



Race and income moderate the association between depressive symptoms and obesity

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ABSTRACT

Complex interrelationships between race, sex, obesity and depression have been well-documented. Because of differences in associations between socioeconomic status (SES) and health by race, determining the role of SES may help to further explicate these relationships. The aim of this study was to determine how race and income interact with obesity on depression. Combining data from the 2007–2014 National Health and Nutrition Examination Survey, depressive symptoms was measured with the Patient Health Questionnaire-9 and obesity was assessed as body mass index ≥ 30 kg/m². Three-way interactions between race, income and obesity on depressive symptoms were determined using ordered regression models. Significant interactions between race, middle income and obesity (OR = 0.66, 95% CI = 0.22–1.96) suggested that, among white women, obesity is positively associated with depressive symptoms across income levels, while obesity was not associated with depression for African American women at any income level. Obesity was only associated with depressive symptoms among middle-income white men (OR = 1.44, 95% CI = 1.02–2.03) and among high-income African American men (OR = 4.65, 95% CI = 1.48–14.59). The associations between obesity and depressive symptoms vary greatly by race and income. Findings from this study underscore the importance of addressing obesity and depression among higher income African American men.

1. Introduction

The tremendous growth in obesity rates in recent years is accompanied by large racial disparities (Flegal et al., 2016; Ogden et al., 2014). More than half of African American women are obese, compared to only one-third of white women (Ogden et al., 2014). Men have lower rates of obesity than women (Flegal et al., 2016), and race disparities among men have grown recently (Flegal et al., 2010; Flegal et al., 2013).

Obesity is associated with mortality and several comorbidities (Bastien et al., 2014; Flegal et al., 2013; Ogden et al., 2007; Centers for Disease Control and Prevention, 2015), including some psychiatric illnesses, for which race and sex differences are observed (Albert, 2015; Barnes and Bates, 2017). This highlights the importance of addressing obesity in terms of prevention of these consequent conditions. Numerous studies have documented positive associations between obesity and various forms of depression (Shervin Assari, 2014a, 2014c; Carter and Assari, 2017; Gavin et al., 2010; Heo et al., 2006; Hicken et al., 2013; Kodjebacheva et al., 2015; Lincoln et al., 2014; Linde et al., 2007;

Luppino et al., 2010; Mezuk et al., 2012; Mezuk et al., 2010; Polanka et al., 2017; Rosen-Reynoso et al., 2011; Schieman et al., 2007; Stecker et al., 2006). Though the literature is vast, it is inconsistent and the association between obesity and depression is not well-understood (Stunkard et al., 2003). The proposed mechanisms (Markowitz et al., 2008) range from the physiological (e.g. dysregulation of the hypothalamic-pituitary-adrenal axis and mood due to inflammation from obesity) (Shervin Assari, 2014c; Assari and Lankarani, 2016) to the sociocultural (e.g. anti-obesity stigma) (Puhl and Heuer, 2009). These mechanisms suggest that chronic stress plays a central role in the association between obesity and depression (Lincoln, 2017; Ouaknin et al., 2018).

Observed racial and sex differences in the association between obesity and depression suggest that these demographics could be important moderators of these mechanisms. For instance, compared to whites, obesity rates are higher among African Americans (Ogden et al., 2014), yet are less likely to be diagnosed with major depressive disorder (Barnes and Bates, 2017; Woodward et al., 2012), and report higher rates of depressive symptoms (Pratt and Brody, 2014) and

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psychological distress (Barnes and Bates, 2017). Though the racial discrepancy in major depression and depressive symptoms and distress is hypothesized to be methodological (Barnes and Bates, 2017), in general, studies have also shown that the association between obesity and depression is strongest among white women, and weak or non-existent among African Americans (Carter and Assari, 2017; Gavin et al., 2010; Heo et al., 2006; Hicken et al., 2013; Lincoln et al., 2014; Mezuk et al., 2010; Polanka et al., 2017; Rosen-Reynoso et al., 2011; Schieman et al., 2007; Stecker et al., 2006). This suggests potential physiological and/or cultural differences in the proposed mechanisms such as rates of chronic stress, coping pathways and behaviors (Hudson et al., 2012; Jackson et al., 2010; Lincoln, 2017).

