THE EFFECTS OF HORMONAL CONTRACEPTIVES ON SERUM ELECTROLYTES, BLOOD PRESSURE, AND BODY MASS INDEX: A COMPARATIVE CROSS-SECTIONAL STUDY IN SOUTHWEST ETHIOPIA

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ABSTRACT

BACKGROUND: Hormonal contraceptives are commonly used for family planning; however, their potential effects on health parameters such as serum electrolyte levels, body mass index (BMI), and blood pressure remain unclear. Therefore, this study aimed to assess the effects of hormonal contraceptives on serum electrolyte levels, body mass index, and blood pressure among users and non-users in Southwest Ethiopia.

METHODS: This comparative cross-sectional study included 290 women, with participants randomly selected from each group (hormonal contraceptive users and non-users). Data were collected using a structured questionnaire. SPSS version 21 was used for analysis, and the results were summarized using figures and tables. An independent t-test was employed to assess the variability between the two study groups regarding serum electrolyte levels, body weight, and blood pressure. Statistical significance was set at $p < 0.05$.

RESULTS: Hormonal contraceptive users had a significantly higher body mass index (BMI) compared to non-users ($p = 0.034$). Additionally, both systolic ($p = 0.011$) and diastolic blood pressure ($p = 0.007$) were significantly elevated in hormonal contraceptive users. The mean sodium level was slightly higher in hormonal contraceptive users (141.5 ± 2.4) than non-users (140.1 ± 2.3), but not significantly ($p = 0.149$). No significant differences were found for potassium (4.6 ± 0.5 vs. 4.7 ± 0.5, $p = 0.234$), calcium (8.1 ± 0.6 vs. 8.3 ± 0.5, $p = 0.310$), or chloride (103.1 ± 2.5 vs. 102.3 ± 1.7, $p = 0.067$).

CONCLUSION: Hormonal contraceptives do not significantly affect serum electrolyte levels but can increase blood pressure and body mass index. These increases may pose cardiovascular risks, especially in women with pre-existing conditions, and could lead to long-term weight-related health effects.

KEYWORDS: hormonal contraceptives, blood pressure, body mass index, serum electrolytes, Southwest Ethiopia

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INTRODUCTION

Contraception, initiated many years ago[1], encompasses planned strategies to prevent fertilization, employing a variety of approaches including devices, sexual practices, barrier methods, and hormonal contraception methods[2]. Hormonal contraception, a prominent method, harnesses the physiological impacts of estrogen and progesterone agonists. These hormones exert multiple biological effects, inhibiting ovulation and altering cervical mucus to make it scanty, thick, and highly viscous, thereby preventing pregnancy[3]. Hormonal contraceptives are derived from steroids[4]. Specifically, they are based on steroid hormones such as estrogen and progesterone, which play roles in regulating the volume and electrolyte composition of the body[5]. These synthetic compounds mimic the actions of natural hormones, possessing glucocorticoid and/or mineralocorticoid properties. They influence ion transport within epithelial cells of the renal tubules, primarily regulating electrolyte and water balance. It's noted that corticosteroid use is linked with retaining sodium and water while promoting potassium loss[6].

Hormonal contraceptives influence various biochemical profiles in women, including lipid profiles, metabolites, and electrolytes[7, 8]. These contraceptives can lead to disturbances in serum electrolyte levels, alterations in body weight, and changes in blood pressure[9-11]. Specifically, hormonal contraceptives can cause significant derangement in the serum levels of sodium, chloride, potassium, and bicarbonate concentrations[12].

Electrolyte imbalances, such as hyponatremia, dyskinesia, dysglycemia, hypomagnesemia, and hypophosphatemia, are prevalent in both patients and the general population. They are linked with elevated morbidity and mortality rates and represent some of the most frequent clinical challenges encountered[13]. These imbalances can lead to reduced serum levels of magnesium, a vital cofactor in over 300 enzyme systems that regulate various biochemical reactions[14]. Calcium, the primary divalent cation, is predominantly stored in bones and teeth, with its extracellular fraction utilized for various physiological functions including blood clotting, hormone secretion, and muscle contractions[15].

