Research Square

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Oral contraceptives, exercise, and metabolic syndrome in female cancer survivors

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Research Article

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Abstract

Background

We examined the associations among oral contraceptive pill use, regular physical activity, and metabolic syndrome in female cancer survivors.

Methods

We used secondary data from the V to VIII (2010–2020) Korea National Health and Nutrition Examination Survey. This study was reported in accordance with the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) guidelines (https://www.strobe-statement.org/). Chi-square tests and multivariable logistic regression were used to analyze the data.

Results

The use of oral contraceptive pills was a significant risk factor for metabolic syndrome. Conversely, engaging in vigorous physical activity, walking, and muscle-strengthening exercises were significant protective factors against metabolic syndrome.

Conclusions

The use of oral contraceptives and engagement in physical activity influence female cancer survivors' risk of developing metabolic syndrome. These findings support nurses and healthcare professionals in providing tailored contraceptive counseling and implementing physical activity–focused interventions to reduce the risk of metabolic syndrome among female cancer survivors.

1. Background

Metabolic syndrome is defined by five key components—abdominal obesity, high triglycerides, high blood pressure (BP), high blood sugar, and low high-density lipoprotein (HDL) cholesterol [1]—and is associated with increased risks of diabetes, hypertension, cardiovascular diseases, cancer recurrence, and mortality [2, 3]. Its global prevalence is rising [4]. In South Korea, approximately 30% have metabolic syndrome, with rates stable or increasing [5].

With the rapid rise in cancer survivors, focus has been on treatment, early detection, and preventing metastasis and recurrence [6]. However, as survival improves, comprehensive healthcare beyond primary treatment is needed [7]. Cancer survivors, often older adults, frequently have comorbidities and higher risk of new chronic and cardiovascular diseases during treatment [8, 9]. Over 24% of deaths in survivors were due to chronic disease complications like circulatory and endocrine disorders, not cancer [10].

The World Health Organization identifies lack of physical activity as a major risk factor for metabolic syndrome and recommends regular physical activity [11], which can reduce the risk of metabolic syndrome by improving its various components, including waist circumference, BP, blood glucose, and lipid levels [12, 13]. Regular physical activity enhances cardiorespiratory function and physical capacity [14], lowers BP and lipid levels, raises HDL cholesterol and insulin sensitivity [13], but improvements in metabolic syndrome components vary by exercise type [12].

The risks of oral contraceptive pills, especially increasing cancer recurrence, complications, and metabolic syndrome in female cancer survivors, have gained attention [15]. They contain estrogen and progestin [16] and are known to raise metabolic syndrome risk [17], though some studies find no significant link [18].

Given conflicting study results, oral contraceptive pill use among female cancer survivors should be minimized due to potential increased risk of cancer recurrence and metabolic syndrome [15], but associations with physical activity and metabolic syndrome remain unexplored.

3. The Study

This study explores the links between oral contraceptive use, regular exercise, and metabolic syndrome in female cancer survivors. First, associations between oral contraceptive use and metabolic syndrome across demographics were analyzed. Second, patterns of regular physical activity were examined by demographic characteristics. Third, relationships among oral contraceptive use, regular physical activity, and metabolic syndrome components were investigated. Finally, associations between oral contraceptive use, regular physical activity, and metabolic syndrome in female cancer survivors were assessed.

4. Methods

4.1. Design

This study was a retrospective, cross-sectional, and secondary descriptive analysis of data from the V to VIII (2010–2020) Korea National Health and Nutrition Examination Survey (KNHANES V–VIII). This study was reported in accordance with the Strengthening the Reporting of Observational Studies

in Epidemiology (STROBE) guidelines (https://www.strobe-statement.org/).

4.2. Participants and Data Collection

Data from the V (2010) to VIII (2020) KNHANES waves over 10 years were merged to increase statistical power. KNHANES is a nationwide, probability-based health and nutrition survey conducted by the Korea Disease Control and Prevention Agency under Article 16 of the National Health Promotion Act. The survey assesses health behaviors, chronic disease prevalence, and nutritional intake. The target population is South Korean citizens, surveyed via two-stage stratified cluster sampling.

KNHANES has high statistical precision and adequate power. Its advantage as a data source for secondary analysis is maintaining estimate reliability through weighting, even for rare populations (e.g., female cancer survivors). Samples were extracted using stratified cluster sampling with districts and households as units. The KNHANES raw dataset includes health surveys, examinations, and nutritional data. This study analyzed only health survey and examination data.

Cancer survivors were those who answered “Yes” to “Have you ever been diagnosed with any cancer (gastric, liver, colorectal, breast, cervical, lung, thyroid, or other cancers) by a physician?” but no longer had cancer at the survey. Female cancer survivors were those who selected “Female” as their sex; for respondents with multiple cancers, only the primary cancer was analyzed.

Inclusion criteria were female cancer survivors; exclusion criteria were benign tumor diagnosis or missing oral contraceptive data (n = 638), metabolic syndrome variables (n = 102), or demographics data (n = 8). From all KNHANES V–VIII (2010–2020) respondents, 1775 diagnosed with cancer before the survey were initially considered. After applying exclusion criteria, 748 individuals were excluded. Consequently, 1027 respondents were included in the analysis.