The proposed mechanisms have potentially uncovered the consequences of race, obesity and depression, yet these explanations do not take into account socioeconomic status (SES). Studies have demonstrated complex relationships between race, SES and health (Braveman et al., 2010; Nuru-Jeter et al., 2018; Williams et al., 2010; Williams et al., 2016). Both obesity and depression are strongly associated with SES (Braveman et al., 2010; Ogden et al., 2010; Ogden et al., 2007; Sareen et al., 2011; Wang and Beydoun, 2007), but these associations may differ by race (Braveman et al., 2010). For example, there is a strong negative association between obesity and income among white women, but the association is less strong among African American women, and at times, inverse among African American men (Chang and Lauderdale, 2005; Zhang and Wang, 2004). Studies specifically among low-income, African American adults have found depression symptomatology to be associated with body mass index (Florez et al., 2015). Furthermore, studies show that accounting for income does not account for race differences in obesity (Bell et al., 2018) and that associations between income and depression differ by race (Hawkins et al., 2015). Theories like the “Diminishing Returns Hypothesis” suggest that income and other measures of SES are not associated with health among African Americans in the same manner as among whites because of racial differences in wealth, power and access to resources and experiences of discrimination-induced stress and other factors associated with higher SES among African Americans in particular (Cole and Omari, 2003; Farmer and Ferraro, 2005; Nuru-Jeter et al., 2018; Pearson, 2008; Turner et al., 2017; Williams et al., 2010; Williams et al., 2016).

The aim of this study is to examine the interrelationships between race, income, obesity and depression. It is hypothesized that the associations between obesity and depression would vary by income in addition to race. Because of differing associations between race, obesity and depression among women (Carter and Assari, 2017; Gavin et al., 2010; Heo et al., 2006; Hicken et al., 2013; Lincoln et al., 2014; Mezuk et al., 2010; Polanka et al., 2017; Rosen-Reynoso et al., 2011; Schieman et al., 2007; Stecker et al., 2006), the study determined these interrelationships by sex. The results of this study will add to the literature that interrogates the mechanisms between depression and obesity with an intersectional approach to further prevention efforts of the effects of obesity on depression.

2. Methods

The National Health and Nutrition Examination Survey (NHANES) is an ongoing nationally representative survey of the health, functional, and nutritional statuses of the U.S. population. Each sequential series of this cross-sectional survey sampled the civilian non-institutionalized population, with an oversample of low-income individuals, participants aged between 12 and 19 years, adults over the age of 60 years, African Americans, and Mexican Americans (Zipf et al., 2013). This survey used a stratified, multistage probability sampling design where data was collected in two phases. First, information regarding the participant's health history, health behaviors, and risk factors was obtained during a home interview. Then participants were invited to take part in a medical examination where they receive a detailed physical examination

(Zipf et al., 2013). Data from 2007 to 2014 were combined to obtain a sufficient sample of African Americans across income categories. The sample consisted of 12,220 non-Hispanic black (referred to as African American) and non-Hispanic white adults aged 20 years or older who completed the medical examination and were not missing on any analytic variables.

The dependent variable was depressive symptoms measured by the Patient Health Questionnaire-9 (Kroenke et al., 2001) and scores were categorized as follows: minimal (0–4), mild (5–9), moderate (10–14), moderately severe (15–19) and severe (20–27) (Huang et al., 2006; Kroenke et al., 2001). The main independent variable was obesity. Height and weight were measured in the medical examination. Respondents were considered obese if their body mass index (BMI) was ≥ 30 kg/m². Race was self-reported. Non-Hispanic whites and African Americans were included in these analyses. Household income was categorized as follows: \$0–\$34,999, \$35,000–\$74,999, \$75,000–\$99,999 and \$100,000 or more. Analyses also controlled for the following: age, sex, marital status (currently, formerly or never), educational attainment, household size, insurance status, self-rated health, current smoking and physical inactivity. Age and household size were measured continuously while the rest were analyzed dichotomously or with dummy variables. Educational attainment was categorized as follows: those who did not complete high school, high school graduates or those who completed a General Education Development (G.E.D.) equivalent, those who complete some college or obtained an Associate's degree, and those who received a Bachelor's degree or more. Household size represented the number of people living in the household. Insurance status represented whether the respondent had any health insurance. Self-rated health was analyzed dichotomously. Those who rated their health as fair or poor were given a value of “1” for this variable, and those who reported excellent, very good or good health received a value of “0”. Current smoking status represented survey respondents who currently smoke cigarettes every day or some days. Physical inactivity represented survey respondents who do not participate in any moderate or vigorous physical activity.