Hormonal contraceptives can also lead to increased blood pressure and risk of osteoporosis[16]. The renin-angiotensin-aldosterone system is implicated, as estrogen administration stimulates the hepatic synthesis of plasma renin substrate[17, 18]. Hormonal contraceptives containing estrogen can cause or worsen hypertension, and women who have used these contraceptives have developed high blood pressure as a result[19].

While few studies in Ethiopia have explored the effects of hormonal contraceptives on blood pressure[10, 20] and body weight[10], their impact on serum electrolyte levels remains unexamined. This gap is particularly significant for Ethiopian women of reproductive age (18-49 years) because hormonal contraceptives are widely used, yet potential biochemical effects—such as electrolyte imbalances that could influence cardiovascular, renal, and neuromuscular health—remain underexplored in this population. Understanding these effects is essential for informing clinical practice and ensuring the safe use of hormonal contraceptives in low-resource settings, where routine biochemical monitoring may be limited.

Methodology

Study Area, Period, and Populations

A hospital-based comparative cross-sectional study was conducted at MTUTH and GSGH from September 1 to October 15, 2021. The source population comprised all women aged 18–49 years, with the study population including those randomly selected who met the eligibility criteria. Hormonal contraceptive users included those using oral contraceptive pills, injectables (Depo-Provera), or Norplant. Non-users included women who had never used hormonal contraceptives, those who discontinued use over six months prior, and those using IUCDs, emergency pills, or who had

undergone tubal ligation. The six-month cutoff was applied to minimize residual hormonal effects, as physiological changes typically normalize within a few months after discontinuation.

The study included all women aged 18 to 49 years who had used hormonal contraceptives for at least one month. Women were excluded if they were taking medications known to affect serum electrolyte levels, blood pressure, or body weight—such as corticosteroids, diuretics, antihypertensive drugs, or hormonal therapies other than contraceptives. Additional exclusion criteria included women with serious clinical conditions (e.g., cancer, HIV, or tuberculosis), those who were critically ill or mentally incapable of communication, those with endocrine disorders (e.g., known thyroid diseases or goiter), and pregnant women.

Sample Size Determination

The sample size was determined using Epi Info version 7 StatCalc. Based on a prior study conducted in Jimma[20], the mean diastolic blood pressure (DBP ± SD) for hormonal contraceptive users and non-users was 74.9 ± 6.7 mmHg and 77.9 ± 9.2 mmHg, respectively. Using 80% power, a 95% confidence level, and a 2:1 ratio of hormonal contraceptive users to non-users, the calculated sample size was 285. With a 10% allowance for non-response, the final adjusted sample size was 314.

Sampling Procedure

A systematic random sampling technique was used, whereby every eligible woman who presented during the data collection period was invited to participate.

Operational Definitions

- Hormonal contraceptive users: Women using oral pills, injectables (Depo-Provera), or Norplant within the last six months.
- Non-users: Women who had never used hormonal contraceptives, stopped use over six months ago, or used IUCDs, emergency pills, or tubal ligation.
- Electrolyte imbalance: Serum levels outside normal reference ranges—sodium (<135 or >145 mmol/L), potassium (<3.6 or >5.5 mmol/L), calcium (<8.8 or >10.7 mg/L), and chloride (<96 or >106 mmol/L)[21].
- BMI: Calculated as weight in kilograms divided by the square of height in meters (kg/m^2).
- Hypertension: Systolic blood pressure ≥140 mmHg and/or diastolic ≥90 mmHg. Normotension: systolic 90–120 mmHg and/or diastolic 60–80 mmHg.
- Mentally incapable: Individuals unable to understand the study or give informed consent due to cognitive or psychiatric conditions.