4.3. Measurements

4.3.1. Oral Contraceptive Pill Use

Oral contraceptive pill use, based on “use” or “do not use” responses in the KNHANES women’s health domain, was the outcome variable categorized as “Yes” or “No.”

4.3.2. Regular Physical Activity

Physical activity was classified into four categories: “regular vigorous exercise,” “regular moderate exercise,” “regular walking,” and “regular muscle-strengthening exercise,” following definitions from previous studies. “Regular aerobic exercise” was excluded because this variable was not available in the secondary data from 2010 to 2014. The measurement was performed using the Korean version of the Global Physical Activity Questionnaire, which was developed by the World Health Organization and is reliable and valid.

Exercise types were classified as “vigorous physical activity,” “moderate physical activity,” “walking,” and “muscle-strengthening exercise.” Definitions from previous studies [19] were referenced to establish criteria for regular exercise based on exercise type.

We asked, “Do you participate in vigorous sports, exercise, and leisure activities such as running, jump roping, hiking, basketball, swimming, and badminton that make you short of breath or cause your heart to palpitate for at least 10 minutes, excluding physical activity for commuting to work or other places?” Those active ≥ 20 minutes/day on ≥ 3 days/week were the “regular vigorous exercise” group; others were the “non-regular vigorous exercise” group.

We asked, “Do you participate in moderate sports, exercise, and leisure activities such as fast walking, jogging, weight training (muscle-strengthening exercise), golf, dance sports, or Pilates that make you slightly short of breath or cause your heart to palpitate for at least 10 minutes, excluding physical activity for commuting to work or other places?” Those active ≥ 30 minutes/day on ≥ 5 days/week were the “regular moderate exercise” group; others, the “non-regular moderate exercise” group.

Respondents answered “On how many days in the past week did you walk for at least 10 minutes, including walking to and from work or school, moving about, and exercise?”; those who walked at least three days were the “regular walking” group, others the “non-regular walking” group. They also answered “On how many days in the past week did you participate in muscle-strengthening exercises such as push-ups, sit-ups, weight lifting, and pull-ups?”; those active at least two days were the “regular muscle-strengthening exercise” group, others the “non-regular muscle-strengthening exercise” group.

4.3.3. Metabolic Syndrome

The International Diabetes Federation and American Heart Association/National Heart, Lung and Blood Institute [20] criteria were used for metabolic syndrome, and the Korean Society for the Study of Obesity [21] criteria for waist circumference. Metabolic syndrome was defined as having at least three of these: waist circumference ≥ 85 cm; triglycerides ≥ 150 mg/dL or dyslipidemia medication; HDL cholesterol < 50 mg/dL or dyslipidemia medication; systolic BP ≥ 130 mmHg, diastolic BP ≥ 85 mmHg, or antihypertensive medication; fasting glucose ≥ 100 mg/dL or diabetes treatment.

4.3.4. Demographic Characteristics

Demographic characteristics included age, income, education, marital status, smoking, drinking, and exercise participation. The sample was categorized by age (20–29, 30–39, 40–49, 50–59, 60–69, ≥ 70 years); income quartiles (1Q–4Q); education (below high school, high school, college or higher);

marital status (married or single—including never married, separated, widowed); smoking (current, ex-, non-smoker); drinking (none, mild, moderate, severe); and exercise participation as “yes” or “no.”

4.3.5. Clinical Characteristics

Clinical characteristics included body mass index (BMI), waist circumference, systolic and diastolic BP, fasting blood glucose, triglycerides, total cholesterol, HDL cholesterol, female cancer survivorship stage, and cancer type.

Cancer survival stages were early (within two years), long-term (two to five years), and permanent (beyond five years) [22], with cancer types classified as gastric, liver, colorectal, breast, cervical, lung, thyroid, and others per the KNHANES [22].

4.4. Data Analysis

To minimize selection bias from KNHANES’ complex sampling, results were estimated accounting for primary sampling units, stratification, and weights, analyzed per the KNHANES’ guidelines [23].

KNHANES assigns weights to represent the South Korean population. The Korea Centers for Disease Control & Prevention [23] detail the methods and formulas for calculating sampling weights; this study applied correlation weights from the combined health survey and examination data accordingly. For complex sample analysis, cluster variables, stratification variables, and sampling weights were used to align with the KNHANES design, enhancing estimate accuracy.

Continuous variables were shown as means ± standard errors; categorical variables as percentages. Secondary data were analyzed using IBM SPSS Statistics version 25.0 (IBM Corp., Armonk, NY, USA). Chi-square tests examined differences in oral contraceptive use, physical activity, and metabolic syndrome status. Multivariable logistic regression assessed associations between oral contraceptive use, physical activity, and metabolic syndrome. Statistical significance was set at $P < .05$.

4.5. Ethical Considerations

The project was submitted for evaluation to the institutional review board of Semyung University (No. SMU-EX-2022-03-002). Since this study was a secondary analysis using the KNHANES data, the institutional review board exempted it from formal ethical approval.

5. Results

5.1. Oral Contraceptive Pill Use and Metabolic Syndrome by Demographic Characteristics

The analysis revealed significant links between oral contraceptive use and metabolic syndrome, age, education, marital status, drinking, waist circumference, and systolic BP. Oral contraceptive users had a significantly higher metabolic syndrome prevalence (59.0%, $P = .001$). Individuals aged older than 70 years had the highest oral contraceptive use prevalence (39.4%, $P < .001$). Among oral contraceptive users, most had less than a high school education (60.2%, $P = .001$). Waist circumference was significantly larger in oral contraceptive users than non-users (82.45 ± 0.62 cm, $P = .003$).

