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Original Research Paper

Possible Impact of Depression on Lipid Profile Indices and Intestinal Fatty Acid Binding Proteins in Newly Diagnosed Hypertensive Individuals in NAUTH, Nnewi, Nigeria

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ABSTRACT:

Background: Depression and hypertension are significant global health concerns, both of which have been implicated in metabolic disorders, including dyslipidemia. This study investigates the potential impact of depression on intestinal fatty acid-binding proteins (I-FABP) and lipid profile indices in newly diagonised hypertensive individuals in Nnamdi Azikiwe University Teaching Hospital (NAUTH), Nnewi, Nigeria. **Materials and Methods**: A total of 121 participants were categorized into four groups: hypertensive individuals with depression (Group A, n=30), hypertensive individuals without depression (Group B, n=31), non-hypertensive depressive individuals (Group C, n=30), and healthy controls (Group D, n=30). Anthropometric measurements and biochemical assays were conducted to evaluate lipid profile indices and I-FABP levels using enzymatic colorimetric and enzyme-linked immunosorbent assay (ELISA) methods. **Results**: The results revealed significantly higher systolic blood pressure (SBP), diastolic blood pressure and Body mass index (BMI) in hypertensive with and without depression compared to depressive and control paticipants ($p<0.05$ respectively). Total cholesterol (TC), Triglycerides (TG) and Low-density lipoprotein (LDL) were significantly increased while high density lipoprotein cholesterol was significantly higher in hypertersive with and without depression compared to control participants ($p<0.05$ respectively). Intestinal fatty acid-binding protein (I-FABP) was significantly higher in depressive individuals compared to both hypertensive individuals and controls ($p=0.001$ respectively). **Conclusion**: the significantly altered lipid function indices and intestinal fatty acid-binding proteins (I-FABP) observed may contribute to cardiovascular and gastrointestinal complications in these populations.

Keywords: Hypertension, Depression, Intestinal Fatty Acid Binding Proteins, Dyslipidemia Nigeria

INTRODUCTION:

Depression is a multifaceted mental disorder characterized by persistent sadness, loss of interest in pleasurable activities, cognitive impairments, and physical symptoms such as fatigue and sleep disturbances. It affects millions worldwide and is commonly associated with chronic conditions such as hypertension, diabetes, and cardiovascular diseases. The co-occurrence of depression and hypertension is of particular concern due to their shared biological pathways and bidirectional influence (Luppino *et al*., 2010). Depression in hypertensive individuals is linked to poor health outcomes, including reduced adherence to medications, increased inflammation, and alterations in lipid metabolism (Sullivan *et al*., 2018).

Hypertension and depression have been associated with altered metabolic and inflammatory pathways (Brown *et al*., 2021). These conditions often coexist and exacerbate each other, leading to increased morbidity and mortality rates. Depression is a serious mental illness affecting millions worldwide, often coexisting with chronic conditions such as hypertension (Luppino *et al*., 2010). The prevalence of depression in individuals with chronic illnesses such as hypertension is notably high, as both conditions share common pathophysiological pathways, including dysregulation of the hypothalamic-pituitary-adrenal

(HPA) axis, inflammation, and oxidative stress (Lichtman *et al*., 2008; Ukibe *et al*., 2025). Hypertension and depression are leading contributors to global disease burden, often manifesting with overlapping metabolic disturbances (Brown *et al*., 2021). While hypertension is primarily characterized by persistent elevation in blood pressure and vascular dysfunction, depression is linked to chronic stress, inflammatory responses, and dysregulation of neurohormonal pathways (Williams & Kumar, 2020). Metabolic dysregulation, particularly lipid profile abnormalities, has been observed in individuals with depression. Previous studies have reported elevated levels of total cholesterol (TC), triglycerides (TG), and low-density lipoprotein cholesterol (LDL-C), along with reduced high-density lipoprotein cholesterol (HDL-C) levels in depressed individuals. These lipid disturbances may further exacerbate cardiovascular risk in hypertensive patients (Bowman and Funderburg, 2019). Emerging evidence suggests that depression influences lipid metabolism, leading to an increased risk of cardiovascular diseases (Sullivan *et al*., 2018).