Data Collection

Socio-demographic variables collected included age, educational level, marital status, residence, occupation, and religion. Contraceptive-related variables included type and duration of hormonal contraceptive use. Obstetric variables included gravidity and parity. Clinical measurements included serum electrolyte levels (sodium, chloride, potassium, calcium), body weight, and blood pressure.

Data were collected using a structured, pre-tested questionnaire through interviews conducted by six BSc midwives. Anthropometric and clinical measurements were also obtained.

Anthropometric Measurements:

Body weight was measured using a digital standing scale (Detecto, UK) while participants wore light clothing and no headwear. The scale was calibrated to zero before each use, and accuracy was verified using a known object. Weight was recorded to the nearest 0.1 kg.

Clinical Measurements:

Blood pressure was measured on the left arm while participants were seated using an Arm-Omron digital BP monitor. Two readings were taken five minutes apart, and the average of the last two was recorded.

Blood Sample Collection and Analysis:

Five millilitres of venous blood were collected using serum separator tubes. Samples were centrifuged

for 10 minutes at 3000 rpm at room temperature by trained professionals. Serum was analyzed for electrolytes. Samples were collected in a non-fasting state and processed within two hours.

Statistical Analysis

Data were entered into EpiData Manager version 4.0.2.101 and exported to SPSS version 21 for cleaning and analysis. EpiData was used for its validation features to minimize entry errors. SPSS was chosen for its statistical analysis capabilities. Data were presented using proportions, tables, and mean values with standard deviations. Independent t-tests were used to compare means of serum electrolytes, body weight, and blood pressure between users and non-users. Normality was assessed with the Shapiro-Wilk test and visual inspection; Levene's test was used to assess homogeneity of variances. A p-value < 0.05 was considered statistically significant.

Ethics Statement

Ethical clearance was obtained from the Mizan-Tepi University Postgraduate Research Review Committee (PGC/049/2021) on August 13, 2021. A support letter was secured for the study hospitals. Informed written consent was obtained from all participants. For individuals unable to read or write, the study's purpose was explained and consent was obtained from their legal representatives. All procedures adhered to international ethical guidelines for health-related research involving humans.

Results

Socio-demographic characteristics

In this study, 290 respondents participated, consisting of 192 hormonal contraceptive users and 98 nonusers, resulting in a response rate of 92.4%. Most respondents were in the age category of 18-27 years old (64.1%), married (86.6%), and housewives (54.8%). More than three-fourths (78.3%) of participants resided in urban areas, while 21.7% lived in rural areas (Table 1).

Table 1: Socio-demographic characteristics of the study participants in Public Health Hospitals, Southwest Ethiopia, 2021.

Variables	Categories	Total	Nonusers	Users
Age (years)	18-27	186 (64.1)	63 (33.9)	123 (66.1)
	28-37	99 (34.1)	33 (33.3)	66 (66.7)
	38-47	5 (1.7)	2 (40.0)	3 (60.0)
Marital status	Single	28 (9.7)	10 (35.7)	18 (64.3)
	Married	251 (86.6)	84 (33.5)	167 (66.5)
	Divorced/separated/widow	11 (3.8)	4 (36.4)	7 (63.6)
Religion	Orthodox	175 (60.3)	59 (33.7)	116 (66.3)
	Protestant	99 (34.1)	32 (32.3)	67 (67.7)
	Muslim	12 (4.1)	5 (41.7)	7 (58.3)
	Catholic	4 (1.4)	2 (50.0)	2 (50.0)
Educational status	Unable to read and write	57 (19.7)	19 (33.3)	38 (66.7)
	Able to read and write	12 (4.1)	4 (33.3)	8 (66.7)
	Primary school (1-8)	102 (35.2)	35 (34.3)	67 (65.7)
	Secondary school (9-12)	86 (29.7)	29 (33.7)	57 (66.3)
	College and University	33 (11.4)	11 (33.3)	22 (66.7)
Occupational status	Employed	72 (24.8)	24 (33.3)	48 (66.7)
	Student	30 (10.3)	10 (33.3)	20 (66.7)
	Housewife	159 (54.8)	54 (34.0)	105 (66.0)
	Merchant	12 (4.1)	4 (33.3)	8 (66.7)
	Others*	17 (5.9)	6 (35.3)	11 (64.7)
Ethnicity	Bench	46 (15.9)	16 (34.8)	30 (65.2)
	Kaffa	204 (70.3)	69 (33.8)	135 (66.2)
	Amhara	22 (7.6)	7 (31.8)	15 (68.2)
	Oromo	13 (4.5)	5 (38.5)	8 (61.5)
	Sheka	5 (1.7)	1 (20.0)	4 (80)
Residence	Rural	63 (21.7)	21 (33.3)	42 (66.7)
	Urban	227 (78.3)	77 (33.9)	150 (66.1)

