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The effect of cinnamon supplementation on eating disorder indices among people suffering from binge eating disorder: a randomized controlled trial

Mahan Gholami¹, Ebrahim Mokhtari², Jamileh Abolghasemi³ and Mohammadreza Vafa^{1,4*}

Abstract

Background Binge eating disorder is one of the main eating disorders that is characterized by recurrent binge eating episodes that lead to complications like high blood pressure, diabetes, dyslipidemia, etc. Many psychological and biological factors can lead to binge eating disorder and one of the main physiological reasons is insulin resistance. Cinnamon is an old favorite that has positive effects on insulin sensitivity. So, we examined the effect of cinnamon on binge eating disorder in this study.

Methods This study was conducted on 40 binge eating disorder patients with a BMI between 25 and 39.9 kg/m². They were divided into two groups one of them consumed 6 g of cinnamon per day while the other group consumed 6 g of white wheat as a placebo. Before and after the study we examined weight, height, Body Shape Questionnaire (BSQ), and Binge Eating Scale (BES) scale in all participants and did the statistical analysis.

Results There were no significant differences in baseline characteristics, gender, height, weight, BMI, education, and marriage status between the two groups. There were no significant changes between BSQ, BES, weight, and height after the study either.

Conclusion According to our findings, although the weight of the patients in the cinnamon group decreased significantly, after the end of the study, no significant difference was observed in the weight, BMI, and BAS and BSQ indices between the two groups.

Trial registration The study protocol was registered in the Iran Registry of Clinical Trials (IRCT) center (IRCT code: IRCT20090822002365N26, Registration date: 2021/11/7).

Keywords Cinnamon, Binge eating disorder, BMI, Body weight, Body shape

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Introduction

Eating disorders are serious and sometimes fatal diseases that cause severe disturbances in a person's eating behavior. Binge eating disorder (BED) is one of the eating disorders that is associated with frequent episodes of binge eating. Unlike bulimia nervosa and other unclassified eating disorders, this disorder is not associated with compensatory behaviors [1].

It is thought that BED disorder is an indicator disease; This means that it is caused by the symptoms of another disease, depression, accidents and trauma, disturbance in beliefs related to physical appearance, history of abuse in childhood, genetics, history of repeated diets, unsuccessful severe and inflexible dietary restrictions, and other factors are among the causes of the disease. are related to this disorder [2, 3].

According to previous studies, insulin resistance, especially insulin resistance of the central nervous system (CNS), are important factors in the occurrence and exacerbation of BED disorder [4]. In the CNS, the highest concentrations of insulin receptors are found in the arcuate neurons of the hypothalamus, hippocampus, and cortex [4]. By crossing the blood-brain barrier and activating these receptors, insulin can suppress hunger and induce a sense of satiety, create pleasure and food reward, and suppress nutritional behaviors following food reward [5]. It has been observed that CNS resistance to insulin has been associated with hyperphagia, which can be one of the reasons for binge eating episodes in people with BED disorder with high body mass index [6]. Also, insulin plays a significant role in cognitive processes related to food, on the other hand, fasting insulin levels and insulin resistance have been observed in people with eating disorders and obesity, more than in non-diseased people with the same BMI [7, 8]. Considering the important role of insulin in the processes related to eating, it is expected that by improving insulin signaling in the nervous system, the centrality of eating-related behaviors in people with eating disorders with high BMI will improve.

Dietary interventions are part of the treatment of all eating disorders. Cinnamon is a spice that has been used for a long time as a preservative and medicinal ingredient [9]. Cinnamon, having chromium, polyphenols, and cinnamaldehyde, has a positive effect on insulin sensitivity [10]. In previous studies, it has been observed that the consumption of cinnamon can directly increase the insulin sensitivity of the brain [11], which was associated with consequences such as increased motor activity in response to food, increased basal metabolism, and increased brain activity [12]. Therefore, it is expected that after consuming cinnamon and increasing the insulin sensitivity of affected people, the feeling of satiety and hunger suppression will increase, or the effect on the reward centers of the brain will cause pleasure and

subsequently positive cognitive processes. Previously, it has been observed that the daily consumption of 1000 micrograms of chromium per day for 6 months was associated with a decrease in the number of binge eating episodes in people with BED disorder compared to the placebo group [13]. Chromium is the main effective ingredient of cinnamon in reducing insulin resistance [11]. In addition, cinnamon has other antioxidant substances and cinnamaldehyde, each of which has positive effects on insulin sensitivity [14].

