ORIGINAL RESEARCH ARTICLE

Changes in serum brain derived neurotrophic factor following high intensity interval training among obese undergraduates

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Abstract
The study examined changes in Serum Brain Derived Neurotrophic Factor (BDNF) following High Intensity Interval Training (HIIT) programme among obese undergraduates. The pretest-posttest randomized experimental design was employed for the study. The population of the study comprised one hundred and twenty (120) obese undergraduates, out of which a total of twenty-four (24) obese undergraduates made up the sample for the study. Simple random sampling technique was employed to select the participants. The anthropometric profiles of the participants were descriptively analyzed using mean and standard deviation, while independent sample t-test was used to test the hypothesis. Statistical significance was accepted at p value of <0.05. The results obtained indicated an increase in Serum BDNF (1.05 ± 1.4 vs 1.42 ± 2.2) among HIIT group, with no statistical significant difference. It was therefore concluded that the HIIT protocol-initiated alterations in the serum BDNF concentration of the obese undergraduates. HIIT may represent an effective intervention for elevating BDNF levels, as well as potentially promoting brain health. It was recommended that further research with prolonged exercise duration and larger sample size is required to elicit statistical significance, as well as to confirm the finding that increased serum BDNF levels are associated with HIIT intervention among obese undergraduate population.

Keywords: *BDNF, Obese undergraduates and HIIT*

Introduction
Obesity is a serious health issue characterized by abnormal or excessive body fat accumulation. Empirical studies conducted among university undergraduates in Nigeria reflect a high prevalence of obesity (Obirikorang, *et al.*, 2017; Chukwuonye, *et al.*, 2013). A common way of measuring and classifying obesity is to use the Body Mass Index (BMI). In general, higher BMI values leads to increased risk of health complications. Increased body mass, excess weight and abdominal obesity have been associated with cognitive impairment across the duration of life (Prickett, *et al.*, 2015). Obesity is usually linked to poor cognitive state across lifespan with decline in daily functions and health as well as decline in motor control capabilities (Gunstad, *et al.*, 2006). An

evidence by Prickett, *et al.* (2015) showed a correlation between obesity and impaired brain functions, as well as obesity-related changes in brain plasticity. In an attempt to resolve this claim, Cherif, *et al.* (2016) asserted that exercises geared towards weight loss may improve cognitive functions. Although, the underlying mechanism which is biological in nature, as postulated from Cherif, *et al.* (2016) report is yet to be unraveled.

Growing evidence exist that Brain Derived Neurotrophic Factor (BDNF) is actively involved in facilitating the benefits of exercise on cognitive functions as well as mediating decreased food intake (Szuhany, *et al.,* 2015). BDNF is a protein grouped among the neurotrophin class. BDNF has expression in Central Nervous System (CNS) repair, as well as plasticity and linking of synapses. Furthermore, loss-of-function mutations in the BDNF receptor may lead to neurodegenerative disorders, depression, and obesity (Szuhany, *et al.,* 2015). Obesity-related health conditions including cognitive function may be moderated by physical activity. Physical exercise is a sub-class of the physical-activity domain. Physical exercises elicit impact on the brain anatomy and function in humans (Alberto, *et al,* 2018). During high intensity exercise (above 80% $MaxVO_2$), an increased neurotrophic factor was observed (Marston, et al., 2017).

High Intensity Interval Training (HIIT) is characterized by sessions of intermittent, relatively brief bursts of vigorous activity with intensity of above or equal to 85% Peak Oxygen Uptake (VO_2peak), intermixed by low intensity exercise or rest-phases for recovery. HIIT session takes 45 minutes with warm up and relaxation phases. The training bouts are usually executed at optimal effort with intensities at 80 to 100% of maximal heart rate (Saanijoki, *et al.,* 2018). The exertion is performed with a duration not longer than 60 seconds with recovery periods (rest or low-intensity exercise) of up to 4minutes.