Reproductive health characteristics and type of hormonal contraception

Most hormonal contraception users (93.2%) and non-users (95.9%) reported conceiving less than four times in their lifetime. Hormonal contraceptive users showed a trend toward more instances of four or more pregnancies compared to non-users ($p = 0.235$), and no significant difference in menarche age was observed between the two groups ($p = 0.343$) (Table 2).

Table 2: Reproductive health characteristics of the study participants in Public Health Hospitals, Southwest Ethiopia, 2021.

Variables	Categories	Hormonal contraception		P-value
		Nonusers	Users	
Gravidity	0 – 4 pregnancies	94 (95.9)	179 (93.2)	0.235
	≥ 4 pregnancies	4 (4.1)	13 (6.8)	
Menarche age	< 14 years	46 (46.9)	79 (41.1)	0.343
	≥ 14 years	52 (53.1)	113 (58.9)	

Types of hormonal contraceptives

Among the hormonal contraception users, the majority (56.3%) utilized Depo-Provera, while 32.8% of the study subjects opted for Norplant (Fig. 1).

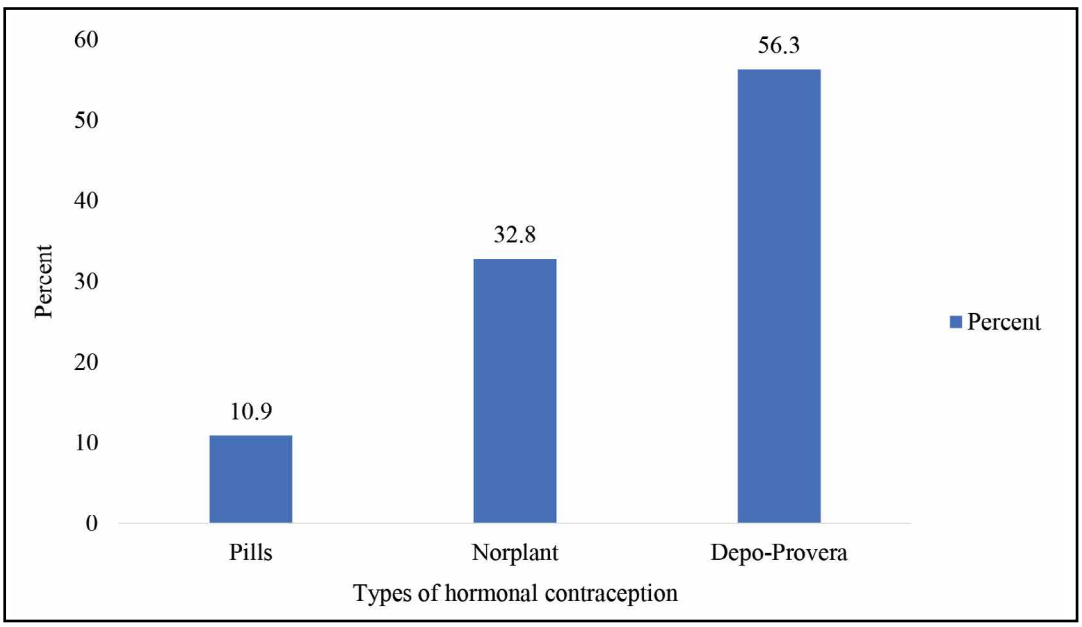

Figure 1: Types of hormonal contraception among study participants in Public Health Hospitals, Southwest Ethiopia, 2021.