The analysis of metabolic syndrome revealed significant differences in age, education, drinking status, exercise, BMI, waist circumference, BP, fasting glucose, triglycerides, total cholesterol, and HDL cholesterol. Individuals with metabolic syndrome had the highest proportion of less than high school education. Individuals with metabolic syndrome had significantly higher BMI than those without (Table 1).

Table 1
Oral contraceptive pill use and metabolic syndrome by demographic characteristics (N = 1,027)

Variable	Total	Oral contraceptive pill use		*P*	Metabolic syndrome		*P*
	Mean or % ± (SE)	Yes	No		Yes	No	
Metabolic syndrome (%)	45.5 (2.0)	59.0 (4.5)	42.4 (2.1)	.001			
Yes							
No	54.5 (2.0)	41.0 (4.5)	57.6 (2.1)				
Age (in years) (%)	1.2 (0.4)	0 (0)	1.4 (0.5)	< .001	0.5 (0.5)	1.8 (0.7)	< .001
20–29							
30–39	5.0 (0.9)	1.2 (0.9)	5.9 (1.1)		1.3 (0.7)	8.1 (1.5)	
40–49	15.4 (1.4)	6.2 (2.0)	17.5 (1.6)		7.7 (1.4)	21.8 (2.2)	
50–59	31.7 (1.8)	22.6 (4.3)	33.8 (2.0)		27.1 (2.5)	35.6 (2.5)	
60–69	22.4 (1.5)	30.6 (3.8)	20.5 (1.6)		27.7 (2.4)	18.0 (1.9)	
≥ 70	24.3 (1.5)	39.4 (4.1)	30.8 (1.6)		35.7 (2.4)	14.7 (1.7)	
Income (%)	23.7 (1.7)	30.6 (4.2)	22.1 (1.8)	.17	24.4 (2.4)	23.1 (2.2)	.869
1st Q							
2nd Q	23.4 (1.6)	18.9 (3.0)	24.4 (1.7)		24.4 (2.4)	22.6 (2.1)	
3rd Q	26.7 (1.7)	24.4 (4.2)	27.3 (1.8)		26.0 (2.4)	27.4 (2.4)	
4th Q	26.2 (1.7)	26.1 (3.7)	26.2 (1.9)		25.2 (2.3)	27.0 (2.4)	
Educational level (%)	45.8 (1.8)	60.2 (4.4)	42.4 (1.9)	.001	60.8 (2.6)	33.1 (2.3)	< .001
< High school							
High school	32.8 (1.7)	27.5 (4.3)	34.1 (1.9)		24.6 (2.4)	39.7 (2.5)	
College or over	21.4 (1.6)	12.2 (3.0)	23.5 (1.8)		14.5 (2.1)	27.2 (2.3)	
Marital status (%)	1003 (97.4)	99.8 (0.2)	96.9 (0.7)	< .001	98.6 (0.6)	96.5 (0.9)	.068
Married							
Single	24 (2.6)	0.2 (0.2)	3.1 (0.7)		1.4 (0.6)	3.5 (0.9)	
Smoking status	3.5 (0.7)	5.7 (2.0)	3.0 (0.7)	.232	4.3 (1.2)	2.9 (0.8)	.539
Current							
Ex-smoker	3.9 (0.6)	3.5 (1.2)	3.9 (0.7)		3.6 (0.9)	4.1 (0.9)	
Non-smoker	92.6 (0.9)	90.8 (2.3)	93.0 (1.0)		92.1 (1.5)	93.1 (1.2)	
Drinking status (%)	45.7 (1.8)	56.0 (4.3)	43.4 (2.0)	.021	51.1 (2.5)	41.2 (2.5)	.027
None							
Mild	35.0 (1.8)	32.0 (4.0)	35.7 (2.1)		32.1 (2.6)	37.4 (2.5)	
Moderate	17.9 (1.4)	10.4 (2.4)	19.6 (1.7)		14.9 (2.1)	20.5 (2.0)	
Severe	1.4 (0.5)	1.6 (1.0)	1.4 (0.5)		1.9 (0.8)	1.0 (0.5)	
Exercise	27.0 (1.7)	22.3 (3.3)	28.1 (1.9)	.133	19.0 (2.0)	33.8 (2.6)	< .001
Yes							
No	73.0 (1.7)	77.7 (3.3)	71.9 (1.9)		81.0 (2.0)	66.2 (2.6)	
Body mass index	23.72 ± 0.12	23.92 ± 0.21	23.67 ± 0.14	.313	25.32 ± 0.16	22.37 ± 0.14	< .001
Waist circumference	80.65 ± 0.35	82.45 ± 0.62	80.24 ± 0.40	.003	86.15 ± 0.51	76.05 ± 0.39	< .001
Blood pressure	121.0 ± 0.69	126.57 ± 1.70	119.77 ± 0.71	< .001	126.92 ± 0.94	116.12 ± 0.93	< .001
Systolic							

Note. SE = standard error, HDL = high-density lipoprotein.