The complex interplay between hypertension, depression, and lipid metabolism remains an area of active research, particularly concerning their effects on intestinal fatty acid-binding proteins (I-FABP), which are critical markers of intestinal integrity and lipid transport. The Changes in lipid metabolism and intestinal fatty acid-binding proteins (I-FABP) may contribute to cardiovascular and gastrointestinal complications in these populations (Williams & Kumar, 2020). Emerging evidence suggests that both conditions impact lipid metabolism, contributing to dyslipidemia, which increases the risk of cardiovascular diseases and metabolic disorders (Anderson *et al*., 2018). Additionally, alterations in I-FABPs, which play a crucial role in intestinal lipid absorption and transport, may be associated with depression. Disruptions in I-FABPs can reflect compromised intestinal integrity, increased gut permeability, and systemic inflammation, further linking depression to metabolic disorders (Tomas *et al*., 2019).

Intestinal fatty acid-binding proteins (I-FABP) play a crucial role in lipid absorption and transport, and altered levels have been implicated in conditions such as metabolic syndrome and gastrointestinal dysfunction (Gaffar and Aathirah, 2023). Intestinal Fatty Acid-Binding Protein (I-FABP) is a biomarker associated with intestinal epithelial cell damage. It is a small cytoplasmic protein primarily found in enterocytes lining the small intestine. I-FABP plays a crucial role in fatty acid transport within these cells (Blaser *et al.,* 2019). A study by Thuijls *et al*. (2011), "Early diagnosis of intestinal ischemia using urinary and plasma fatty acid binding proteins," investigated the utility of I-FABP in the early detection of intestinal ischemia. Elevated levels of I-FABP in plasma and urine were identified as promising markers for diagnosing this condition. Another study by Schurink *et al.* (2015), "Intestinal fatty acid-binding protein as a diagnostic marker for complicated and uncomplicated bowel obstruction," explored the diagnostic potential of I-FABP in differentiating between complicated and uncomplicated bowel obstruction highlighting the significance of I-FABP as a sensitive indicator of intestinal damage. Given the increasing prevalence of hypertension and depression in Nigeria, especially in the study area (Anderson *et al*., 2018; Ukibe *et al*., 2024), there is an urgent need to explore their combined effects on lipid metabolism and intestinal health.

MATERIALS AND METHODS:

Study Site:

This cross-sectional study involved newly diagnosed hypertensive individuals attending outpatient clinic at internal medicine unit at Nnamdi Azikiwe University Teaching Hospital (NAUTH), Nnewi, Anambra State, Nigeria.

Study Design and population:

A cross sectional study was conducted to evaluate the serum lipid profile and I-FABP level in hypertensive individuals with and without clinical depressive disorders in the department of internal medicine at Nnamdi Azikiwe University Teaching Hospital (NAUTH), Nnewi, Anambra State, Nigeria. Apparently healthy individuals were recruited among the hospital staff as control. Participants within the ages of 18-65 years were recruited. Informed consent was obtained from each of the participants and patients request form and record was used to obtain their bio-data, height, weight, blood pressure. A total number of 121 participants were recruited for the study which comprises 31 hypertensive patients without depression, 30 hypertensive patients with depression, 30 depressive participants and 30 apparently healthy individuals who served as control.

Inclusion and Exclusion Criteria:

Hypertensive individuals within the ages of 18-65 years with and without clinical depressive disorders were selected for the study. Age matched control participants without depression or hypertension. Control participants with hypertension and depression were excluded. participants that are not within the required age bracket and depressed participants taking antidepressants drugs were also excluded from the study.

Informed Consent:

Consents of the participants were sought and obtained before sample collection.

Ethical Approval:
The ethical approval for the research was obtained from the board of ethics committee of Nnamdi Azikiwe University Teaching Hospital (NAUTH) Nnewi, Nigeria.

