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Sedentary Lifestyle and Overweight in Relation to the Risk of Polycystic Ovary Syndrome in Senior High School Students in Surabaya

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A B S T R A C T

Introduction: Adolescent polycystic ovary syndrome (PCOS) is one of the endocrine and metabolic disorders characterized by oligomenorrhea and hyperandrogenism. A sedentary lifestyle in adolescence increases the risk of overweight and obesity. This study aimed to examine the relationship between a sedentary lifestyle and being overweight as the risk of PCOS in adolescents.

Methods: This was an observational analytic study with a cross-sectional design. This study was held at State Senior High School (SMAN) 5 Surabaya from February to April 2020. The sample of this research was chosen by random sampling of all female students in SMAN 5 Surabaya. The data were collected by direct measurement of students' weight and height and a questionnaire consisting of Global Physical Activities Questionnaire, menstrual cycle, and Ferriman–Gallwey score. The data were analyzed using logistic regression analysis.

Results: Of 82 students (100%), 32 students were overweight (39%), 5 students had obesity (6.1%), 44 students were performing a sedentary lifestyle (53.7%), 42 students had Ferriman–Gallwey score ≥5 (51.2%), 38 students had an abnormal uterine bleeding pattern (43.3%), and 35 students were at risk of PCOS (42.6%). Logistic regression analysis showed there was a significant relationship between a sedentary lifestyle and the risk of PCOS ($p = 0.004$) and a significant relationship between being overweight and the risk of PCOS ($p < 0.001$).

Conclusion: Sedentary lifestyle and overweight have the role of increasing the risk of PCOS in adolescents.

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Introduction

A sedentary lifestyle is an inactive behavior including a lack of movement and exercise.[1] Most high school students in Surabaya are spending more time performing a sedentary lifestyle. Based on the results of Basic Health Research in 2018, the proportion of inactivity among adolescents reached almost 25%.[2] This might happen because the academic activity in school mostly consisted of only sitting in class rather than doing physical activity. The sports subject that requires physical activity is only conducted for 150 minutes per week. Unhealthy eating patterns, the non-diversity of food availability in school canteens, and the habit of eating fast food high in sugar, salt, and oil are some of the main causes of the inadequate intake of nutritious foods. A sedentary lifestyle and unhealthy eating patterns with low nutrition that occur continuously will lead to overweight and even obesity.

Being overweight is an abnormal or excessive accumulation of lipids that may cause dangerous risks to health. Based on the results of Basic Health Research in 2010, the prevalence of overweight and obesity in school children in East Java was 12.4%, which was above the national prevalence.[3] This obesity rate continued to increase, in 2007 it was 18.8% and in 2013 it was 26.6%. Meanwhile, in the proportion of central obesity based on provinces, East Java reached 30%, which was above the central obesity rate for Indonesia over 15 years of age which reached 31%.[2]

In an obesity condition, the storage of triglycerides in adipocyte cells increases, resulting in the release of free fatty acids into the bloodstream causing lipotoxicity which disrupts the work of insulin receptors. Insulin receptor dysfunction that occurs for a long time causes the body to develop insulin resistance. In the early phase, pancreatic beta cells will compensate by increasing insulin secretion. However, if this compensation continues, the body will experience hyperinsulinemia.[4] Insulin has a role in stimulating androgen production in the ovaries. Hyperinsulinemia can increase ovarian androgen production directly by stimulating cytochrome P450c17a and steroidogenesis and indirectly by stimulating the release of gonadotropin hormone-releasing hormone (GnRH) resulting in increased secretion of luteinizing hormone (LH).[5] It can be concluded that hyperinsulinemia can cause hyperandrogenism. The increase in androgens causes a decrease in the aromatization of follicle-stimulating hormone (FSH), resulting in the immaturity of the follicles. It causes a decrease in estrogen and ovulation does not occur. In addition, excessive levels of free androgens in the blood cause an increase in the conversion of androgens to dihydrotestosterone in peripheral tissues, causing hypersecretion of oil glands and an increase in changes in vellus hair to terminal hair in hair follicles, called hirsutism.[6]

Based on the consensus by the International Pediatric Subspecialty Societies in 2015, it was found that the diagnostic criteria for adolescent polycystic ovary syndrome (PCOS) are a combination of abnormal uterine bleeding patterns and evidence of hyperandrogenism.[7]

This study aimed to determine the impact of sedentary lifestyle and obesity on the increased risk of PCOS in adolescents, the relationship between sedentary lifestyle behavior and overweight on increasing the risk of PCOS in adolescents, and determine which factor has a dominant effect on increasing the risk of PCOS in adolescents. Through this study, it is expected that adolescents can discover the bad effects of sedentary lifestyle habits and obesity to prevent the risk of developing PCOS in the near and long term. In addition, it is expected that schools and local education offices can increase academic activities that involve physical activity for students and provide healthy and nutritious food in school canteens.