2.1. Statistical analyses

The mean and proportional differences between race groups for demographic, SES, and covariates were evaluated using Student's *t* for continuous variables and chi-square tests for categorical variables. Ordered regression models were used to assess the relationship between obesity, race and income with depressive symptoms. In Model 1, analyses were adjusted for age, marital status, educational attainment, insurance, fair/poor health, current smoking status and physical inactivity. The interactions of race and income with obesity on the odds of depressive symptoms were assessed using multiplicative interaction terms in Model 2. If any interactions were significant, the associations between obesity and depressive symptoms by race and income were assessed. Regression analyses were nested by sex. Following the procedure recommended by the National Center for Health Statistics, all analyses used Taylor-linearization procedures for the complex multistage sampling design and a weight variable was created to account for the combining of multiple years of NHANES and using variables from the medical examination (C.L. Johnson et al., 2013a; C. L. Johnson et al., 2013b). P-values less than or equal to 0.05 were considered statistically significant and all *t*-tests were two-sided. All statistical procedures were performed using Stata statistical software, Version 14 (StataCorp LP, College Station, TX).

3. Results

Table 1 displays demographic and health status differences by race. African Americans were younger, less likely to be currently married, college graduates, and insured. African American were more likely to be female, report fair/poor health, be current smokers and physically

Table 1
Obesity, depressive symptoms, income and other selected characteristics by race, NHANES 2007–2014.

	African American	White	p-Value
	N = 3755	N = 8465	
Age (years), mean \pm S.E.	44.8 \pm 0.5	49.2 \pm 0.3	< 0.001
Female, %	55.5	51.8	< 0.001
Marital status, %			
Currently	42.0	65.5	< 0.001
Formerly	24.2	18.9	
Never	33.9	15.7	
Educational attainment, %			
Less than high school graduate	22.8	12.1	< 0.001
High school graduate/GED equivalent	26.4	22.9	
Some college/Associate's degree	34.1	32.3	
College graduate or more	16.6	32.8	
Insured, %	74.9	86.8	< 0.001
Fair/poor health, %	23.9	14.6	< 0.001
Current smoker, %	25.9	20.9	< 0.001
Physically inactive, %	54.7	44.7	< 0.001
Obese, %	47.3	34.4	< 0.001
Depressive symptoms, %			
Minimal	73.1	77.7	< 0.001
Mild	16.5	14.7	
Moderate	6.2	4.8	
Moderately severe	3.1	2.0	
Severe	1.1	0.8	
Income, %			
Less than \$35,000	48.8	27.5	< 0.001
\$35,000–\$74,999	30.8	31.1	
\$75,000–\$99,999	9.5	13.2	
\$100,000+	10.9	28.3	

inactive. A greater percentage of African Americans were obese (47.3%) compared to whites (34.4%, $p < 0.001$). Race differences in depressive symptoms were observed ($p < 0.001$). More African Americans were in the mild, moderate, moderately severe and severe depressive symptoms categories. Race differences in income category were also observed ($p < 0.001$). African Americans were less likely to be in the highest income group (10.9% versus 28.3%).

Table 2 demonstrates the odds of the dependent variable, depressive symptoms, over all categories. For women, in Model 1, obesity was associated with 40% greater odds of depressive symptoms (OR = 1.40, 95% CI = 1.22–1.60). There was no race difference in odds of depressive symptoms, and compared to women with incomes < \$35,000, those with incomes \geq \$100,000 had 47% lower odds of depressive symptoms (OR = 0.53, 95% CI = 0.39–0.72). In Model 2, there was a significant interaction between obesity, race and income between \$75,000 and \$99,999 among women (OR = 0.33, 95% CI = 0.12–0.89). For men, there was no association between obesity and depressive symptoms in Model 1. African American men had 20% lower odds of depressive symptoms than white men (OR = 0.80, 95% CI = 0.67–0.96), and those with incomes \geq \$100,000 had 44% lower odds of depressive symptoms compared to men with incomes < \$35,000 (OR = 0.56, 95% CI = 0.43–0.73). Interactions between obesity, race and income among men are included in Model 2. Race interacts with income \geq \$100,000 (OR = 0.35, 95% CI = 0.13–0.98) and there was a significant interaction between obesity, race and income \geq \$100,000 among men (OR = 3.78, 95% CI = 1.01–14.17). Combining these two interaction results suggests that the interaction between race and high income on depressive symptoms is important.