Variable	Total	Oral contraceptive pill use		*P*	Metabolic syndrome		*P*
	Mean or % ± (SE)	Yes	No		Yes	No	
Diastolic	74.54 ± 0.36	74.21 ± 0.86	74.62 ± 0.41	.674	75.87 ± 0.48	73.43 ± 0.51	< .001
Fasting blood glucose	100.99 ± 0.80	104.38 ± 2.37	100.21 ± 0.79	.095	110.62 ± 1.45	92.94 ± 0.52	< .001
Triglycerides	120.25 ± 2.54	130.90 ± 7.99	117.80 ± 2.46	.114	151.46 ± 4.29	94.14 ± 2.46	< .001
Total cholesterol	196.61 ± 1.47	195.47 ± 3.07	196.87 ± 1.62	.68	190.58 ± 2.27	201.66 ± 1.80	< .001
HDL cholesterol	53.30 ± 0.50	53.41 ± 1.33	53.27 ± 0.51	.921	47.49 ± 0.56	58.16 ± 0.67	< .001
Stage of female cancer survivorship	3.6 (0.7)	4.7 (2.0)	3.4 (0.7)	.245	3.3 (0.9)	3.9 (1.03)	.328
< 2 years							
2–4 years	13.6 (1.3)	9.4 (2.3)	14.6 (1.5)		11.5 (2.0)	15.3 (1.9)	
≥ 5 years	82.8 (1.4)	85.9 (2.9)	82.0 (1.6)		85.2 (2.1)	80.7 (2.1)	
Cancer type	11.5 (1.1)	15.0 (3.0)	10.7 (1.2)	.152	7.7 (1.4)	14.7 (1.7)	.002
Gastric							
Liver	0.3 (0.2)	0.3 (0.3)	0.3 (0.2)	.853	0.4 (0.3)	0.2 (0.2)	.53
Colorectal	6.5 (0.9)	7.2 (2.0)	6.3 (1.0)	.626	9.4 (1.6)	4.1 (0.9)	.002
Breast	21.4 (1.6)	20.4 (3.6)	21.6 (1.8)	.777	19.2 (2.0)	23.2 (2.2)	.157
Cervical	24.1 (1.8)	26.2 (4.1)	23.7 (1.8)	.538	27.9 (2.6)	21.0 (2.3)	.04
Lung	1.5 (0.4)	1.6 (1.0)	1.4 (0.5)	.861	1.9 (0.7)	1.1 (0.5)	.331
Thyroid	24.8 (1.8)	20.7 (4.3)	25.7 (2.0)	.335	22.7 (2.7)	26.5 (2.4)	.294
Others	18.8 (1.5)	20.4 (3.6)	18.4 (1.6)	.606	19.7 (2.2)	18.1 (2.1)	.594

Note. SE = standard error, HDL = high-density lipoprotein.

5.2. Regular Physical Activity by Demographic Characteristics

Table 2 shows that individuals engaging in vigorous physical activity had a significantly lower metabolic syndrome prevalence than those who did not. BMI, waist circumference, fasting blood glucose, and triglycerides were significantly lower in the vigorous than non-vigorous physical activity group.

Table 2
Regular physical activity by demographic characteristics (N = 1,027)

