ORIGINAL ARTICLE

Effect of intermittent fasting on cardiovascular parameters of young adult offspring of hypertensive parents

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ABSTRACT

Background: Offspring of hypertensive parents have been reported to have alteration on their sympathovagal balance and have exaggerated response to stressful conditions. Many Christians observe a period of fasting at the beginning of every year, which imposes some stress on their bodies. **Objective:** This study aims to investigate the effect of 21-day intermittent fasting on some cardiovascular parameters in offspring of hypertensive and normotensive parents. **Materials and Methods:** Eighty young adults (20–28 years) were divided into equal number of male and female offspring of hypertensive and normotensive parents based on questionnaire. Their body weight, height, waist circumference (WC), body mass index (BMI), systolic blood pressure (SBP), diastolic blood pressure (DBP), and heart rate (HR) were recorded 1 week before the fasting period began and then weekly for 3 weeks, in which they fasted. **Results:** The weight, BMI, and WC reduced during fasting, but the reductions were not significant ($P > 0.05$). The SBP and DBP were higher in male offspring of hypertensive parents than all other groups. SBP was also significantly ($P < 0.05$) higher in males than females before fast and during fast. Fasting significantly reduced the SBP in the male offspring of both hypertensive and normotensive parents. The HR reduced in the females during fast but increased from a lower level in males to a value not significantly different from prefasting level. **Conclusion:** Fasting reduces the high SBP and DBP in male offspring of hypertensive parents, which is beneficial to their cardiovascular system.

Keywords: Blood pressure, fasting, heart rate, hypertensive, offspring

INTRODUCTION

Hypertension runs in families, and parental history of hypertension has been found to increase the risk of developing hypertension later in life, if both parents are hypertensives.[1] Offspring of hypertensive parents have been shown to exhibit 30%–50% higher risk of developing hypertension.[2,3] They also have an increased risk of obesity or metabolic syndrome.[4,5] Furthermore, normotensive offspring of hypertensive parents have been reported to have an exaggerated cardiovascular response to exercise, physiologic maneuvers, and stress when compared to offspring of normotensive parents.[6-9] Offspring of hypertensive parents may have different genes for blood pressure regulation that interacts with environmental factors,

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stress, and salt, resulting in high blood pressure.[10-12] Thus, the development of hypertension may occur early, depending on the intensity and frequency of interaction with stressful environmental factors.[10,12]

Fasting is practiced by different religious groups.[13,14] Differences, however, exist in the period of abstinence from food. It is well known that long-term intermittent and periodic fasting promotes health and reduces the risk of many chronic diseases such as cancer, neurodegenerative diseases, metabolic syndrome, and hypertension.[14] In both human and animal studies, fasting has been shown to reduce the systolic blood pressure (SBP) and diastolic blood pressure (DBP) as well as the heart rate (HR).[15,16]

While fasting has been shown to be beneficial to the cardiovascular system, it is noteworthy to say that fasting imposes some stress on the body.[14,17] The previous study showed that offspring of hypertensive parents exhibited exaggerated response to stress;[18,19] it is, however, not known if fasting exerts more stress on their body system than children of normotensive parents. It is also important to know if fasting is harmful or beneficial to the cardiovascular system of offspring of hypertensive parents.

Many Christians observe several days of fasting at the beginning of the year and many go as long as 40 days of intermittent fasting and majority of persons observe 16 h fast and then an 8-h nutritional window. This research therefore aims to investigate the cardiovascular effects of 21 days of fasting in offspring of hypertensive and normotensive parents. We intend to study how the beneficial effect of fasting will relate with the stress it exerts on the body system.

MATERIALS AND METHODS

Participants

The study was carried out in Makurdi town of Benue State, Nigeria. Participants were obtained from persons that engaged in routine Christian religious 21 days fast by January 2020 and observed a daily 18 h fast and then and 6-h nutritional window (fasted from 12.00 am to 6.00 pm and ate 6.01 pm to 11.59 pm); they were in no wise forced to fast. The purpose of the study was explained to them and willing and written consent was obtained before the study. A total of eighty healthy young adults within the age group of 20–28 year were randomly recruited for the study. They were divided into two groups (each group consisted of 40 subjects) based on history of hypertension in their parents. The participants having parental history of hypertension in at least one parent were taken as the study group. Those having both normotensive parents were taken as control for comparison. Each group above was further divided into two equal groups based on gender.