Sample Collection:
Three ml (3ml) of venous blood was collected from the subjects and the blood was dispensed into a plain container and allowed to clot, then centrifuged at 4000 rpm for 10 minutes then the serum was extracted into another plain container which was accurately labelled with the participants accurate details and the samples were transported to the laboratory for analysis.

Assay Methodologies:

Screening for Clinical Depressive Disorder:
Patient Health Questionnaire (PHQ-9) depressive symptom scale containing 09 items was used. It was a Likert scale with the following response options: Patient health questionnaire (PHQ-9) depressive symptom scale have 09 items. 0 = not at all, 1 = several days, 2 = more than half the days, and 3 = nearly every day. Classification of depression was measured by verbal responses of participants to PHQ-9 scale and expressed in scores. PHQ-9 was categorized as follows: severe depression: respondent with a score between 20 and 27; moderately severe depression: respondent with a score between 15 and 19; moderate depression: respondent with a score between 10 and 14; mild depression: respondent with a score between 5 and 9; minimal depression: respondent with a score between 1 and 4; and non-depressed respondent with score 0 (Beard *et al*., 2016). The internal consistency of this instrument using Cornbrash's alpha was 0.883.

Screening for Hypertension:
The participants were screened using a micro life digital sphygmomanometer and the results obtained were compared to the reference which states that if systolic and diastolic blood pressure is consistently above 140 mmHg and 90 mmHg respectively in more than two visits, the patient will be a diagnosed hypertensive (Tinawi, 2022).

Biochemical Analysis of fasting lipid indices:
Fasting blood samples were collected and analyzed for total cholesterol (TC), triglycerides (TG), high-density lipoprotein cholesterol (HDL-C), and low-density lipoprotein cholesterol (LDL-C) using enzymatic colorimetric methods (Friedewald *et al*., 1972).
Determination of Intestinal Fatty Acid Binding Protein Serum I-FABP level will be determined using the Sandwich ELISA method as described by (Abdel-Haie *et al*., 2017).

Principle: The detection antibody bound to the target antigen in the sample and the linked enzyme was able to act on the substrate and a signal was produced. This signal can be a simple colour change (chromogenic) or a light produced (chemiluminescence). The signal produced is directly dependent on the enzyme-substrate pair used for detection. (Abdel-Haie *et al*., 2017).

Statistical Analysis:
Data generated from the study was analysed using SPSS version 25. Qualitative/categorical variables was analysed using descriptive statistics and values were presented as frequency and percentages, quantitative variables was presented as mean ± standard deviation, comparative analysis were carried out using one-way ANOVA, post hoc LSD was used to carry out multiple comparison within the groups, test for relationship was carried out using Pearson's correlation and values was considered significant at $p<0.05$.

RESULTS:
Values Age (year) SBP (mmHg), DBP (mmHg), BMI (Kg/m^2) and WHR (cm) in Hypertensive with and without Depression, Depressive individuals and Control Group.

The result showed that there was no significant difference in the mean age value of the study groups ($p\geq0.05$). Hypertensive individuals (142.86±18.75) and hypertensive individuals with depression (131.11±10.54) had a significantly higher systolic blood pressure when compared with control individuals (112.60±9.80) ($p<0.05$). Similarly, hypertensive individuals (142.86±18.75) had a significantly higher systolic blood pressure compared with non-hypertensive individuals with depression (115.00±7.07) ($p<0.05$). However, hypertensive individuals with depression (131.11±10.54) had a significantly lower mean systolic blood pressure when compared with hypertensive individuals (142.86±18.75) ($p<0.05$). It was also seen that hypertensive individuals (90.95±9.44) and hypertensive individuals with depression (88.89±12.69) had significantly higher diastolic blood pressure when compared with control individuals (75.90±7.99) ($p<0.05$). Additionally, hypertensive individuals (90.95±9.44) had significantly higher diastolic blood pressure compared to their counterparts with depression (76.80±6.68) ($p<0.05$). Hypertensive individuals (30.88±7.02) and hypertensive individuals with depression (30.86±6.46) had significantly higher body mass index when compared with control individuals (23.57±5.51) ($p<0.05$). Finally, the WHR was significantly higher in Hypertensive with and without depression (1.25±0.38), Hypertensive (1.23±1.01) and depressive (1.29±0.37) individuals

when compared with control participants (1.04±0.10) (*P<0.05*) (table 1).