Besides the protocol of Gibala (2015), several researchers have presented divergent high and low exercise bout durations (Stoggl & Bjorklund, 2017). Although, a duration of 30 minutes and above may be considered appropriate. HIIT can be performed while running, swimming, on cyclical exercises, and whole-body exercise (Schleppenbach, *et al.*, 2017). Connolly, *et al.* (2017) asserted that HIIT improves human physical performance. The attendant impact of HIIT on human brain-function exist; although, the available evidence appears to be scarce. Short-term HIIT has been shown to elicit improvements in intense exercise performance, and appear to be beneficial as an addition to an already high training volume (Chin, *et al.*, 2019). Marquez, *et al.* (2015) further opined that short bouts of HIIT are slightly more potent when compared to continuous HIIT in elevating serum BDNF. In contrast, the study conducted by Zhang, *et al.* (2015); and Nazari, *et al.* (2016) revealed that long term/chronic effect of 12-week HIIT protocol potentiated a significant increase in serum BDNF and anthropometric parameters, respectively. In this study, an acute bout/short term HIIT programme was adopted.

In light of the above, this study examined changes in the serum BNDF following High Intensity Interval Training (HIIT) among obese undergraduates of the University of Benin.

Hypothesis

An hypothesis was formulated to guide the study.

- There will be no significant difference in the Serum BDNF concentration of obese undergraduates following HIIT programme in the experimental and control groups.

Methodology

This study adopted the pretest-posttest randomized experimental design. A sample size of twenty-four (24) from a population of one hundred and twenty (120) obese undergraduates of the

University of Benin in the 2019/2020 academic session were selected. The cohort belonged to an Obesity Fitness Group (OFG), which regularly participate in exercise sessions at the University of Benin. The selected sample constituted 20% of the total population. The inclusion criteria for the study involved participants without any form of visible disability. An exclusion criterion of participants below the BMI categorization of 30 kg/m^2 was adhered strictly. The selection was through a simple random sampling technique. The sampled participants were then randomly assigned to the experimental and control groups. This involved serializing the 24 selected obese students and respectively assigning numbers to the participants and selecting the even numbers to the experimental and the odd numbers to the control group. This yielded 12 obese undergraduates in each of experimental and control group.

An ethical approval was obtained from the Ethics Board of University of Benin, Benin-City, Nigeria.

Anthropometric Measurements

The subjects were briefed on the study's objectives and familiarized with the anthropometric assessments and equipment. Data were collected by conducting pre-test measurements of anthropometric parameters before the commencement of the High Intensity Interval Training (HIIT) programme, which was in an acute form. Post-test measurements were conducted immediately after the intervention duration has elapsed using the same procedures.

Specifically, the participants' heights were measured while standing with bare foot using a calibrated stadiometer. The subject's percentage body fat and body weight indices were estimated using an Omron Body Composition Monitor (Omron Healthcare, 2019), wearing minimal clothing. Internal consistency type of reliability was adopted in the present study. A pilot study was carried out to confirm the suitability of the HIIT protocol and instrument, to which eight (8) independent subjects were selected, with four (4) each per group. The multilevel modeling method was adopted in obtaining the data that was subjected to Interclass Correlation Coefficient (ICC). A Correlation Coefficient of 0.75 was obtained and considered a high reliability. Hence, this justified the aptness of employing the instrument and protocol for this study.

Biochemical Analysis

The procedure for obtaining blood sample was in accordance with WHO (2010) standard. Blood sampling was obtained twice, pre-training and immediately after the acute training. Blood sampling were obtained from the antecubital veins of the overnight-fasting subjects by a medical laboratory scientist, with participants sitting on a chair for 15 minutes. Blood samples were stored for one hour at room temperature to allow blood-clotting. The blood sample was centrifuged and expressed serums left at -80°C pending final measurements. BDNF concentrations were measured using Enzyme-linked-immunosorbent assay (ELISA) kit (Eastbiopharm, Hangzhou Co. Ltd, China).