Methods

This study used an observational analytic study and cross-sectional design with multivariate logistic regression analysis to determine the relationship between a sedentary lifestyle and being overweight with the risk of PCOS. The study was conducted at State Senior High School (SMAN) 5 Surabaya. The data were collected from February to April 2020. The population of this study was all female students of SMAN 5 Surabaya. The subjects of this study were 82 students of SMAN 5 Surabaya selected using a random sampling technique. The instruments of the study were a curated weight and height scale and a questionnaire consisting of 4 subcategories, namely the results of individual physical activity assessments, body weight and height measurements, menstrual patterns, and clinical signs of hyperandrogenism. After selecting random sampling, the selected subjects were given a complete explanation of the study and filled out a statement of agreement.

Based on the analysis guide by World Health Organization (WHO) Global Physical Activity Questionnaire (GPAQ), the questionnaire is assessed by multiplying the number of days and duration (minutes) with a constant metabolic equivalent of task (MET) value of 8 in the category of vigorous work and recreation and constant MET value of 4 in the category of moderate work, recreation, and transportation. Furthermore, the entire value is the result of multiplying each domain by the MET value added. If the sum of all these values is more or equal to 600 MET-minutes, the respondent is included in the physically active category, and when the sum of all values is less than 600 MET-minutes, the respondent is included in the physically inactive category. The body mass index (BMI) criteria used were WHO criteria for BMI in the Asia Pacific region with 4 categories, underweight (18.5 kg/m2), normal (18.5-22.9 kg/m2), overweight (23-24.9 kg/m2), and obesity (> 25 kg/m2). Based on the Ferriman-Gallwey score interpretation, the hirsutism cut-off point for the Asian population is ≥5. The abnormal uterine bleeding was diagnosed if the respondent answered ‘yes’ in bleeding period lasts outside 3-7 days, irregular menstrual cycle, menstrual cycle lasts beyond 45 days, and/or heavy menstrual bleeding. The students were stated at risk of PCOS if they had abnormal uterine bleeding pattern and had Ferriman-Gallwey score ≥5.

The methods used in this study were an observational analytic study with cross-sectional design. Data analysis used logistic regression test. There was a significant partial effect of the independent variable on the dependent variable if the p-value < 0.05. Data were processed using Microsoft Excel and analyzed using IBM SPSS 25.

Results

Distribution of Physical Activity

The study included 82 students. Based on the answers of the questionnaire, none of the students did vigorous work (0%), 51.9% of the students performed moderate work, 32.9% were actively transporting by walking or cycling for 10 minutes continuously, 23.2% did vigorous recreation activities, and 48.8% did moderate recreation activities. After being calculated using the guideline of WHO GPAQ, 53.7% of the students were under the cut-off recommendation of WHO GPAQ (<600 MET-minutes) and 46.3% of the students reached the cut-off recommendation of WHO GPAQ (>600 MET-minutes).

Table 1. Distribution of student's physical activity

Global Physical Activity Questionnaire	n	%
Work		
Vigorous	0	0
Moderate	42	51.9
Transport	27	32.9
Recreation		
Vigorous	19	23.2
Moderate	40	48.8
MET-minutes		
< 600 MET-minutes	44	53.7
≥ 600 MET-minutes	38	46.3

Distribution of BMI

Based on the direct measurement, 19.5% were underweight, 35.4% had normal weight, 39% were overweight, and 6.1% were obese.

Table 2. Distribution of BMI

BMI	n	%
Underweight	16	19.5
Normal weight	29	35.4
Overweight	32	39
Obesity	5	6.1
Total	82	100

Distribution of Ferriman-Gallwey Score and Menstrual Pattern

Based on the results of the questionnaire, 48.8% of the students had Ferriman-Gallwey score less than 5, 51.2% had Ferriman-Gallwey score more than 5, 11% had irregular menstrual pattern, 23.1% had a heavy menstrual bleeding, 12.2% had both of irregular menstrual pattern and heavy menstrual bleeding, and 53.7% had a normal menstrual pattern.

Table 3. Distribution of Ferriman-Gallwey score and menstrual pattern

Characteristics	n	%
Ferriman-Gallwey Score		
Ferriman-Gallwey score <5	40	48.8
Ferriman-Gallwey score ≥5	42	51.2
Menstrual Patterns		
Irregular menstrual pattern	9	11
Heavy menstrual bleeding	19	23.1
Irregular pattern and heavy menstrual bleeding	10	12.2
Normal menstrual pattern	44	53.7

Prevalence of the Risk of PCOS by BMI

Table 4 shows the distribution of the student's physical activity and BMI as the independent variable and the risk of PCOS as the dependent variable.