Variable	Total	Regular physical activity (Mean or % ± (SE))										
	Mean or % ± (SE)											
		Vigorous		*P*	Moderate		*P*	Walking		*P*	Muscle-strengthening		*P*
		Yes (n = 57)	No (n = 970)		Yes (n = 54)	No (n = 973)		Yes (n = 573)	No (n = 454)		Yes (n = 140)	No (n = 887)	
Metabolic syndrome	45.5 (2.0)	22.6 (6.1)	46.9 (2.0)	.001	37.3 (7.7)	45.9 (2.0)	.282	42.1 (2.4)	50.0 (2.9)	.025	31.8 (4.4)	47.7 (2.1)	.002
Yes													
No	54.5 (2.0)	77.4 (6.1)	53.1 (2.0)		62.7 (7.7)	54.1 (2.0)		57.9 (2.4)	50.0 (2.9)		68.2 (4.4)	52.3 (2.1)	
Age (in years) (%)	1.2 (0.4)	0 (0.0)	1.3 (0.5)	< .001	0 (0.0)	1.2 (0.5)	.445	1.0 (0.4)	1.5 (0.8)	.297	2.0 (1.4)	1.0 (0.5)	.197
20–29													
30–39	5.0 (0.9)	10.5 (5.3)	4.7 (1.0)		5.4 (3.3)	5.0 (1.0)		4.4 (1.1)	5.9 (1.6)		5.1 (2.4)	5.0 (1.0)	
40–49	15.4 (1.4)	29.8 (8.0)	14.5 (1.3)		17.7 (7.1)	15.3 (1.4)		15.7 (1.8)	15.0 (2.1)		17.6 (3.8)	15.1 (1.4)	
50–59	31.7 (1.8)	43.3 (8.3)	31.0 (1.9)		30.6 (7.0)	31.8 (1.9)		34.5 (2.5)	28.1 (2.7)		30.2 (4.9)	31.9 (1.9)	
60–69	22.4 (1.5)	14.2 (4.6)	22.9 (1.6)		32.5 (7.4)	21.9 (1.5)		23.1 (2.0)	21.6 (2.2)		29.4 (4.4)	21.3 (1.6)	
Over 70	24.3 (1.5)	2.2 (1.6)	25.6 (1.6)		13.8 (4.9)	24.8 (1.5)		21.4 (2.1)	28.0 (2.4)		15.7 (3.2)	25.6 (1.6)	
Income (%)	23.7 (1.7)	9.1 (3.9)	24.6 (1.8)	.105	19.7 (6.3)	23.9 (1.7)	.829	23.4 (2.2)	24.1 (2.5)	.966	18.3 (4.1)	24.5 (1.8)	.005
1st Q													
2nd Q	23.4 (1.6)	26.1 (8.1)	23.2 (1.6)		23.6 (6.5)	23.4 (1.6)		23.0 (2.1)	23.9 (2.3)		14.3 (3.3)	24.8 (1.7)	
3rd Q	26.7 (1.7)	35.1 (7.7)	26.2 (1.7)		24.7 (6.7)	26.7 (1.8)		26.7 (2.2)	26.7 (2.8)		27.8 (4.5)	26.6 (1.9)	
4th Q	26.2 (1.7)	29.8 (7.1)	26.0 (1.7)		32.0 (7.5)	25.9 (1.7)		26.9 (2.2)	25.3 (2.6)		39.5 (5.0)	24.2 (1.8)	
Educational level (%)	45.8 (1.8)	27.9 (7.5)	46.8 (1.9)	.075	42.8 (1.9)	45.9 (1.9)	.319	41.2 (2.4)	51.6 (3.0)	.019	28.2 (4.4)	48.5 (2.0)	.001
< High school													
High school	32.8 (1.7)	42.6 (8.2)	32.3 (1.8)		33.2 (1.8)	33.2 (1.8)		36.8 (2.4)	27.7 (2.7)		43.0 (4.9)	31.3 (1.8)	
College or over	21.4 (1.6)	29.5 (7.4)	20.9 (1.6)		21.0 (1.6)	21.0 (1.6)		22.0 (1.9)	20.7 (2.5)		28.8 (4.5)	20.3 (1.7)	
Marital status (%)	1003 (97.4)	96.7 (3.2)	97.5 (0.6)	.804	99.1 (0.9)	97.4 (0.6)	.211	97.4 (0.8)	97.6 (0.9)	.866	94.3 (2.3)	97.9 (0.6)	.06
Married													
Single	24 (2.6)	3.3 (3.2)	2.5 (0.6)		0.9 (0.9)	2.6 (0.6)		2.6 (0.8)	2.4 (0.9)		5.7 (2.3)	2.1 (0.6)	
Smoking status	3.5 (0.7)	1.3 (1.3)	3.7 (0.7)	.217	9.0 (4.6)	3.3 (0.7)	.103	2.2 (0.7)	5.2 (1.3)	.034	4.9 (2.1)	3.3 (0.8)	.675
Current													
Ex-smoker	3.9 (0.6)	1.8 (1.3)	4.0 (0.7)		1.4 (1.1)	4.0 (0.7)		4.7 (1.0)	2.8 (0.8)		3.5 (1.5)	3.9 (0.7)	

Note. SE = standard error, HDL = high-density lipoprotein.