The association between obesity and depressive symptoms by sex, race and income is displayed in Table 3. Among African American women, obesity was not associated with depressive symptoms at any income level. For every income level except middle-income (\$35,000–\$74,999), white women who were obese had greater odds of

depressive symptoms. Obese African American men with incomes \geq \$100,000 had more than four times the odds of depressive symptoms compared to those who were not obese (OR = 4.65, 95% CI = 1.48–14.59). There was no association between obesity and depressive symptoms among white men, except for among those with incomes between \$35,000 and \$75,000 (OR = 1.44, 95% CI = 1.02–2.03).

4. Discussion

Both obesity and depression are major risk factors for numerous poor health outcomes (Carney et al., 2002; Flegal et al., 2013). This study sought to further understand the ways in which the association between obesity and depressive symptoms differs by race through an examination of the role of income. The results suggest that race and income interact on the association between obesity and depressive symptoms. Specifically, obesity was strongly associated with depressive symptoms among the highest income African American men only. Among white women, obesity was associated with depressive symptoms at almost every income levels, and only among middle-income white men. Obesity was not associated with depressive symptoms among African American women at any income level. This work underscores the importance of disentangling the association of race and SES to gain a better understanding of the how each operates to impact health outcomes.

To the authors' knowledge, no previous studies have sought to determine racial differences in the association between obesity and depressive symptoms within income categories. However, the literature has examined race differences in the obesity-depression relationship (Carter and Assari, 2017; Gavin et al., 2010; Heo et al., 2006; Hicken et al., 2013; Lincoln et al., 2014; Mezuk et al., 2010; Polanka et al., 2017; Rosen-Reynoso et al., 2011; Schieman et al., 2007; Stecker et al., 2006). In general, studies have shown that obesity is positively associated with depression among whites, particularly among women, and not among African Americans (Carter and Assari, 2017; Gavin et al., 2010; Heo et al., 2006; Hicken et al., 2013; Lincoln et al., 2014; Mezuk et al., 2010; Polanka et al., 2017; Rosen-Reynoso et al., 2011; Schieman et al., 2007; Stecker et al., 2006). The current study found that both race and income moderate the association between obesity and depressive symptoms measured categorically. By examining African Americans at all income levels, previous studies may have overlooked demographic differences within African Americans that can lead to disparate associations between obesity and depression (Carter and Assari, 2017; Gavin et al., 2010; Heo et al., 2006; Hicken et al., 2013; Lincoln et al., 2014; Mezuk et al., 2010; Polanka et al., 2017; Rosen-Reynoso et al., 2011; Schieman et al., 2007; Stecker et al., 2006). These studies differ from the results of the current study in that obesity was associated with depressive symptoms among African American men with income \geq \$100,000. In addition to the analysis within income groups, the results of the current study may differ due to the measurement of depression. Some studies use the Center for Epidemiological Studies Depression scale (CES-D) to measure depression, while our study used the PHQ-9. The current study also measured depression in categories instead of dichotomously. These differences may be associated with discrepancies in the interrelationships between race, obesity and depression. African Americans may be less likely to be diagnosed with moderate or severe clinical depression, but may be just as likely to have mild depression or depressive symptoms (Barnes and Bates, 2017; Woodward et al., 2012). In the current study, obesity was associated with depressive symptoms among white women at most income levels, which agrees with the literature (Carter and Assari, 2017; Gavin et al., 2010; Heo et al., 2006; Hicken et al., 2013; Lincoln et al., 2014; Mezuk et al., 2010; Polanka et al., 2017; Rosen-Reynoso et al., 2011; Schieman et al., 2007; Stecker et al., 2006).

Studies have demonstrated race differences in weight misperception and other related concepts that suggest anti-obesity stigma among

Table 2
Association between obesity, race, income and depressive symptoms by sex, NHANES 2007–2014.