Since the effect of cinnamon on the improvement and symptoms of people suffering from BED disorder has not been investigated until now, and considering the usefulness of cinnamon consumption on systemic and CNS insulin sensitivity in previous studies, we aimed to investigate a new way to control the symptoms and treat people suffering from BED disorder.

Materials and methods

Study population

In this parallel randomized controlled trial study, after approval of the research in the Ethics Committee of the Vice-Chancellor for Research and Technology of Iran University of Medical Sciences and obtaining the necessary permits code (ethics code IR.IUMS.REC.1400.304 and IRCT code: IRCT20090822002365N26), the selection of participants in the research began. The patients who visited the Kimiagar Nutrition Clinic and were examined by a nutrition expert were examined by a psychologist and were diagnosed with BED if their age were between 18 and 60 years old, had a BMI between 25 and 39.9 kg/m² and had a willingness to participate in the project. After re-screening by a nutritionist, eligible people were included in the study. People with the following characteristics were not included in the study: suffering from gastrointestinal diseases, heart diseases, hypertension, diabetes, debilitating diseases such as HIV and tuberculosis, kidney diseases, wheat flour allergy, history of suicide, alcohol and tobacco use, history of significant weight changes in the last three months, dietary history in the last three months, use of food supplements in the last three months, use of blood sugar and lipid-lowering drugs. Also, the exclusion criteria were: the occurrence of any accident that affects the health of the person, contracting any acute disease during the study, and unwillingness to continue cooperating in the research.

There were 56 individuals examined to enter the study. However, with 16 people exclude for various reasons, including eating disorders other than BED ($n=8$), having an underlying disease ($n=3$), unwillingness to cooperate ($n=4$) and other exclusion criteria ($n=1$), finally 40 individuals included the study and were randomly allocated to the intervention and placebo groups ($n=20$ in each group) (Fig. 1).