Serum electrolytes

The mean sodium level was slightly higher in hormonal contraceptive users (141.5 ± 2.4) compared to non-users (140.1 ± 2.3), but this difference was not statistically significant (p = 0.149). For potassium, the mean value was similar between the groups (non-users: 4.7 ± 0.5, users: 4.6 ± 0.5, p = 0.234). Calcium levels were also similar (non-users: 8.3 ± 0.5, users: 8.1 ± 0.6, p = 0.310). Chlorine levels showed a trend toward significance (non-users: 102.3 ± 1.7, users: 103.1 ± 2.5, p = 0.067), but no significant difference was found (Table 3).

Table 3: Comparing serum electrolytes between hormonal contraceptive users and non-users in Public Health Hospitals, Southwest Ethiopia, 2021.

Types of electrolytes	Hormonal contraceptive				P-value
	Nonusers		Users		
	Mean ± SD	95% CI	Mean ± SD	95% CI	
Sodium	140.1 ± 2.3	[139.6, 140.6]	141.5 ± 2.4	[141.2, 141.8]	0.149
Potassium	4.7 ± 0.5	[4.6, 4.8]	4.6 ± 0.5	[4.5, 4.7]	0.234
Calcium	8.3 ± 0.5	[8.2, 8.4]	8.1 ± 0.6	[8.0, 8.2]	0.310
Chlorine	102.3 ± 1.7	[102.0, 102.6]	103.1 ± 2.5	[102.8, 103.5]	0.067

Body mass index and blood pressure

Hormonal contraceptive users had a significantly higher body mass index (BMI), systolic blood pressure, and diastolic blood pressure compared to non-users. Specifically, users had a mean BMI of 22.5 ± 2.8 (p = 0.034), systolic blood pressure of 113.6 ± 11.3 (p = 0.011), and diastolic blood pressure of 73.7 ± 7.2 (p = 0.007), all showing statistically significant differences when compared to non-users, who had lower values in each of these measures (Table 4).

Table 4: Comparing of BMI and blood pressure between hormonal contraceptive users and non-users in Public Health Hospitals, Southwest Ethiopia, 2021.

Types of electrolytes	Hormonal contraceptive				P-value
	Nonusers		Users		
	Mean ± SD	95% CI	Mean ± SD	95% CI	
BMI	21.8 ± 3.0	[21.2 to 22.4]	22.5 ± 2.8	[22.1, 22.9]	0.034
Systolic blood pressure	111.6 ± 9.6	[109.7, 113.5]	113.6 ± 11.3	[112.0, 115.2]	0.011
Diastolic blood pressure	72.4 ± 6.6	[71.1, 73.7]	73.7 ± 7.2	[72.7, 74.7]	0.007

Discussion

This study aimed to assess the impact of hormonal contraceptives on serum electrolyte levels, BMI, and blood pressure among users and non-users at MTUTH and GSGH in Southwest Ethiopia. Hormonal contraceptive users had significantly higher BMI ($p = 0.034$), systolic blood pressure ($p = 0.011$), and diastolic blood pressure ($p = 0.007$) compared to non-users. However, no statistically significant differences were found in serum electrolyte levels between the groups, including sodium ($p = 0.149$), potassium ($p = 0.234$), and calcium ($p = 0.310$). Chloride levels showed a trend toward significance ($p = 0.067$), but this difference was not statistically significant.

