is particularly high for uncontrolled products, such as those sold over the Internet.[25] Moreover, the consumption of DS has been related to a higher propensity of positive doping violations.[5,10,17,18] For all these reasons, studies are strongly warranted to assess the actual risk-benefit profile of DS in sport since, although some DS may possibly enhance athletic performance, scientific evidence confirming their benefit is inconsistent.[5,8,20,26]

Doping

According to our results, knowledge about doping agents was very limited, as indicated by the low number of doping agents spontaneously named (on average, 3 per individual) and by the inability to recognize doping substances from a fixed list (on average, only 50% were correctly identified). Erythropoietin was among the most well-known doping substances, as expected, being the most commonly banned substance used in cycling.[1] Nonetheless, the novel erythropoiesis-stimulating drug Hematide was known by only 7 out of 40 cyclers and recognized as a doping agent by only 5. The same occurred for testosterone and nandrolone, the former being correctly identified by most of the subjects and the latter by only a few, thus further emphasizing the lack of structured information about doping. Additional evidence in this regard is provided by the inability of these subjects to mention several important and commonly used prescription drugs among doping agents, for example, antiasthma and diuretics or other masking agents. Insulin and corticosteroids, which may be commonly used even by young athletes, were mentioned as potential doping agents, respectively, by only 3 and 2 subjects out of 40 (Table 4). When included in a fixed list of substances (Table 5), salbutamol was recognized as doping by only half of the cyclists and albumin and probenecid, a masking agent, by only 9 and 2, respectively. Sildenafil and tramadol were erroneously identified as banned substances. Pseudoephedrine/cetirizine, commonly used for rhinitis and allergy, was known by half of participants and was considered as doping by 5% of the athletes. Noteworthy, on the year of the survey, pseudoephedrine was simply included in the Monitoring Program, whereas starting from 2010, it has been considered by WADA as a prohibited substance.

Results about the limited knowledge on doping are in line with findings showing that the sources of information about doping used by our sample of subjects are mainly nonmedical and are represented by Internet (82.5%), newspapers/radio/television (60%), and relatives/friends. Such sources are likely responsible for this partial and sectorial (ie, used in cycling) knowledge about doping. Moreover, although the main source of information for drugs and DS was reported to be specialized doctors and GP, 1 homeopathic product (*damiana compositum*) was considered a prescription medicine and a DS, several prescription drugs were not clearly identified (in particular, antibiotics), and 6 DS were included in the list of prescription drugs, thus suggesting that even knowledge about medicines and DS is far from optimal. Finally, although according to the published studies, teammates and/or the coach are important sources of information at least for drugs and DS,[27,28] in our survey, both the trainer and friends were mentioned by only 6.7% to 15.4% of the subjects (but relatives/friends were indicated by 35% as sources of information in the case of doping).

These findings clearly reveal that the subjects included in our survey hardly recognize which products are illegal,

which are the correct indications for drugs and DS, what are the possible adverse effects, and which risks are associated with each of these substances. The risk, for example, for unintentional doping using faked DS, prescribed medications, or drugs used for nonmedical indication seems thus very high.

Indeed, 95% of the cyclists were aware about the risk of doping, whereas only 5% tried to minimize the risk of doping, restricting it to some agents such as erythropoiesis-stimulating agents and psychotropic drugs. Nonetheless, an apparent uneasiness when asked to express personal opinions about the occurrence of doping in cycling was observed in our sample because the athletes declared that doping was widespread in cycling in general and at amateur level; however, when referring to their own team, an attitude of denial was evident, as only 17.5% admitted doping diffusion in their team and only to a very limited extent (Table 6). Interestingly, medications and DS mainly used (group B and iron), together with frequent drug use indications such as "anemia" and "to maintain hematocrit," underlie the particular attention toward hematocrit values within cyclists. Moreover, the significant correlation between the use of prescription drugs and doping knowledge (especially represented by erythropoiesis-stimulating agents, very common in cycling) may suggest that higher medication users were potentially closer to doping risk.

One of the limitations of a survey of this nature is the risk of underreporting. However, it has been demonstrated that information gathered through anonymous self-administrated questionnaire may be reliable.[29,30] Indirect evidence for underreporting might be possibly represented by the clear attitude toward denial of doping occurrence in the teams to which participants belonged; however, this finding also represents, in our opinion, valuable information that should be taken into account when planning educational interventions aimed at preventing the use of doping substances. An additional limitation in our survey might be represented by the number of participants, which was relatively small. However, subjects were member of 5 different teams from 3 different regions of northern Italy. Moreover, this limitation however did not prevent us from obtaining several interesting insights in young professional athletes in which data are still lacking.

In conclusion, the collected data confirms that a large number of athletes use DS hoping to improve performance, although often uncritically and despite the lack of evidence about their efficacy and the recognition that such practices may carry risks (toxicity, drug interactions, possibility of "inadvertent" doping, etc). In addition, we observed superficial and "hematic-oriented" doping knowledge together with a potentially hidden use, suggested by "denial attitude." The results of the present study will hopefully provide the basis for direct interventions aimed at increasing the knowledge and awareness of the risks of doping in younger cyclists through educational and preventive programs. Indeed, nowadays, according to some authors, doping practice in cycling has become a more individualized and less institutionalized one. Therefore, cyclists have been given more power in the choice to use doping agents, with less involvement of the physicians and a progressive increase in the underground market such as over the Internet.[28] Educational programs should also include DS and prescription medications because they are closely related to a higher propensity toward doping, and the consequences of their inappropriate use such as adverse reactions and involuntary doping.

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