	Women		Men	
	Model 1	Model 2	Model 1	Model 2
	OR (95% CI)	OR (95% CI)	OR (95% CI)	OR (95% CI)
Obesity	1.40 (1.22–1.60)	1.32 (1.06–1.64)	1.19 (1.00–1.42)	1.19 (0.87–1.63)
African American	0.85 (0.72–1.01)	0.88 (0.68–1.14)	0.80 (0.67–0.96)	0.76 (0.55–1.05)
Income				
Less than \$35,000	1.00	1.00	1.00	1.00
\$35,000–\$74,999	0.80 (0.66–0.95)	0.77 (0.57–1.04)	0.70 (0.56–0.89)	0.62 (0.46–0.82)
\$75,000–\$99,999	0.67 (0.51–0.87)	0.59 (0.38–0.90)	0.63 (0.46–0.85)	0.69 (0.46–1.02)
\$100,000 or more	0.53 (0.39–0.72)	0.45 (0.31–0.64)	0.56 (0.43–0.73)	0.61 (0.42–0.90)
Obesity × African American		0.85 (0.65–1.12)		1.01 (0.62–1.63)
Obesity × income				
Less than \$35,000		1.00		1.00
\$35,000–\$74,999		1.01 (0.65–1.56)		1.26 (0.79–2.01)
\$75,000–\$99,999		1.37 (0.68–2.76)		0.80 (0.47–1.37)
\$100,000 or more		1.46 (0.90–2.38)		0.80 (0.47–1.37)
African American × income				
Less than \$35,000		1.00		1.00
\$35,000–\$74,999		1.06 (0.65–1.73)		1.44 (0.88–2.35)
\$75,000–\$99,999		1.63 (0.82–3.22)		1.23 (0.62–2.45)
\$100,000 or more		1.81 (0.83–3.92)		0.35 (0.13–0.98)
Obesity × African American × income				
Less than \$35,000		1.00		1.00
\$35,000–\$74,999		1.23 (0.69–2.18)		0.72 (0.37–1.41)
\$75,000–\$99,999		0.33 (0.12–0.89)		0.66 (0.22–1.96)
\$100,000 or more		0.52 (0.17–1.62)		3.78 (1.01–14.17)

Model 1 adjusts for age, marital status, educational attainment, insurance, fair/poor self-rated health, smoking status and physical inactivity. Model 2 additionally includes multiplicative interaction terms.

Table 3
Associations between obesity and depressive symptoms by sex, race and income, NHANES 2007–2014.

	Women	Men
	OR (95% CI)	OR (95% CI)
African American		
Less than \$35,000	1.12 (0.92–1.35)	1.20 (0.84–1.71)
\$35,000–\$74,999	1.41 (0.93–2.14)	1.17 (0.68–2.02)
\$75,000–\$99,999	0.55 (0.21–1.43)	0.58 (0.24–1.41)
\$100,000 or more	1.01 (0.29–3.55)	4.65 (1.48–14.59)
White		
Less than \$35,000	1.29 (1.04–1.60)	1.19 (0.86–1.66)
\$35,000–\$74,999	1.32 (0.92–1.89)	1.44 (1.02–2.03)
\$75,000–\$99,999	2.07 (1.09–3.95)	1.03 (0.57–1.86)
\$100,000 or more	1.87 (1.16–3.02)	1.00 (0.64–1.57)

Models adjusted for age, marital status, educational attainment, insurance, fair/poor self-rated health, smoking status and physical inactivity.

white women (Baruth et al., 2015; Capodilupo, 2015; Capodilupo and Kim, 2014; Chithambo and Huey, 2013; Dorsey et al., 2009, 2010; Duncan et al., 2011; Hendley et al., 2011; Lynch and Kane, 2014; Puhl and Heuer, 2009; Roehling et al., 2007). White women may experience mood dysregulation due to stress or anti-obesity stigma which may be associated depression. The lack of dose-response observed in these results (that is, obesity was associated with depressive symptoms at almost every income level among white women), suggests a lack of causality with regard to income, and that anti-obesity stigma may be present among white women at all income levels. Though the current study did not address the potential bi-directional relationship between obesity and depression, it is possible that depression can lead to obesity among white women.