Variable	Total	Regular physical activity (Mean or % ± (SE))											
	Mean or % ± (SE)												
Non-smoker	92.6 (0.9)	96.6 (1.9)	92.4 (1.0)		89.6 (4.7)	92.8 (1.0)		93.1 (1.2)	92.0 (1.5)		91.6 (2.5)	92.8 (1.0)	
Drinking status (%)	45.7 (1.8)	27.1 (7.1)	46.8 (1.8)	.081	37.7 (7.4)	46.1 (1.8)	.414	41.3 (2.5)	51.4 (2.8)	.05	31.5 (4.3)	47.9 (1.9)	.025
None													
Mild	35.0 (1.8)	49.3 (8.3)	34.1 (1.9)		44.5 (7.9)	34.5 (1.9)		38.4 (2.4)	30.5 (2.8)		43.5 (4.9)	33.6 (1.9)	
Moderate	17.9 (1.4)	23.6 (7.7)	17.6 (1.5)		14.0 (5.0)	18.1 (1.5)		19.2 (2.0)	16.2 (2.1)		23.7 (4.2)	17.0 (1.5)	
Severe	1.4 (0.5)	0 (0.0)	1.5 (0.5)		3.7 (3.6)	1.3 (0.5)		1.1 (0.5)	1.8 (0.9)		1.2 (1.2)	1.4 (0.5)	
Exercise	27.0 (1.7)	100 (0.0)	22.8 (1.6)	< .001	100 (0.0)	23.6 (1.6)	< .001	36.2 (2.4)	15.1 (2.0)	< .001	49.9 (5.0)	23.5 (1.7)	< .001
Yes													
No	73.0 (1.7)	0 (0.0)	77.2 (1.6)		0 (0.0)	76.4 (1.6)		63.8 (2.4)	84.9 (2.0)		50.1 (5.0)	76.5 (1.7)	
Body mass index	23.72 ± 0.12	22.30 ± 0.41	23.80 ± 0.12	< .001	23.50 ± 0.4	23.73 ± 0.12	.577	23.57 ± 0.16	23.91 ± 0.17	.147	22.99 ± 0.31	23.83 ± 0.13	.011
Waist circumference	80.65 ± 0.35	76.14 ± 1.13	80.92 ± 0.36	< .001	80.24 ± 1.16	80.67 ± 0.36	.721	80.46 ± 0.44	80.90 ± 0.54	.522	78.27 ± 0.81	81.02 ± 0.38	.002
Blood pressure	121.0 ± 0.69	113.51 ± 1.91	121.48 ± 0.71	< .001	121.30 ± 3.18	121.03 ± 0.70	.934	121.52 ± 0.94	120.42 ± 1.04	.44	116.43 ± 1.73	121.75 ± 0.72	.004
Systolic													
Diastolic	74.54 ± 0.36	75.31 ± 1.60	74.50 ± 0.36	.605	75.53 ± 1.36	74.50 ± 0.38	.466	75.02 ± 0.49	73.92 ± 0.57	.147	73.27 ± 0.80	74.74 ± 0.40	.095
Fasting blood glucose	100.99 ± 0.80	93.84 ± 2.29	101.41 ± 0.83	.002	103.05 ± 3.54	100.90 ± 0.82	.554	101.77 ± 1.20	99.98 ± 0.96	.244	95.77 ± 1.17	101.79 ± 0.89	< .001
Triglycerides	120.25 ± 2.54	97.78 ± 8.03	121.57 ± 2.62	.005	116.83 ± 10.55	120.41 ± 2.60	.741	115.52 ± 2.79	126.41 ± 4.40	.034	105.84 ± 0.58	122.46 ± 2.78	.009
Total cholesterol	196.61 ± 1.47	189.58 ± 4.53	197.03 ± 1.53	.12	198.66 ± 5.40	196.52 ± 1.52	.703	195.78 ± 1.92	197.70 ± 2.16	.498	196.88 ± 3.18	196.57 ± 1.62	.931
HDL cholesterol	53.30 ± 0.50	57.26 ± 2.14	53.07 ± 0.51	.057	58.11 ± 3.11	53.08 ± 0.48	.108	54.21 ± 0.62	52.12 ± 0.79	.036	55.63 ± 1.30	52.94 ± 0.54	.058
Stage of female cancer survivorship	3.6 (0.7)	9.9 (6.1)	3.3 (0.6)	.237	7.1 (4.9)	3.5 (0.7)	.595	4.4 (1.1)	2.7 (0.7)	.212	5.0 (2.0)	3.4 (0.7)	.71
< 2 years													
2–4 years	13.6 (1.3)	11.2 (4.7)	13.7 (1.4)		11.4 (5.1)	13.7 (1.4)		14.9 (1.9)	12.0 (1.9)		12.6 (3.2)	13.7 (1.5)	
≥ 5 years	82.8 (1.4)	78.9 (7.1)	83.0 (1.4)		81.5 (6.6)	82.8 (1.4)		80.7 (2.1)	85.4 (2.0)		82.3 (3.6)	82.8 (1.5)	
Cancer type	11.5 (1.1)	10.0 (5.6)	11.6 (1.1)	.061	8.3 (3.6)	11.6 (1.2)	.733	13.4 (1.7)	9.0 (1.4)	.093	6.6 (2.4)	12.2 (1.2)	.077
Gastric													
Liver	0.3 (0.2)	0 (0.0)	0.3 (0.2)	.011	0 (0.0)	0.3 (0.2)	.865	0.1 (0.1)	0.5 (0.4)	.311	0.5 (0.5)	0.2 (0.2)	.194
Colorectal	6.5 (0.9)	1.7 (1.7)	6.8 (0.9)	.003	5.4 (3.6)	6.5 (0.9)	.907	6.2 (1.1)	6.9 (1.4)	.906	6.6 (2.2)	6.5 (0.9)	.119
Breast	21.4 (1.6)	19.1 (6.5)	21.5 (1.6)	.033	20.6 (6.1)	21.4 (1.6)	.732	22.3 (2.2)	20.3 (2.3)	.637	25.4 (4.6)	20.8 (1.7)	.526
Cervical	24.1 (1.8)	25.0 (6.6)	34.1 (1.8)	.062	20.9 (6.3)	24.3 (1.8)	.82	27.0 (2.7)	21.9 (2.1)	.209	16.9 (3.4)	25.3 (1.9)	.062

Note. SE = standard error, HDL = high-density lipoprotein.

Variable	Total	Regular physical activity (Mean or % ± (SE))											
	Mean or % ± (SE)												
Lung	1.5 (0.4)	3.3 (3.2)	1.4 (0.4)	.019	0.1 (0.1)	1.5 (0.4)	.303	2.0 (0.7)	1.1 (0.5)	.33	1.4 (1.4)	1.5 (0.4)	.325
Thyroid	24.8 (1.8)	20.6 (7.2)	25.0 (1.8)	.19	22.2 (6.8)	24.9 (1.8)	.884	26.4 (2.3)	22.7 (2.9)	.233	24.9 (4.3)	24.7 (1.9)	.237
Others	18.8 (1.5)	25.5 (7.1)	18.4 (1.5)	.035	26.8 (7.7)	18.4 (1.5)	.349	16.8 (2.0)	21.3 (2.3)	.198	23.9 (4.6)	18.0 (1.6)	.224

Note. SE = standard error, HDL = high-density lipoprotein.