Training Protocol

The Experimental group was exposed to the HIIT protocol. The HIIT protocol involve performing 10-minute warm up session that included jogging, stretching, and running for a 5-minute 50% to 85% of maximum heart rate (training started with 50% of intensity) at commencement of each session. Then, participants performed 20-minute strength training for large muscles of the upper and lower body, which included windmills, burpees, sit-ups, heel raise, side jumps, alternate lateral tilting and alternate leg-arm kicking at 50% to 80% of one repetition maximum (training commenced with 50% of intensity and increased steadily). Three (3) sets of 10 repetitions (with 1-minute rest interval between sets and 2-minute rest interval between exercises) were performed.

Training sessions were concluded using a 10-minute cooling-down session by slow walk. It has been demonstrated that this type of exercise protocol corresponded to acute HIIT (Nazari, et al., 2016). The recommended protocol of High Intensity Interval Training (HIIT) was validated by Machado, et al. (2017). The control group participants were not subjected to the High Intensity Interval Training (HIIT) protocol, rather each of the exercises for the experimental group was also executed by the control group, although without applying the necessary increment or overload. This means that the tempo or intensity with which they started was the same till the end of the training programme.

Statistical Analysis

Statistical Package for Social Sciences (SPSS) – IBM version 20, was employed to analyze the data. Descriptive statistics of mean and standard deviation was employed to describe the anthropometric and BDNF profile of the sample collected. The formulated hypothesis was tested using inferential statistics of independent sample t-test to determine the differences between the intervention and control groups. The alpha level was set at 0.05 level of significance.

Results

Table 1: Physical and Anthropometric Characteristics of the Subjects (n=24)

Variable	Measuring	Group: Control (n=12)	Group: Experimental (n=12)
Age (yrs)	Pre-training	26.3 ± 9.4	27.5 ± 4.1
Height (cm)	Pre-training	1.69 ± 0.1	1.74 ± 0.1
Weight (kg)	Pre-training	86.4 ± 9.4	92.0 ± 8.2
	Post-training (Acute)	86.2 ± 9.2	91.5 ± 8.6
BMI (kg/m^2)	Pre-training	30.6 ± 4.5	30.3 ± 3.0
	Post-training (Acute)	30.6 ± 4.2	29.9 ± 3.1
Body Fat (%)	Pre-training	39.6 ± 10.6	37.5 ± 10.8
	Post-training (Acute)	38.8 ±11.4	37.9 ± 10.5

**** BMI – Body Mass Index, Values expressed as Mean ± SD***

Table 1 presents means and standard deviations of physical and anthropometric characteristics (age, height, body mass index, body fat percentage) of participants in the experimental and control groups.

Table 2: Descriptive Statistics Showing the Serum BDNF concentration of the experimental and control participants

Variable	Experimental		Control	
	Pre	Post	Pre	Post
BDNF (ng/ml)	1.05 ± 1.4	1.42 ± 2.2	2.50 ± 3.1	2.68 ± 3.2

**** BDNF – Brain Derived Neurotrophic Factor.***

Values expressed as Mean ± SD

Table 2 reflects an increase in Serum BDNF with a mean and standard deviation of 1.05 ± 1.4 and 1.42 ± 2.2 were observed at posttest assessment in the experimental group when the pretest and posttest assessments are compared. Similarly, among the control group, a slight increase in Serum BDNF with a mean and standard deviation of 2.50 ± 3.1 and 2.68 ± 3.2 were indicated at posttest assessment when compared with pretest assessment respectively. In order to ascertain if the increased difference is significant or not, the need to test the hypothesis became necessary.