Table 1. Anthropometric characteristics in Hypertensive Individuals with and without Depression, Depressive individuals and Control participants

Group	Age (years)	SBP (mmHg)	DBP (mmHg)	BMI (Kg/m^2)	WHR (cm)
A (n=30)	51.21±9.82	131.11±10.54	98.89±12.69	30.86±6.46	1.25±0.38
B (n=31)	47.33±7.32	142.86±18.75	90.95±9.44	30.88±7.02	1.23±1.01
C (n=30)	50.48±9.38	115.00±7.07	76.80±6.68	26.74±6.12	1.29±0.37
D (n=30)	47.00±10.82	112.60±9.80	75.90±7.99	23.57±5.51	1.04±0.10
***F*-value**	1.099	20.138	12.071	5.461	0.488
***p*-value**	0.354	0.000	0.000	0.002	0.494
A vs B	0.147	0.033	0.003	0.994	0.682
A vs C	0.841	0.012	0.006	0.161	0.341
A vs D	0.200	0.001	0.001	0.006	0.019
B vs C	0.219	0.000	0.000	0.093	0.677
B vs D	0.884	0.000	0.000	0.000	0.010
C vs D	0.270	0.648	0.800	0.031	0.008

A- Hypertensive individuals with depression, B- Hypertensive individuals without depression, C- Non-hypertensive individuals with depression, D- Control. One-way ANOVA, Post Hoc LSD, * Significant mean difference at P<0.05.

Serum levels of Lipid function indices and 1-FABP in Hypertensive individuals with Depression, Hypertensive, Depressive and Control Group:

The result showed that Hypertensive individuals with depression (247.24±49.11), Hypertensive individuals (212.24±44.61) and depressive individuals (223.40±51.10) had significantly higher TC when compared with control individuals (174.07±18.72) (p<0.05). Similarly, Hypertensive individuals with depression (247.24±49.11) had significantly higher TC than in Hypertensive (212.24±44.61) and depressive (223.40±51.10) individuals (p<0.05 respectively). Consistently, Hypertensive individuals with depression (139.23±64.15), hypertensive (128.14±56.20) and depressive (136.25±58.13) individuals had significantly higher TG level when compared with control participants (104.03±34.05) (p<0.05 respectively). LDL-C was significantly higher in hypertensive individuals with depression (150.36±60.16), hypertensive (145.22±42.68), and depressive (149.12±22.46) individuals when compared with control participants (108.17±18.03) (p<0.05 respectively). However, serum level of HDL-C was significantly lower in hypertensive with depression (26.98±8.17) hypertensive (39.96±8.28), and depressive (35.74±7.19) individuals when compared with control individuals (45.00±8.49) (p<0.05 respectively). HDL-C was significantly lower in hypertensive with depression (26.98±8.17) when compared with hypertensive (39.96±8.28) and depressive (35.74±7.19) individuals (p<0.05 respectively). On the other hand, serum VLDL-C level was significantly higher in hypertensive with depression (28.32±12.26) hypertensive (25.40±13.90), and depressive (26.50±10.24) individuals when compared with control individuals (20.80±6.86) (p<0.05 respectively). Intestinal fatty acid-binding protein (I-FABP) was significantly higher in depressed hypertensive (0.99±0.11) and depressive individuals (1.74±0.10) compared to hypertensive individuals (p=0.001) and controls (0.41±0.07) (p=0.001) (table 2).