In comparison, obesity was not associated with depression among African American women at any income level. Studies show that income is less impactful on obesity and depression among African Americans (Bell et al., 2018; Chang and Lauderdale, 2005; Hawkins

et al., 2015; Hudson et al., 2012). For white men, obesity was associated with depressive symptoms only among those with incomes between \$35,000 and \$74,999. Though anti-obesity stigma among white women may not be observed among white men, an unmeasured factor like subjective social status may potentially be associated with stress (Tang et al., 2016) for middle-income white men.

Even though there were likely small numbers of highest income African American men (n = 431), obesity was strongly positively associated with depressive symptoms in this group. African American men with incomes ≥ \$100,000 possibly experience more stress and face more discrimination due to a confluence of potentially increased racially diverse social interactions as well as racial wealth gap and other racial inequalities that may affect this group in particular (Bruce et al., 2015; Cole and Omari, 2003; Colen et al., 2018; Hudson et al., 2012; Thorpe et al., 2013; Williams et al., 2003; Williams and Wyatt, 2015). Moreover, Hudson et al. (2012) found higher SES African Americans experienced more racial discrimination as well as reporting higher odds of depression. Watkins et al. discuss psychosocial coping (e.g. mastery, emotional support, community participation, church involvement and economic disadvantage) with regard to depression among African American men (Watkins et al., 2006). For high-income African American men, economic disadvantage could play an important role in the depression-obesity association. Because of various forms of structural racism, high SES African American men have less income and wealth than their white counterparts (Williams et al., 2010; Williams et al., 2016). This may be manifested with higher rates of depression through obesity-related factors like unhealthy coping behaviors and stress (Jackson et al., 2010). For both African American men and women with incomes between \$75,000 and \$99,999, there was no association between obesity and depression. It is possible that this group may have sufficient income-related resources to combat the stress that may facilitate the relationship between obesity and depression, but do not have the potentially higher levels of stress experienced by their higher income counterparts.

The results of this study have important public health implications. Though major life-time depression is less prevalent among African

Americans (Barnes and Bates, 2017; Woodward et al., 2012), those who are obese should be screened for depression at similar rates as whites, particularly high-income African American men. Results also suggest that, for women, there is no racial difference in depressive symptoms after accounting for covariates for which there are demographic differences such as marital status, education, physical inactivity and smoking. Moreover, studies have demonstrated that African Americans may be more likely to suffer from dysthymia (Woodward et al., 2012), so health practitioners should be more diligent in screening for and treating depression among African Americans.

This study has several strengths. It used nationally representative data and combined multiple years of data. This study used the Patient Health Questionnaire-9 (Kroenke et al., 2001), so the results may not be comparable to studies that use other measures of depression. The PHQ-9 also uses relatively fewer questions to assess depression. There may also be race differences in willingness to answer questions related to depression. Obesity was measured dichotomously, but important BMI cut-points vary by race and gender, as does the association with depression (S. Assari, 2014b). The study is also limited in that there may still be comparably small numbers of higher income African Americans included in the analyses. The study is cross-sectional, so causal associations could not be detected. This study only included African Americans and whites. Results could differ with other ethnic groups. The study used 3-way interactions, which are difficult to interpret. Lastly, this study uses self-reported income which generally has some level of missingness in surveys. Income was missing for 9.4% of survey respondents.

In conclusion, this study sought to examine race differences in the associations between obesity and depressive symptoms across income categories. For white women, obesity was positively associated with depressive symptoms across income levels. However, among African American women, obesity was not associated with depressive symptoms at any income level. Obesity was associated with depressive symptoms among the highest income African American men. The results of this study demonstrate the importance of addressing mental health among African Americans. While this study was unable to empirically test proposed mechanisms, the results of this study suggest a potentially important role of chronic stress, specifically among high-income African American men. An intersectional view should be applied as the chronic stress in the pathway between obesity and depression likely varies for white women and high-income African American men. Future studies should seek to empirically examine the mechanisms by which the associations between obesity and depression vary by race and income. Studies should also examine obesity categories and the potential bi-directional nature of these relationships. The current study adds to the literature in an attempt to develop conceptual frameworks that seek a better understanding of the associations between obesity and depression.

Conflicts of interest

There are no conflicts of interest.

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