The purpose of the study was explained to the participants; they were then instructed to fill up a questionnaire giving details regarding parental history of hypertension. Accordingly, they were divided into study and control groups. All the data were collected between 12.00 pm and 2.00 pm daily.

This study was conducted according to the guidelines laid down in the Declaration of Helsinki, and all procedures involving human subjects were approved by the Health Research Ethics Committee of Benue State University Teaching Hospital, Makurdi on January 2, 2020 (HREC NO: BSUTH/MKD/HREC/2020/023). Written informed consent was obtained from all subjects. This study was conducted in the month of January 2020 and all subjects engaged in 21 days of fasting (16-h fast and then an 8-h nutritional window).

Anthropometric measurements

Participants' physical characteristics were measured once every week for 3 weeks using standard procedures as previously described by Musa *et al*.[20] The weight was measured using electronic weighing scale (Seca digital floor scale, Sec-800; Seca, Birmingham, UK), height was measured using a wall-mounted stadiometer (Model Sec-206; Seca, UK). The height was measured to the nearest 0.1 cm, without shoes, with the subject stretching to the maximum height and the head positioned in the Frankfort plane. Weight was measured to the nearest 0.1 kg with subjects removing shoes and in light clothing. Waist circumference (WC) was measured at the mid-point between the lower rib and the upper margin of the iliac crest in a horizontal plane using an inelastic tape rule measured to the nearest 0.1 cm. Participants' body mass index (BMI) was calculated as: BMI = weight (kg)/height (m^2).

Measurement of cardiovascular parameters

Cardiovascular parameters were also obtained once every week for 3 weeks along with the anthropometric parameters. Resting HR was determined manually by counting the pulse rate of the radial artery using a stop watch for 1 min. The SBP and DBP were measured using a mercury sphygmomanometer (Accoson/BS 2744/England).

Inclusion criteria

1. Healthy asymptomatic young adults, aged 20–28 years (males and females)[21]
2. Nonsmokers.

Exclusion criteria

1. Any acute illness
2. Diabetes mellitus
3. Antihypertensive medication
4. History of chest pain, breathlessness, and orthopnea
5. Handicapped individuals
6. Trained subjects (sports and yoga).

Statistical analysis

Results were reported as mean ± standard error of mean differences between groups were determined using two-way repeated measure analysis of variance with least significant difference *post hoc* test. Analysis was done using IBM SPSS Statistics for Windows, version 21 (IBM Corp., Armonk, N.Y., USA). Difference was considered significant when $P < 0.05$.

RESULTS

Effect of fasting on anthropometric parameters

The average age of the participants was 23.20 ± 1.83 years, and their age distribution is shown in Table 1. The heights also ranged from 1.5 m to 1.9 m [Table 1].

Results showed that there were reductions in the average weight and BMI of persons in the four groups from week 1 of fast to week 3 relative to the values before fasting began, these reductions were however not significant ($P > 0.05$). There was also no significant ($P > 0.05$) sex difference in the values for the weight and BMI of the participants as shown in Table 1.

There was a reduction in the WC of participants in all the groups during the fasting period relative to the values before fasting began, though the differences were not significant ($P > 0.05$). The WC of male offspring of normotensive parents was however significantly higher ($P < 0.05$) than male offspring of hypertensive parents before fasting began [Table 1].

Effect of fasting on blood pressure and heart rate

Result showed that the SBP was significantly ($P < 0.05$) higher in the males than females irrespective of the blood pressure of their parents. The SBP of male offspring of hypertensive parents was however the highest before fasting and throughout the fasting period. There was a significant ($P < 0.05$) reduction in the SBP during fasting in the male participants. The reduction in SBP was more in male offspring of hypertensive parents, because the decrease was significant ($P < 0.05$) even from the 2nd week of the fast, while it became significant in offspring of normotensive parents by the 3rd week [Table 2]. Furthermore, the SBP of male offspring from either hypertensive or normotensive parents was not significantly different before fast and throughout the 3 weeks of fast. There was no significant ($P > 0.05$) difference or reduction in SBP before fast and during fasting in females from either hypertensive or normotensive parents. The female SBP was also not significantly different ($P > 0.05$) as shown in Table 2.