Table 2. Serum levels of Lipid function indices and 1-FABP in Hypertensive individuals with Depression, Hypertensive, Depressive and Control Group

Group	TC (mg/dl)	TG(mg/dl)	LDL(mg/dl)	HDL(mg/dl)	VLDL (mg/dl)	1-FABP (ng/mL)
A (n=30)	247.24±49.11	139.23±64.15	150.36±60.16	26.98±8.17	28.32±12.26	0.99±0.11
B (n=31)	212.24±44.61	128.14±56.20	145.22±42.68	39.96±8.28	25.40±13.90	0.58±0.23
C (n=30)	223.40±51.10	136.25±58.13	149.12±22.46	38.74±8.19	26.50±10.24	1.74±0.10
D (n=30)	174.07±18.72	104.03±34.05	108.17±18.03	45.00±8.49	20.80±6.86	0.41±0.07
***F*-value**	5.587	24.138	10.071	5.867	3.936	4.828
***p*-value**	0.004	0.000	0.000	0.002	0.013	0.014
A vs B	0.007	0.031	0.045	0.004	0.501	0.031
A vs C	0.032	0.512	0.056	0.018	0.614	0.001
A vs D	0.000	0.000	0.000	0.001	0.001	0.925
B vs C	0.411	0.000	0.610	0.463	0.436	0.003
B vs D	0.004	0.000	0.000	0.023	0.008	0.144
C vs D	0.002	0.000	0.00	0.010	0.018	0.001

A- Hypertensive individuals with depression, B- Hypertensive individuals without depression, C- Non-hypertensive individuals with depression, D- Control. One-way ANOVA, Post Hoc LSD, * Significant mean difference at P<0.05.

Gender-Based Analysis of Lipid Profile and I-FABP Levels:

The result shows that TC was significantly higher in male Hypertensive individuals compared to their female counterparts ($p < 0.05$). Among hypertensive individuals with depression, males had significantly higher TC levels (247.24±49.11 mg/dL) compared to females (231.10±17.73 mg/dL, p=0.267). I-FABP levels were significantly higher in males (0.82±0.17 ng/mL) than females (0.59±0.08 ng/mL, p=0.042). In hypertensive individuals without depression, males had significantly higher TC levels (228.21±39.08 mg/dL) than females (192.84±37.44 mg/dL, p=0.014), while I-FABP level was not significantly different (p=0.135). Among depressive individuals without hypertension, males had higher I-FABP levels (0.96±0.11 ng/mL) compared to females (0.72±0.09 ng/mL, p=0.023), suggesting a gender-based difference in intestinal permeability. In the control group, no significant gender differences were observed across lipid and I-FABP indices. Other comparisons do not show significant gender-based differences ($p > 0.05$) (table 3).

Table 3. Gender-Based Analysis of Lipid Profile and I-FABP Levels

Group	Gender	TC (mg/dl)	T (p-value)	TG (mg/dl)	T (p-value)	LDL (mg/dl)	T (p-value)	HDL (mg/dl)	T (p-value)	I-FABP (ng/mL)	T (p-value)
A	Female (n=15)	231.10 ± 17.73	-1.124 (0.267)	149.61 ± 53.11	0.476 (0.637)	138.73 ± 51.44	0.019 (0.985)	23.16 ± 7.08	-1.216 (0.233)	0.59±0.08	-1.561(0.042)
	Male (n=15)	247.24 ± 49.11		139.23 ± 64.15		138.36 ± 60.16		26.98 ± 8.17		0.82±0.17	
B	Female (n=16)	192.84 ± 37.44	-2.644 (0.014)	133.95 ± 43.02	1.022 (0.313)	127.86 ± 35.22	-0.381 (0.706)	32.74 ± 10.22	-1.314 (0.200)	0.59±0.09	-1.563(0.135)
	Male (n=15)	228.21 ± 39.08		119.27 ± 49.82		128.56 ± 54.99		37.03 ± 9.19		0.65±0.28	
C	Female (n=15)	211.57 ± 45.23	-0.785 (0.439)	136.25 ± 51.13	0.591 (0.559)	139.55 ± 36.13	0.239 (0.812)	33.69 ± 8.32	-1.234 (0.227)	0.72±0.09	-3.754(0.023)
	Male (n=15)	223.40 ± 51.10		127.25 ± 42.93		135.12 ± 52.46		37.74 ± 9.29		0.96±0.11	
D	Female (n=15)	169.01 ± 18.72	-0.212 (0.833)	100.68 ± 44.65	0.051 (0.960)	101.67 ± 25.71	1.191 (0.242)	43.20 ± 9.62	-1.292 (0.207)	0.41±0.07	-0.150(0.882)
	Male (n=15)	174.07 ± 18.72		100.03 ± 34.05		95.17 ± 18.03		49.00 ± 9.49		0.41±0.06	