BMI serves as a crucial measure for characterizing height-to-weight proportions in adults, reflecting an individual's level of fatness and serving as a risk indicator for various health conditions[22]. In this study, hormonal contraceptive users exhibited a significantly higher BMI compared to non-users. This finding aligns with research by Muluken and colleagues[10], which also reported a significant increase in BMI among Depo-Provera users. The rise in BMI among users could be linked to increased appetite and higher dietary intake, possibly stemming from modifications to the hypothalamic appetite control centre[10].

This study also demonstrated a significant increase in both systolic and diastolic blood pressure among hormonal contraceptive users compared to non-users. This finding is consistent with previous studies indicating that hormonal contraceptives can elevate blood pressure[23, 24]. This effect may be attributed to the regulatory influence of progesterone and estrogen on vascular tone, mediated by factors such as nitric oxide, prostacyclin, angiotensin, and the sympathetic nervous system[25]. Estrogen is known to influence the renin-angiotensin-aldosterone system, potentially leading to fluid retention and increased vascular resistance. Progesterone can affect vascular smooth muscle by promoting vasoconstriction and influencing endothelial function[26]. Together, these hormonal changes may contribute to the elevated systolic and diastolic blood pressure observed in users.

In terms of serum electrolytes, hormonal contraceptive users did not show significant differences compared to non-users. Sodium primarily regulates extracellular fluid volume and cell membrane potential by exchanging with potassium across cell membranes[21]. Chloride, mainly found in extracellular fluid, is regulated by the kidneys. In this study, hormonal contraceptive users showed insignificantly higher serum levels of sodium and chloride compared to non-users, consistent with prior research indicating no significant effect of oral contraceptives on these electrolytes[27]. Potassium, an intracellular ion[21], also showed a non-significant reduction in serum levels among hormonal contraceptive users, consistent with findings from other studies suggesting minimal impact of hormonal contraceptives on serum electrolytes[12].

The difference in serum calcium levels between hormonal contraceptive users and non-users was also found to be insignificant, consistent with findings from previous research by Hasanat and colleagues[14]. The lack of significant differences in serum electrolyte levels suggests that hormonal contraceptives do not significantly affect these parameters. This was expected, as electrolyte balance is tightly regulated by homeostatic mechanisms. Clinically, the findings indicate that hormonal contraceptives do not cause meaningful changes in serum sodium, potassium, calcium, or chloride levels. However, further research with larger sample sizes or different populations may provide more insight into potential long-term effects. Longitudinal studies are needed to evaluate the extended impact of hormonal contraceptives on body composition, cardiovascular health, and electrolyte balance.

The cross-sectional nature of this study limits the ability to draw causal conclusions. The lack of stratification by contraceptive type and adjustment for key confounding factors such as lifestyle and genetic influences limits the generalisability and strength of the findings. Since data were collected

at a single point in time and baseline BMI at contraceptive initiation was unavailable, it is difficult to attribute BMI differences solely to contraceptive use. Additionally, including women with as little as one month of contraceptive use may not adequately reflect long-term effects. Finally, the hospital-based sample may not be fully representative of the broader population.

Conclusions

This study showed that hormonal contraceptives do not significantly alter serum electrolyte levels among users. However, their use is associated with significant increases in BMI and blood pressure. These findings serve as a preliminary investigation and highlight the need for further well-designed research into the effects of hormonal contraceptives on various health outcomes. It is also important that users are adequately informed about the full range of possible side effects, enabling them to make informed decisions and consider alternative options when necessary.

Declarations

Availability of data and materials: The dataset used in this study is available from the corresponding author upon reasonable request.

Consent for publication: Not applicable.

Conflict of interest: The authors declare no conflicts of interest.

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Authors' contributions:

TY, HA, and WW: Conceptualisation; methodology; software; validation; formal analysis; investigation; visualisation; data curation; writing – original draft; writing – review and editing.

NS, MH, GFA, MSA, and AFA: Methodology; investigation; data curation; project administration; funding acquisition; resources; supervision; writing – original draft; writing – review and editing.

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