Table 3: Independent Samples t-test of the Experimental and Control Groups

Variables		Levene's Test for Equality of Variances		t-test for Equality of Means						
		F	Sig.	t	Df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
									Lower	Upper
Serum BDNF	Equal variances assumed	6.323	.020	1.108	22	.280	1.26667	1.1434	-1.1047	3.6380
	Equal variances not assumed			1.108	19.457	.281	1.26667	1.1434	-1.1228	3.6561

**** No significant difference (p<0.05) between the control and experimental group***

From Table 3, differences in the serum BDNF prior to and following an acute HIIT programme was determined using an Independent Sample t-test. No significant difference in the control and intervention groups with mean scores of serum BDNF indicating [t(22)=1.108, p=0.280]. Thus, the hypothesis which states that there is no significant change in the BDNF levels of the experimental and control obese undergraduates following HIIT programme was accepted. It therefore implies that HIIT had no substantial effect on the BDNF levels of the University of Benin obese undergraduates.

Discussion

This study evaluated changes in BDNF concentration following HIIT protocol among obese undergraduates. The outcome of this study indicated an increase in the serum BDNF concentration following an HIIT intervention among the obese undergraduates. However, the observed increase was not statistically significant. This finding is in agreement with the submissions of Nazari, et al. (2016); Saucedo Marquez, et al. (2015), which reported heightened serum BDNF concentration of the participants. The increase in the BDNF concentration after the acute HIIT programme could be attributed to its stimulated secretion from several tissues (muscles and brain). This could be slightly different from chronic training, which could be attributed to increased gene expression and activation of transcription-pathways. Wrann, et al. (2013) posited that musculo-skeletal contractions during HIIT programme can be a possible initiator of the biochemical processes that cause heightened BDNF concentration in the brain. The extent of physical exertion during an intervention phase may be potent in altering BDNF concentration. Varying exercise types and intensities may also affect BDNF responses.

In contrast to this finding, the study by Mehrjardi (2017) and Kim (2016) reported a significant decline in serum BDNF concentration. This discrepancy in findings are not far-fetched as a different sample involving athletes was studied, and among the same cohort, previous studies have showed that basal BDNF in sport persons was reduced by habitual exercising (Nofuji, et al., 2008; Babaei, et al., 2014). Another reason for this discrepancy in findings could be that about storage of 90% of blood BDNF proteins occurs in the platelets, with platelet-activation facilitating its secretion or released during clotting process (Kim, 2016). Exercise induces mechanical and functional stress, leading to nerve injury and muscle damage (Kuipers, 1994). Athletes participate in series of elevated intensity exercises which may lead to tissue damage tissue, and continuous repair is required. BDNF is active in repair process and injury recovery (Kim, 2016). The findings of Kim (2016) further reflected chances that BDNF release from platelets to injured tissues elevates in order to facilitate repair process, which in turn decreases BDNF stored in platelets. The decrease in serum BDNF may also be attributed to the type of training protocols involving regular taekwondo exercises. Timing and varying blood sampling methods may have also contributed to the discrepancies.

Interestingly, despite an increased serum BDNF from both the control and experimental group in this study, it is worth noting that the observed increase was higher for participants exposed to the HIIT intervention, suggesting that the HIIT programme may be an effective means of promoting brain health.

The result of an independent sample t-test resulted to acceptance of the null hypothesis of no significant alteration in the serum concentration of the obese undergraduates following a single exercise bout of HIIT programme. The implication is that the HIIT programme administered had no substantial effect on the participants' serum BDNF.

Conclusion

Based on the findings of this study, the following conclusions were made:

- HIIT protocol initiated an increase in the serum BDNF concentration of the obese undergraduates.
- HIIT protocol did not elicit any significant change in the serum BDNF level of the obese undergraduates.
- The advantageous effect of HIIT may be observed almost immediately, as single session of training rapidly improves cognitive function.

Recommendations

Based on the findings, the following recommendations were made:

- Further research with prolonged exercise duration and larger sample size is essential to elicit statistical significance, as well as to confirm the finding that increased serum BDNF levels are associated with HIIT intervention among university obese population.
- Obese students should be sensitized to the various benefits of HIIT programme as they relate to the general health and well-being of individuals.
- Coaches and personal trainers should attend courses or seminars, where they can learn more on how to incorporate HIIT programme into their training regimen in eliciting increase in serum BDNF.

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