Among individuals who engaged in walking as a physical activity, the proportion of those without metabolic syndrome was significantly higher than non-walkers. In this group, smoking status varied significantly, with the highest proportion being non-smokers, followed by former smokers and current smokers. Individuals who engaged in walking as a physical activity had significantly lower triglyceride levels and significantly higher HDL cholesterol levels than non-walkers.

Among individuals who did muscle-strengthening activity, a significantly higher proportion were without metabolic syndrome compared to those who did not. In this group, BMI, waist circumference, fasting blood glucose, and triglycerides were significantly lower than in those not engaging in muscle-strengthening activity.

5.3. Crude OR Among Oral Contraceptive Pill Use, Regular Physical Activity, and Metabolic Syndrome Components

Table 3 shows crude associations between oral contraceptive use, regular physical activity, and metabolic syndrome components in female cancer survivors. Three metabolic syndrome components were significant for oral contraceptive use. Oral contraceptive pill use was significantly associated with an increased likelihood of larger waist circumference, elevated BP, and higher fasting blood glucose levels.

Table 3
Crude OR among oral contraceptive pill, regular physical activity, and metabolic syndrome components (N = 1,027)

Variable	Oral contraceptive pill		Vigorous physical activity		Moderate physical activity		Walking physical activity		Muscle physical activity	
	OR (95% CI)	*P*	OR (95% CI)	*P*	OR (95% CI)	*P*	OR (95% CI)	*P*	OR (95% CI)	*P*
Increased waist circumferences										
Yes	1.492 (1.023–2.177)	.038	0.31 (0.152–0.632)	.001	0.89 (0.473–1.676)	.718	0.885 (0.668–1.172)	.392	0.484 (0.317–0.739)	.001
No	1		1		1		1		1	
Increased triglycerides										
Yes	1.363 (0.931–1.997)	.111	0.446 (0.220–0.902)	.025	0.873 (0.446–1.708)	.69	0.829 (0.620–1.107)	.203	0.632 (0.405–0.987)	.044
No	1		1		1		1		1	
Decreased HDL cholesterol Yes	1.263 (0.846–1.887)	.254	0.419 (0.212–0.827)	.012	0.688 (0.366–1.295)	.246	0.695 (0.516–0.937)	.017	0.804 (0.526–1.230)	.314
No	1		1		1		1		1	
Increased blood pressure										
Yes	2.08 (1.406–3.075)	< .001	0.395 (0.193–0.808)	.011	0.649 (0.341–1.233)	.186	0.863 (0.636–1.170)	.342	0.502 (0.335–0.752)	.001
No	1		1		1		1		1	
Increased fasting blood glucose										
Yes	1.621 (1.104–2.381)	.014	0.378 (0.173–0.828)	.015	0.921 (0.483–1.753)	.801	0.881 (0.655–1.184)	.4	0.621 (0.401–0.963)	.033
No	1		1		1		1		1	

Note. OR = odds ratio, CI = confidence interval, HDL = high-density lipoprotein.

In the vigorous physical activity group, all five metabolic syndrome components were significant. Vigorous physical activity was significantly associated with a reduced likelihood of larger waist circumference, lower triglyceride levels, increased HDL cholesterol, lower BP, and lower fasting blood glucose levels.

For walking as a physical activity, only one component of metabolic syndrome was significant. Walking as a physical activity was significantly associated with increased HDL cholesterol levels. In muscle-strengthening physical activity, four metabolic syndrome components were significant. Muscle-strengthening physical activity was significantly associated with a reduced likelihood of a larger waist circumference, lower triglyceride levels, lower BP, and lower fasting blood glucose levels.

5.4. Crude OR Among Oral Contraceptive Pill Use, Regular Physical Activity, and Metabolic Syndrome

Table 4 presents the detailed results of the crude associations between oral contraceptive pill use, regular physical activity, and metabolic syndrome among female cancer survivors. Oral contraceptive pill use was significantly related to metabolic syndrome, and vigorous physical activity was significantly related to metabolic syndrome. Walking was significantly related to metabolic syndrome, and muscle-strengthening physical activity was also significantly related to metabolic syndrome.

Table 4
Crude OR among oral contraceptive pill, regular physical activity, and metabolic syndrome (N = 1,027)

Variable	Metabolic syndrome	
	OR (95% CI)	*P*
Oral contraceptive		
Yes	1.955 (1.305–2.928)	.001
No	1	
Vigorous physical activity		
Yes	0.33 (0.162–0.672)	.002
No	1	
Moderate physical activity Yes	0.701 (0.364–1.350)	.288
No	1	
Walking physical activity		
Yes	0.725 (0.548–0.961)	.026
No	1	
Muscle physical activity		
Yes	0.511 (0.332–0.787)	.002
No	1	

6. Discussion

This study utilized secondary data from the 2010 to 2020 KNHANES to examine the associations among oral contraceptive pill use, regular physical activity, and metabolic syndrome in female cancer survivors. Approximately 59% of female cancer survivors who used oral contraceptive pills had metabolic syndrome. These results align with previous studies that have identified an association between oral contraceptive pill use and metabolic syndrome [24]. The use of oral contraceptive pills containing estrogen and progesterone has been linked to cardiomegaly and activation of the renin-angiotensin system, which increases the angiotensin response and can contribute to hypertension [25].