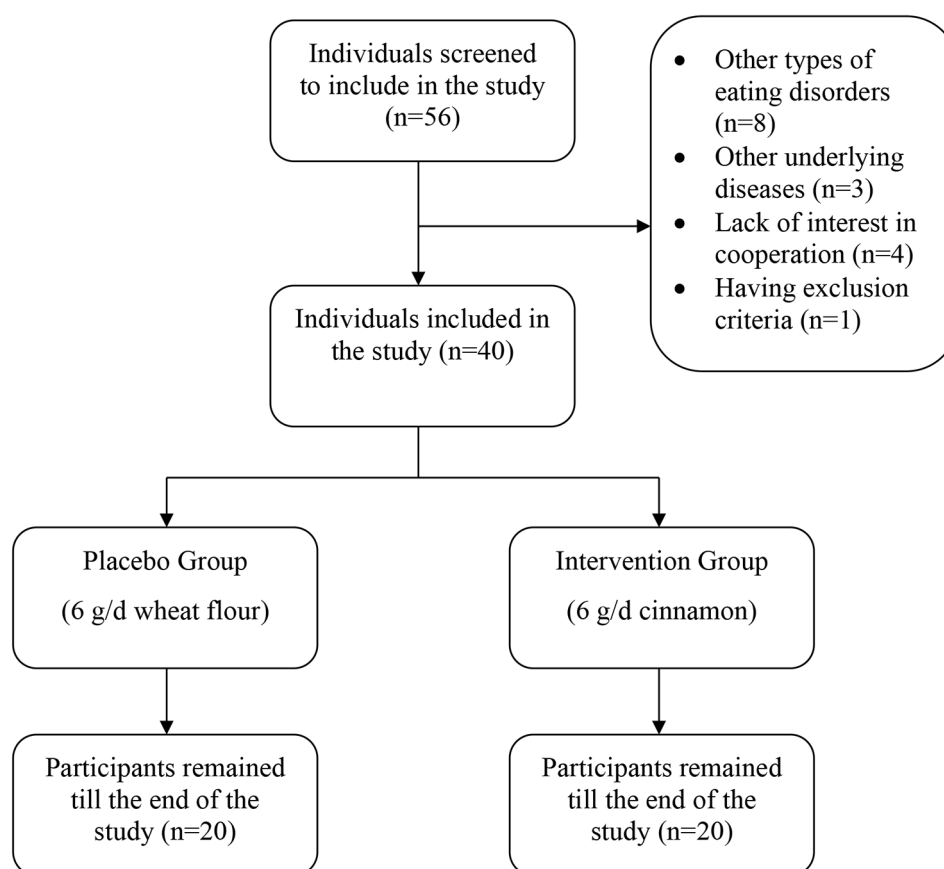


Fig. 1 Flowchart of the study participant selection

The study reporting adheres to the CONSORT guidelines for reporting clinical trials. Each person was explained about the trial procedures and the necessary information was provided to them. Also, written informed consent was obtained from all participants.

Sample size

Given the confidence interval (CI) of 95% and the power of 80%, and also considering the standard deviation (SD) of 0.79 and the means difference between intervention and control groups of 0.53 according to previous studies [13], and 10% drop out, finally, the sample size was determined to be 20 people in each group.

Implementation of the study

At the beginning of the study, individual characteristics, including educational status, age, gender, height, and weight were taken from each participant, and then BMI was calculated. The Body Shape Questionnaire (BSQ) and Binge Eating Scale (BES) scale were completed by a trained nutrition expert.

In the cinnamon group, 20 men ($n=17$) and women ($n=3$) with BED received a package containing 180 capsules, each one containing 2 g of cinnamon powder,

which were prepared in the beneficiary pharmacy. In the placebo group, 20 men ($n=18$) and women ($n=2$) without BED, a package containing 180 capsules, each one containing 2 g of wheat flour. Cinnamon and placebo capsules were taken 3 times a day for 8 weeks. At the end of the study, the measurements were made again. The researchers contacted the participants every week and asked about the forgotten pills and reminded them of the conditions of the research.

Randomization

In the present study, the allocation of people in a placebo group was done by simple randomization using a table of random numbers. Using this table, each of the 40 participants was given a random number. In the next step, people were assigned to the group A and B (each group=20 individuals) one by one. Then, group A was designated as the intervention group and group B as the placebo group. It should be noted that both the researcher and the person who performed the random assignment were blinded to the participants' information.

Anthropometric measurements

The weight of the volunteers was measured without a coverall, mask, and shoes with the minimum possible clothes and it was requested to wear the same clothes in the next steps, if possible, to minimize weight changes related to the type of clothing. All anthropometric measurements were performed according to the World Health Organization (WHO) method. became A digital scale used for weighing. Height was measured using a caliper and without shoes. Body mass index was obtained by dividing weight in kilograms by the square of height in meters.

BES and BSQ questionnaires

The BES was designed by Gormally et al. [15] to measure the severity of binge eating in people with obesity. This scale consists of 16 items. The subject is asked to choose the sentence that best describes him. The items are graded from 0 to 3, and the total score ranges from 0 to 48. Mootabi et al. [16] have confirmed the validity and reliability of this scale in Iran with a cut-off point of 17 to determine the BED (Cronbach's alpha coefficient=0.85).

Participant's perception of physical appearance is checked by the BSQ questionnaire [17]. This questionnaire encompasses 34 question items. Each item is answered using a 6-point Likert scale: 1 (never), 2 (rarely), 3 (sometimes), 4 (often), 5 (very often), and 6 (always). The maximum score is 204 and the higher the score means more concern the person has about the size and shape of the body. The reliability and validity of this questionnaire have been confirmed by Sadeghi et al. in Iran (Cronbach's alpha coefficient=0.95) [18].

Statistical analysis

Data analyses were conducted using the Statistical Package for Social Sciences (version 22.0; SPSS Inc, Chicago, IL) [19]. The normality of variables was assessed using histogram charts and Kolmogorov–Smirnov analysis. If the necessary assumptions are established, t-tests, independent t-tests, paired Pearson's correlation coefficient, and otherwise, non-parametric

Mann-Whitney-Wilcoxon and Spearman's correlation coefficient tests are used at a confidence level of 95% [20, 21].