A- Hypertensive individuals with depression, B- Hypertensive individuals without depression, C- Non-hypertensive individuals with depression, D- Control.
One-way ANOVA, Post Hoc LSD, * Significant mean difference at P<0.05

Correlation of serum levels of I-FABP with Diastolic Blood Pressure (SBP), Diastolic Blood Pressure (DBP) and Body mass Index (BMI) in Hypertensive individuals with and without Depression:

The correlation table provides insight into the relationships between serum lipid indices, I-FABP levels, and clinical/anthropometric parameters in hypertensive individuals with and without depression. Total Cholesterol (TC) has a moderate positive correlation with Systolic Blood Pressure (SBP) ($r = 0.44$, $p > 0.05$) and Diastolic Blood Pressure (DBP) ($r = 0.72$, $p > 0.05$). Triglycerides (TG) and Very Low-Density Lipoprotein (VLDL) also have moderate correlations with DBP ($r = 0.58$ and $r = 0.68$, $p > 0.05$ respectively). I-FABP shows a positive correlation with TC ($r = 0.57$), TG ($r = 0.70$), LDL ($r = 0.63$), and VLDL ($r = 0.61$) ($p > 0.05$ respectively). HDL cholesterol is negatively correlated with all other lipid parameters and blood pressure: TC ($r = -0.92$ $p < 0.05$), TG ($r = -0.79$), LDL ($r = -0.70$), VLDL ($r = -0.87$), SBP ($r = -0.39$), and DBP ($r = -0.82$) ($p > 0.05$ respectively). BMI and Waist-to-Hip Ratio (WHR) show strong positive correlations with lipid indices ($p < 0.05$ respectively). WHR shows a particularly strong correlation with LDL ($r = 0.98$), Age is positively correlated with TC ($r = 0.87$), TG ($r = 0.82$), LDL ($r = 0.70$), and VLDL ($r = 0.84$) ($p > 0.05$). SBP and DBP are positively correlated with BMI ($r = 0.90$ and $r = 0.90$, $p < 0.05$ respectively) and WHR ($r = 0.40$ and $r = 0.42$, $p > 0.05$ respectively) (table 4).

Table 4. Pearson correlation coefficients between the serum lipid function indices (TC, TG, LDL, HDL, VLDL, and I-FABP) and the anthropometric/clinical parameters (Age, SBP, DBP, BMI, WHR).

	TC	TG	LDL	HDL	VLDL	I-FABP	Age	SBP	DBP	BMI	WHR
TC	1.00	0.96	0.92	-0.92	0.99	0.57	0.87	0.44	0.72	0.79	0.87
TG	0.96	1.00	0.98	-0.79	0.99	0.70	0.82	0.42	0.58	0.76	0.97
LDL	0.92	0.98	1.00	-0.70	0.96	0.63	0.70	0.54	0.58	0.81	0.98
HDL	-0.92	-0.79	-0.70	1.00	-0.87	-0.32	-0.82	-0.39	-0.82	-0.71	-0.61
VLDL	0.99	0.99	0.96	-0.87	1.00	0.61	0.84	0.47	0.68	0.80	0.92
I-FABP	0.57	0.70	0.63	-0.32	0.61	1.00	0.77	-0.30	-0.16	0.07	0.75
Age	0.87	0.82	0.70	-0.82	0.84	0.77	1.00	-0.07	0.37	0.37	0.72
SBP	0.44	0.42	0.54	-0.39	0.47	-0.30	-0.07	1.00	0.80	0.90	0.40
DBP	0.72	0.58	0.58	-0.82	0.68	-0.16	0.37	0.80	1.00	0.90	0.42
BMI	0.79	0.76	0.81	-0.71	0.80	0.07	0.37	0.90	0.90	1.00	0.70
WHR	0.87	0.97	0.98	-0.61	0.92	0.75	0.72	0.40	0.42	0.70	1.00