The DBP was significantly higher ($P < 0.05$) in male offspring of hypertensive parents than all other groups before fast and during fasting period. There was a reduction in the DBP during fast in male offspring of hypertensive parents, when compared to the prefasting DBP, but the difference was not significant. There was also no significant ($P > 0.05$) difference in the DBP before fast and during fast in the other groups as shown in Table 2.

One week before fast began, the HR of female offspring of hypertensive parents was significantly higher than all other groups. The HR significantly ($P < 0.05$) reduced in the females from week 1 of fast through to week 3. In the males (both offspring of hypertensive and normotensive parents), the HR significantly reduced by week 1 of fasting, but increased by week 2 and week 3, such that by week 3, the HR is not significantly different from the value before fasting began and not significantly different from the value in the females [Table 2].

DISCUSSION

The result of this study showed that there was a reduction in the body weight and BMI as a result of the 3 weeks fast, but these reductions were not significant. This is in line with the observed reduction in weight during fast, as many persons fast to achieve weight reduction.[13,14,17] Similar studies during Ramadan fast among Muslims reported a significant reduction in weight and BMI due to fasting,[22,23] while some others report no significant changes in body weight and BMI during same Ramadan fast.[24-26] In this study, there were also no significant changes in the WC between the prefast and fasting period.

The SBP was significantly higher in the male subjects than in female subjects and was highest in male offspring

Table 1: Effect of fasting on anthropometric parameters

Variables	Period	Offspring of hypertensive parents (*n*=20)		Offspring of normotensive parents (*n*=20)	
		Male	Female	Male	Female
Age (years)		24.45±0.27	22.75±0.28*	23.70±0.47	21.90±0.37*
Height (m)		1.68±0.02†	1.65±0.02†	1.73±0.02	1.61±0.01†
Weight (kg)	Before fast	65.74±1.19	63.53±2.14	65.85±2.65	61.35±1.98
	Week 1	65.65±1.23	63.40±1.99	64.94±2.81	60.43±2.11
	Week 2	65.20±1.18	62.25±2.05	64.45±2.79	59.55±2.02
	Week 3	64.73±1.18	61.65±2.32	64.53±2.79	58.90±2.06
BMI (kg/m^2)	Before fast	23.37±0.62	23.47±0.78	21.86±0.88	23.57±0.71
	Week 1	23.31±0.56	23.42±0.74	21.63±0.87	23.19±0.73
	Week 2	23.15±0.54	23.04±0.76	21.41±0.87	22.87±0.71
	Week 3	22.99±0.58	22.78±0.86	21.44±0.88	22.62±0.73
WC (cm)	Before fast	72.70±1.02†	75.80±1.59	76.75±1.65	75.80±1.44
	Week 1	73.65±0.93	75.80±1.41	76.35±1.53	75.15±1.45
	Week 2	72.45±1.04	75.25±1.40	75.80±1.56	74.70±1.43
	Week 3	71.95±1.02	75.00±1.42	75.35±1.69	74.05±1.54

Data presented as mean±SEM. *Significantly different from male offspring of hypertensive parents with $P<0.05$; †Significantly different from male offspring of normotensive parents with $P<0.05$. BMI: Body mass index; WC: Waist circumference; SEM: Standard error of mean

Table 2: Effect of fasting on blood pressure and heart rate

Variable	Period	Offspring of hypertensive parents (*n*=20)		Offspring of normotensive parents (*n*=20)	
		Male	Female	Male	Female
SBP (mmHg)	Before fast	125.20±2.04	113.80±1.59*,†	120.65±2.14	112.85±1.15*,†
	Week 1	122.20±1.64	113.40±1.80*,†	116.30±1.85	110.45±1.22*,†
	Week 2	119.15±1.98‡	112.40±1.53*,†	116.10±2.03	110.20±0.95*,†
	Week 3	117.70±1.83‡	113.40±1.37*,†	115.60±2.04‡	110.25±1.24*,†
DBP (mmHg)	Before fast	78.50±1.24	73.90±1.60*	73.55±1.55*	71.80±1.14*
	Week 1	77.40±1.09	73.65±1.36*	71.90±1.52*	72.70±1.51*
	Week 2	77.40±1.71	73.40±1.04*	72.80±1.38*	70.50±1.41*
	Week 3	75.60±1.48	75.45±1.24	72.80±1.79*	70.60±1.21*
HR (beats/min)	Before fast	77.10±2.49	86.50±1.78*,†	80.10±2.22	81.55±1.77
	Week 1	70.70±2.31‡	81.00±1.84*,†,‡	74.00±2.26‡	79.00±2.57*,†
	Week 2	74.85±1.60‡	78.40±1.25‡	74.15±1.81‡	76.80±1.52‡
	Week 3	78.75±1.68	78.90±1.80‡	78.25±1.76	76.60±1.92‡