Results

In the present study, 40 people with binge eating disorder with an average age of 31 years were included and randomly divided into two groups: placebo (*n*=20, male=18, female=2) and cinnamon (*n*=20, male=17, female=3). Table 1 shows the basic characteristics of the study participants in two supplement and placebo groups. In the placebo group, 90%, and in the cinnamon group, 85% were men. The average body mass index in the placebo group is 30.37 kg/m² and in the cinnamon group, it is 29.67 kg/m². About any of the examined variables, age, weight, height, BMI, and education level, there was no statistically significant difference between the placebo and cinnamon groups.

Table 2 shows the average score of the BES, weight, BMI, and BSQ indices before and after the intervention in the cinnamon and placebo groups. There was no statistically significant difference in the initial and final BES levels between the placebo and cinnamon groups. The participant's weight in the cinnamon group decreased from 92.50 to 89.99 (*p*-value=0.032). The BMI of people in the cinnamon group decreased from 29.67 to 29.23 (*p*-value=0.041). Regarding the BSQ index, no significant difference was observed between the cinnamon and placebo groups before and after the intervention.

Discussion

In the present study, it was shown that there is no significant difference between the BES, weight, BMI, and BSQ scores between the placebo and cinnamon groups.

It was shown that there is no significant difference between the BES index score in the placebo group compared to the cinnamon group. The BES index in the cinnamon group decreased after 8 weeks, while increased in the placebo group, However, there was no statistically significant difference between the two groups. In previous studies, it has been seen that many people with eating disorders have low insulin sensitivity, and one of the reasons for overeating in these people is the lack of proper signaling of satiety in the central nerves due to the resistance of the central nerves to insulin [22, 23].

Except for a case report study in China in which the symptoms of a person with BED were controlled by a group of spices including cinnamon [24], there is no clinical study on the effects of cinnamon on the index and the present study is the first research in this field. Perhaps it is possible to follow the lack of significant findings in the present study in this context, in other words, there is a possibility that cinnamon in combination with other spices will show better and stronger effects.

Table 1 Baseline demographic characteristics of study participants

	Placebo (<i>n</i> = 20)	Cinnamon (<i>n</i> = 20)	<i>P</i> -value
Age (year)	30.7 ± 6.05	31.2 ± 6.10	0.717
Weight (Kg)	95.11 ± 13.65	92.50 ± 11.8	0.292
Height (cm)	178.5 ± 3.20	174.8 ± 4.5	0.435
BMI (Kg/m ²)	30.27 ± 3.17	29.67 ± 3.08	0.499
Education status (academic), <i>n</i> (%)	13 (65)	13 (65)	0.240
Male, <i>n</i> (%)	18 (90)	17 (85)	0.882

P values were computed using the independent sample t-test and chi-square for continuous and categorical variables, respectively

Table 2 Mean and SD of the primary and secondary outcomes scores before and after the intervention in the cinnamon and placebo groups

	Index		Placebo* (n = 20)	Cinnamon* (n = 20)	P-value ²
Primary outcome	BES (score)	Before	23.30 ± 2.86	23.10 ± 2.40	0.515
		After	23.40 ± 2.83	22.35 ± 3.03	0.474
		P-value ¹	0.443	0.243	
Secondary outcomes	BMI (Kg/m ²)	Before	30.37 ± 3.17	29.97 ± 3.08	0.499
		After	30.49 ± 2.67	29.23 ± 3.25	0.264
		P-value ¹	0.221	0.041	
	Weight (Kg)	Before	95.11 ± 13.65	92.50 ± 11.80	0.292
		After	96.06 ± 11.24	89.99 ± 10.82	0.121
		P-value ¹	0.182	0.032	
	BSQ (score)	Before	102.05 ± 35.87	107.30 ± 25.48	0.612
		After	102.15 ± 36.54	109.85 ± 28.20	0.544
		P-value ¹	0.815	0.720	

¹P values were computed using the paired t-test. ²P values were computed using the independent sample t-test

*Data presented as mean ± SD

Abbreviations: BMI: Body Mass Index, BES: Binge Eating Scale, BSQ: Body Shape questionnaire

Primary outcome BES score, Secondary outcomes: BMI, weight and BSQ

However, few studies have investigated the effects of cinnamon intake on satiety [25, 26]. The findings of these studies were inconsistent, some observed a decrease and some increased satiety and some did not observe a relationship. In BED patients, since the sense of satiety is disturbed, they receive food in an uncontrolled manner and then deliberately throw it back out of the stomach by vomiting, and these compensatory behaviors cause serious injuries in these patients. be made Therefore, by controlling and suppressing the feeling of satiety, such behaviors can be prevented [25].