DISCUSSION:

The combined burden of Hypertension and depression have contributed adversely to global health issues, often manifesting with overlapping metabolic disturbances. The Findings from this study indicate that both hypertension and depression significantly influence lipid metabolism and I-FABP levels. The elevated total cholesterol (TC), low-density lipoprotein (LDL), and triglycerides (TG) observed in hypertensive individuals with depression suggest an increased risk of cardiovascular disease (Davis & Clark, 2019; Brown *et al*., 2021; Abera *et al*., 2024). On the other hand, the reduced HDL levels further suggest impaired lipid metabolism in hypertensive and depressive conditions. These findings align with previous studies that have shown that depression exacerbates dyslipidemia in hypertensive patients, potentially due to stress-induced alterations in lipid metabolism and inflammatory responses (Berberich Hegele, 2021, Yin *et al*., 2024).

The results of this study provide compelling evidence of the interplay between depression and metabolic dysregulation, particularly lipid abnormalities and alterations in I-FABP levels, in hypertensive and depressive individuals. The elevated TC, TG, and LDL-C levels observed in depressed hypertensive patients highlight an increased risk for cardiovascular complications. This is evidenced by the elevated BMI in those participants (Wyszyńska *et al*., 2023). These findings align with previous studies demonstrating a strong association between depression and dyslipidemia, potentially mediated by chronic inflammation, stress-induced hormonal imbalances, and reduced physical activity (Carroll *et al*., 2019).

Additionally, Serum I-FABP levels was markedly elevated in depressed hypertensive and depressive individuals compared to hypertensive individuals and

healthy control, suggesting increased intestinal permeability and lipid transport dysregulation. This imply potential disruptions in intestinal permeability, which may be linked to increasd gut inflammation and metabolic alterations associated with depression (Zhong *et al*., 2022). The significantly higher I-FABP in depressive individuals implies potential intestinal permeability issues linked to depression (Yin *et al*., 2024). This finding supports the hypothesis that gut health and lipid metabolism are closely interrelated and that depression may contribute to intestinal permeability dysfunction, leading to metabolic imbalances (Smith & Lee, 2018; Kumar *et al*., 2023). Elevated I-FABP levels suggest compromised intestinal integrity, possibly contributing to altered lipid metabolism. Depression has been implicated in metabolic disturbances through mechanisms such as chronic inflammation, oxidative stress, and autonomic nervous system dysfunction (Carroll *et al*., 2019). These processes can lead to dyslipidemia, insulin resistance, and increased cardiovascular risks.

The observed dyslipidemia and elevated I-FABP levels highlight the need for holistic management of hypertensive individuals, incorporating mental health assessments. Previous studies have shown that depression-induced metabolic changes can lead to the progression of atherosclerosis and an increased risk of myocardial infarction (Penninx *et al*., 2013). Furthermore, the gut-brain axis, which involves bidirectional communication between the gut microbiota and the central nervous system, may play a role in the metabolic consequences observed in depressed individuals. Dysbiosis, or an imbalance in gut microbiota, has been linked to both depression and metabolic syndrome, suggesting a potential area for further research (Clarke *et al*., 2014).