Data presented as mean±SEM. *Significantly different from male offspring of hypertensive parents with $P<0.05$; †Significantly different from male offspring of normotensive parents with $P<0.05$; ‡Significantly different from value before fast with $P<0.05$. SBP: Systolic blood pressure; DBP: Diastolic blood pressure; HR: Heart rate; SEM: Standard error of mean

of hypertensive parents throughout the period of study, similar to the finding of Uehara *et al*.[11] This higher value of SBP in male offspring of hypertensive parents may indicate exaggerated sympathetic activity in this group as previously described.[9,26,27] This highlights the potential role of the sympathetic nervous system in the pathogenesis of elevated blood pressure in offspring of hypertensive parents. Other studies found increased sympathetic and decreased parasympathetic activities in this group of young adults and suggested that the alteration in the sympathovagal balance could be the major mechanism in the causation of prehypertension.[7,28]

This study further revealed that fasting, which is considered a form of stress significantly reduced the SBP in male participants, there was also no significant reduction in the SBP of the females when compared with the values before fasting began in these young adults. Thus, fasting did not aggravate the values of the SBP in offspring of hypertensive parents, it rather reduced it. This agrees with previous studies that reported that fasting confers beneficial effects on the cardiovascular system.[23,29] Toledo *et al*. likewise found a significantly reduced SBP after 21 days fast, but the age of the participants in their study was 18–99 years, and they did not investigate changes due to gender.[16] This present research however focused on only young adults.

The lower SBP in females than males in this study is in line with studies that reported less cardiovascular risks and differences in the mortality rate in females, when compared with males at premenopausal age. The studies showed that more men die before age 60 than female and the difference is related to the cardioprotective effect of estrogen in women before menopause.[11,29,30]

The DBP is significantly higher in male offspring of hypertensive parents than all other groups. The DBP, however, reduced in these groups of males during fast,

but the differences were not significantly different. The pattern of result for DBP is different from that of SBP, where the values were higher in male offspring of both hypertensive parents and normotensive parents than in females. The nonsignificant change in DBP also reported by Nematy *et al*.[23] The mechanism of the drop in SBP may be associated with an increase in parasympathetic activity due to increase brain-derived neurotrophic factor, increased norepinephrine excretion through the kidneys, and increased sensitivity of natriuretic peptides and insulin.[16]

Result also showed that fasting reduced the HR in the females from the pre-fasting level till the week 3 of the fast. HR was also lower in males by week 1 of fasting relative to the prefast value. The HR in male, however, increased by the 3rd week of fast to a value that is not significantly different from the prefasting value. The reduction in HR during fast is in agreement with previous reports, and this may be as a result of increased activity of the parasympathetic nervous system.[31,32,33,34]

Other studies however observed an increase in HR during fast and have attributed this increase to probable differences in the duration of fasting.[35] The response of male offspring of hypertensive parents is, however, different; values started from lower values and increased significantly by the 3rd week of fasting to a value not significantly different from that before fasting. The increase in HR in the males might be due to an increase in sympathetic nerve activity that overrode the parasympathetic nerve activity as previously reported.[7,28]

CONCLUSION

This study shows that SBP was significantly higher in males than females before and during fast. The SBP was higher in male offspring of hypertensive parents than other groups prefast and during fasting. Their SBP and DBP, however, reduced the during 21-day fasting period. Thus, with regard to the blood pressure, fasting is beneficial to offspring of hypertensive parents.

Limitation of the study

A lot of time was required to convince and get the consent of participants. Furthermore, many persons were smokers and so did not meet inclusion criteria; therefore, we needed to speak with so many people in order to get the required sample size for the study.

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Nil.

Conflicts of interest

There are no conflicts of interest.

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