Also, other studies have shown that taking cinnamon has positive effects on the metabolic state of the body [27, 28]. The results of these studies show a decrease in serum levels of insulin and glucose after a meal, a decrease in insulin resistance, and an improvement in the lipid profile in BED patients. These effects can be useful in improving patients' sense of well-being and reducing disease symptoms. In addition, in a recent meta-analysis it was concluded that taking cinnamon can help patients lose weight and BMI. These effects can be effective in controlling mental disorders and food intake and improve the patient's mental image of his body [29].

The positive effect of cinnamon on insulin resistance has been shown in many studies. For example, in a meta-analysis by Deyno et al. [30], it was shown that daily consumption of at least two grams of cinnamon for 12 weeks is associated with improved insulin sensitivity in people with diabetes and pre-diabetes. The direct positive effect of cinnamon on CNS insulin sensitivity was also shown in a study by Sartorius et al. [11]. In this study, the consumption of cinnamon extract for 6 weeks in rats, in addition to improving blood sugar, increased brain activity, motor activity and energy consumption of

rats was also observed in response to food, which is then improved overeating.

Based on our literature, no study has yet investigated the effect of cinnamon supplementation on the BES index score in eating disorder patients, so, the relationship between cinnamon supplementation and BES is not clear. Our results showed that cinnamon consumption is associated with a decrease in the BES score, but this decrease was not significant. it may be due to the small sample size and the short duration of our study. Although consuming 6 g of cinnamon for 8 weeks based on previous studies seems to be able to reduce insulin resistance, a longer period (at least 6 months) is needed to make behavioral changes in a person.

In other studies investigating the complementary effect of chromium on the symptoms of eating disorders, it has been observed that patients took chromium picolinate supplements for 6 months until positive results were obtained in controlling the disease [31]. The decreasing trend of the BES score in the cinnamon group can be considered a path toward improving the eating disorder, and with the continuation of the consumption trend, significant results could be obtained in the BES index. However, further studies with the sample size and longer duration of the intervention are needed to confirm this claim.

Our results showed that the weight and BMI of people decreased in the cinnamon group and increased in the placebo group, but this difference was not statistically significant. Of course, the within-group changes in the intervention group were statistically significant. Various studies have investigated the effect of cinnamon supplementation on body weight in different populations [27, 32–34]. For example, according to a meta-analysis conducted by Mousavi et al., consumption of more than

2 g of cinnamon per day for more than 12 weeks can be associated with weight loss and waist circumference reduction in healthy adults [34]. Also, in another study by Jain et al. Men and women suffering from metabolic syndrome observed that consuming 3 g of cinnamon for 16 weeks was associated with a reduction in waist circumference and body mass index of the intervention group [35]. Furthermore, Ziegenfuss et al. observed that the consumption of cinnamon extract for 12 weeks was associated with a decrease in fat percentage and an increase in body fat mass [36]. All these studies are in line with our findings; however, more time was needed for these changes to become statistically significant. It is assumed that the short study duration is the main reason for the non-significance of weight loss in cinnamon users because, on the other hand, the trend of weight loss and BMI was also observed compared to the weight gain of the control group and the duration. However, many studies lack proper controls and have various limitations. While there is evidence that cinnamon improves insulin resistance, there is no strong evidence for weight loss. The studies are quite weak in this regard.

A time of at least 12 weeks seems to be necessary to make significant weight changes. Of course, until now the effect of cinnamon and cinnamon extract or chromium or similar effective substances on the weight and BMI of women and men with binge eating disorder had not been investigated and this is a new result in controlling the complications of this disease. The mechanism of this outcome can be explained by improving insulin sensitivity, turning white adipose tissue into brown, increasing metabolism, reducing ghrelin levels and gastric emptying speed, and reducing overeating in affected people [37].