Approximately 77.4% of female cancer survivors who engaged in vigorous physical activity did not have metabolic syndrome. These findings are consistent with previous research highlighting the beneficial effects of exercise on metabolic syndrome among female breast cancer survivors [26]. The group that received a 6-month exercise intervention showed significant improvements in all components of metabolic syndrome compared to the control group [27].

This study identified significant associations between oral contraceptive pill use and components of metabolic syndrome related to waist circumference, BP, and fasting blood glucose. These findings are consistent with previous research demonstrating that oral contraceptive pill use influences cardiovascular disease risk factors, increases waist circumference and hypertension, and elevates blood glucose levels [25].

Previous research suggests that estrogen and progesterone in oral contraceptive pills can affect glucose tolerance, with progesterone exerting the most substantial influence on carbohydrate metabolism [28]. In this study, female cancer survivors' engagement in walking, muscle-strengthening, and vigorous physical activity was significantly associated with metabolic syndrome. These findings were somewhat similar to yet also differed from the results reported in a previous study [29], where moderate to vigorous physical activity showed significant associations with only one component of metabolic syndrome (BP). In contrast, this study found that moderate physical activity had no significant influence on any components of metabolic syndrome, whereas vigorous physical activity was significantly associated with all five components.

Moreover, previous research on endometrial cancer survivors has emphasized the importance of increasing regular physical activity to reduce the risk of cardiovascular disease [26]. Regular physical activity, including walking, not only reduces metabolic syndrome-related factors and cardiovascular disease-related mortality but also prevents cancer recurrence, improves psychological well-being, and enhances quality of life in cancer survivors [30].

6.1. Strengths and Limitations of the Work

The current findings, based on nationally representative data from the 2010 to 2020 KNHANES, demonstrate associations between oral contraceptive pill use, regular physical activity, and metabolic syndrome among female cancer survivors. These results provide fundamental data that can support health promotion and disease prevention strategies for this population.

This study has some limitations. First, since this study was based on KNHANES data from 2010 to 2020, the sample size of female cancer survivors was limited. Second, because KNHANES provides cross-sectional secondary data, causal relationships cannot be established.

Despite these limitations, the significance of this study lies in its use of nationally representative KNHANES data spanning a 10-year period, allowing for an analysis of trends and associations generalizable to female cancer survivors in South Korea.

6.2. Recommendations for Further Research

Future research should build on this study's findings by conducting further analyses of integrated datasets from KNHANES. Additionally, future studies are needed to elucidate the biological and metabolic pathways through which oral contraceptives increase the risk of metabolic syndrome among female cancer survivors. Furthermore, exploratory analyses are needed to examine the effects of oral contraceptives on the risk of metabolic syndrome, considering biomarkers such as composition (type), hormonal regulation, insulin resistance, and dose-response. Furthermore, detailed comparative studies are needed to examine the differences in effects based on cancer type and treatment modality (e.g., chemotherapy, radiation, etc.). Furthermore, studies are needed to quantitatively categorize exercise intensity, frequency, duration, and type to determine the preventive effects of oral contraceptives. Future studies employing interaction effects and multivariate analyses are needed to clarify the relationship between oral contraceptive use, physical activity, and the risk of metabolic syndrome.

6.3. Implications for Policy and Practice

Metabolic syndrome risk assessments should be conducted before prescribing oral contraceptives to female cancer survivors. These assessments should include preliminary analyses and counseling related to BMI, abdominal obesity, BP, fasting blood glucose, and lipid profiles. Health education programs should provide information on preventing metabolic syndrome, including the potential metabolic impact of oral contraceptives, as well as standardized physical activity guidelines.

Health management policies for female cancer survivors should emphasize the prevention of metabolic syndrome. This approach should include tracking and monitoring oral contraceptive use, regular screening and counseling for metabolic syndrome, and collaboration with local health centers, sports facilities, and cancer survivor community centers to develop customized exercise programs for female cancer survivors.

Furthermore, an integrated treatment and prevention system involving oncologists, obstetricians, gynecologists, exercise prescription specialists, and nutritionists should be established. This multidisciplinary health management system should include measures of metabolic syndrome-related indicators, facilitating ongoing monitoring and management.

7. Conclusions

Female cancer survivors who use oral contraceptive pills should adopt preventive measures against metabolic syndrome, including regular physical activity such as vigorous exercise, walking, and muscle-strengthening activities. Additionally, female cancer survivors at risk for metabolic syndrome components should consider limiting their use of oral contraceptive pills and prioritize regular physical activity to mitigate these risks.

Declarations

Ethics approval and consent to participate

The project was submitted for evaluation to the institutional review board of Semyung University (No. SMU-EX-2022-03-002). As this study was a secondary analysis using the KNHANES data, the institutional review board exempted it from formal ethical approval.

Consent for publication

Not applicable.

Competing interests

The author declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

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Author Contribution

YJS conceptualized the study design and performed data collection and analysis. YJS wrote the original draft of the manuscript. Author read and approved the manuscript.

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Data Availability

The dataset used in this study, along with more information about the data, can be obtained from the official website of the Fifth-Eighth Korea National Health and Nutrition Examination Survey (https://knhanes.kdca.go.kr/knhanes).

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