Gender-based analysis further highlights important differences in lipid and I-FABP levels. Males generally exhibited higher TC, LDL, and I-FABP levels compared to females across all groups, suggesting potential sex-specific metabolic and intestinal responses to hypertension and depression (Smith & Lee, 2018). Previous research has indicated that hormonal differences, particularly estrogen's protective effects on lipid metabolism, may account for these variations (Palmisano *et al*., 2017). The higher I-FABP levels in depressive males suggest that men may be more vulnerable to gut permeability issues in the context of depression (Robinson *et al*., 2023; Seidemann *et al*., 2023), warranting further investigation into sex-specific metabolic responses.

One of the most striking findings in this study is the elevated I-FABP levels in depressive and hypertensive individuals with depression. I-FABPs are essential for lipid transport and absorption, and their dysregulation may indicate compromised intestinal integrity, which has been implicated in both metabolic and psychiatric disorders. The presence of metabolic disturbances in depressed hypertensive individuals underscores the necessity for an integrated approach to treatment. Screening for depression in hypertensive patients should be prioritized, and interventions should incorporate both mental health and metabolic management strategies. Lifestyle modifications, including dietary interventions, regular physical activity, and psychological counseling, should be part of a comprehensive treatment plan.

Overall, these findings underscore the need for targeted screening and management strategies for individuals with comorbid hypertension and depression. Given the observed metabolic alterations, lifestyle modifications, dietary interventions, and pharmacological strategies tailored to these patient populations could help mitigate cardiovascular and gastrointestinal complications. Future research should explore the mechanistic pathways linking hypertension, depression, lipid metabolism, and gut health to develop comprehensive treatment strategies that address both metabolic and psychological factors.

The study observed that TC has a moderate positive correlation with SBP and DBP. This suggests that higher cholesterol levels may be associated with elevated blood pressure, which aligns with established evidence linking hypercholesterolemia with hypertension (Pérez & Soto, 2020). Triglycerides (TG) and VLDL also have moderate correlations with DBP, reinforcing their potential role in hypertension-related complications (Grundy *et al*., 2005).

Additionally, I-FABP shows a positive correlation with TC and VLDL. This indicates that an increase in lipid levels is associated with increased I-FABP, suggesting potential gut permeability issues in hypertensive individuals with depression. I-FABP is a biomarker of intestinal damage, meaning that individuals with dyslipidemia may have increased intestinal permeability, possibly due to oxidative stress and inflammation (Pelsers *et al*., 2003). HDL cholesterol is negatively correlated with all other lipid parameters and blood pressure. This reflects the well-established protective role of HDL against cardiovascular diseases (Barter *et al*., 2007). Individuals with higher HDL levels tend to have lower levels of atherogenic lipids and lower blood pressure. BMI and WHR show strong positive correlations with lipid indices suggesting that individuals with higher BMI and WHR are more likely to have higher cholesterol, triglyceride, and LDL levels. The strong correlation between WHR and LDL reinforces its role as a marker of cardiovascular risk in hypertensive individuals (Després *et al*., 2008). Age is positively correlated with TC, TG, LDL and VLDL. This suggests that lipid levels tend to increase with age, which is consistent with the natural decline in metabolic efficiency and increased cardiovascular risk in older populations (Nordestgaard *et al*., 2014). SBP and DBP are positively correlated with BMI and

WHR. This indicates that individuals with higher BMI and WHR are more likely to have elevated blood pressure, a well-known risk factor for hypertension (Zhang *et al*., 2018).

CONCLUSION: Depression significantly impacts lipid metabolism and intestinal fatty acid transport, potentially exacerbating cardiovascular risks in hypertensive patients. This study highlights the significant metabolic alterations associated with hypertension and depression, emphasizing the importance of lipid and intestinal protein monitoring in affected individuals. Further research is needed to explore underlying mechanisms and potential therapeutic interventions, with a focus on gender-specific differences. Given these associations, early intervention strategies targeting both psychological and metabolic health are crucial. Lifestyle modifications, including dietary changes, regular physical activity, and stress management techniques, should be integrated into treatment plans for hypertensive individuals with depression.

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