In the present study, it was shown that in both the placebo and cinnamon groups, there was an increase in the BSQ index score after the intervention compared to before, although the amount of this increase was not statistically significant. Generally, the BSQ index measures a person's concern about their physical appearance. People with eating disorders often have an increased concern about their [38]. Worrying about physical appearance occurs for various reasons such as high BMI, social media influence, and lack of self-confidence [39]. The first step is psychological counseling under the supervision of a psychologist, and in the next step, if the BMI is high, taking selective serotonin reuptake inhibitors drugs under the supervision of a psychiatrist can be helpful [40].

It seems that in our study, a slight increase in the BSQ index was observed due to the diagnosis of the disease in individuals the increase in collective pressure due to entering the study, and also due to the short intervention time. Previous studies mentioned that to reduce body image disturbance, treatment should be continued for at least 6 months to achieve the desired results [41]. Martijn

et al. [42] in their study demonstrated that the effect of mass stimulation for 12 weeks could not be associated with the improvement of concern about body appearance. However, Fitzsimmons-Craft et al. [43] and Gan et al. [44] findings showed that 6 months of collective stimulation intervention can improve the index of physical concern. It seems that the short duration of the intervention is the main reason for not getting the answer about this index.

The current study had some strengths. We have a sufficient sample size even more than similar studies. Other strengths include the use of the appropriate dose for supplementation, no dropout of participants in both groups, and sampling in the conditions of the Covid-19 epidemic, which increased the compliance of people to the intervention protocol. Also, no side effects were reported among the participants in our study.

Our study also had limitations which were: the relatively short duration of the intervention, small sample size, not performing blood tests to accurately check the adherence to treatment in patients. Also, comorbid psychiatric disorders in cases must be evaluated by psychiatrist because binge eating disorder is a comorbid with other psychiatric disorders such as BIPOLAR and MDD. However, since the data collection for this research was done during the peak of the Covid-19 outbreak, we faced many problems both in terms of communication with patients and in terms of time. We did not have information about the participants' diet, physical activity level, and medications. Controlling such confounding variables could be useful in obtaining better results in this research. Therefore, unfortunately, we cannot conclude about cinnamon's effect on weight loss or claim that it contributes to it. Additionally, we could not collect information about glycated hemoglobin, glucose, waist circumference, waist-to-hip ratio, neck circumference, fat percentage, lean mass, and etc. Further, we do not rule out the existence of other possible confounding variables that were unknown to us.

Conclusion

Based on the findings of our study, the weight of the patients in the intervention group decreased significantly within the group, and therefore it is possible that the use of cinnamon to be effective for weight management (weight gain is one of the main complications of this disease). However, no significant difference was observed in the weight, BMI, and BAS and BSQ indices between the two groups.

Abbreviations

BMI	Body Mass Index
BES	Binge eating scale
BSQ	Body shape questionnaire
BED	Binge Eating Disorder

NAFLD	Non-Alcoholic Fatty Liver Disease
NPY	Neuropeptide Y
CCK	Cholecystokinin
PCOS	Polycystic Ovary Syndrome
MS	Metabolic Syndrome
CNS	Central Nervous System
FBS	Fasting Blood Sugar
BBB	Brain Blood Barrier
OS	Oxidative Stress
IR	Insulin Resistance
LDL	Low-Density Lipoprotein
TC	Total cholesterol
TG	Triglyceride

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Author contributions

M.Gh and M.V conceptualized and designed the study. M.Gh analyzed and interpreted the data. E.M, M.Gh, J.A drafted the initial manuscript. M.V and J.A supervised the project, and all authors approved the final version of the manuscript as submitted.

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Data availability

The datasets analyzed in the current study are available from the corresponding author on reasonable request.

Declarations

Ethics approval and consent to participate

Written informed consent was obtained from all participants. All methods were carried out following relevant guidelines and regulations. The study reporting adheres to the CONSORT guidelines for reporting clinical trials. The study protocol was approved by the Ethics Committee of the Vice-Chancellor for Research and Technology of Iran University of Medical Sciences and obtained the necessary permits code (ethics code IR.IUMS.REC.1400.304 and IRCT code: IRCT20090822002365N26).

Consent for publication

Not applicable.

Competing interests

The authors declare no competing interests.

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