Table 4. Prevalence of the risk of PCOS by physical activity and BMI

Characteristics	With PCOS Risk %(n)	Without PCOS Risk %(n)
Physical Activity		
<600 MET-minutes	43.2(19)	56.8(25)
>600 MET-minutes	42.1(16)	57.9(22)
BMI		
Underweight	18.8(3)	81.2(13)
Normal Weight	17.2(5)	82.8(24)
Overweight	75(24)	25(8)
Obesity	60(3)	40(2)

Results of Logistic Regression Test

The overweight variable had a p value of 0.000 < 0.05, hence rejecting H0, meaning obesity had a significant partial effect on the increased risk of PCOS. Physical activity had a p value of 0.004 < 0.05, hence rejecting H0, meaning sedentary lifestyle has a significant partial effect on the increased risk of PCOS. The odds ratio (OR) value of the overweight variable was 16.2, meaning people with higher BMI have an increased risk of PCOS 16.2 times higher than people with normal BMI. The OR value of the lifestyle variable was 6.3, meaning people with low physical activity (below 600 MET-Minutes) have an increased risk of PCOS 6.3 times higher than people who are physically active.

Table 5. Results of logistic regression test

	B	S.E	Wald	df	Sig	Exp(B)
Sedentary Lifestyle	1.852	0.635	8.504	1	0.004	6.373
Overweight	2.769	0.630	19.577	1	0.000	16.260
Constant	-2.736	0.652	17.617	1	0.000	0.065

Discussion

Based on the results of interviews using the GPAQ instrument, it was found that 44 students (53.7%) of SMAN 5 Surabaya had a total number of MET-minutes less than 600 MET-minutes, meaning that below the minimum number a person is said to be physically active. Therefore, it could be assumed that the majority of the students at SMAN 5 Surabaya had low physical activity. This might be due to SMAN 5 Surabaya which is located in the center of Surabaya and away from residential areas, therefore the students chose to use transportation such as cars or motorbikes. In addition, tutoring places that are close to the school could also be the cause of the lack of walking intensity for the students at SMAN 5 Surabaya. In the sports area, 19 students (23.2%) answered that they did vigorous-intensity sports such as fitness, running, football, or other sports that caused an increase and a large pulse rate in at least 10 minutes continuously. From these results, it could be concluded that the physical activity of the respondents was mostly contributed by moderate physical activity, followed by moderate recreational activities, and finally moving places. This could be due to the relatively narrow free time of the students at SMAN 5 Surabaya to do sports for a long time and the majority of the students used motorized vehicles. This trend continued to increase every year because of the high demands of work reduce the time for physical activity.[8]

It could be concluded that 53.7% of the students were physically inactive, 39% of the students were overweight, and 6.1% of the students were obese at SMAN 5 Surabaya. Thus, the high level of inactivity of the students at SMAN 5 Surabaya might trigger the high rate of overweight and obesity. These results are in line with a study conducted by Blundell, *et al*. in 2020 stating that the body of a person with sedentary lifestyle tended to experience chaos in controlling the signals in their body. When a person is not moving actively, their body is unable to send signal to the brain that they are eating too much, therefore their body will lose the ability to compensate the inactivity of the body by reducing the calories intake.[9] This will lead a person's energy expenditure to be less than the calories intake. If it occurs continuously, it can trigger a person to gain weight without realizing it and has excess body weight.

The clinical diagnosis of PCOS in adolescents is a combination of two symptoms, chronic anovulation and evidence of hyperandrogenism.[7] In this study, abnormal uterine bleeding was assessed using questionnaire. 46.3% of the students experienced signs of chronic anovulation. Abnormal uterine bleeding in adolescents can be caused by many things, such as stress, eating disorders, excessive exercise, and incorrect weight loss program.[10,11] In addition, in the first 5 years after menarche, anovulation due to immature hypothalamic-pituitary-ovarian-axis is a common cause of abnormal bleeding.[12,13] Furthermore, there were 42 students (51.2%) who had a Ferriman-Gallwey score ≥ 5, meaning they could be categorized as having hirsutism.

Based on Table 3, it describes that 43.2% physically inactive students had the risk of PCOS. This is similar to a study on 20 inactive respondents compared to active control respondents. There was a significant relationship between physical inactivity and increased insulin resistance.[12] Insulin resistance will cause hyperinsulinemia, which affects cytochrome P450c17a in the ovaries, produce androgens and affects the production of sex hormone binding globulin (SHBG) in the liver, both causing hyperandrogenism and insulin-related stimulation of growth factor tissue production that can stimulate the growth of ovarian cyst.[3] However, a study conducted by Isganaitis, Suehiro, and Cardona in 2017 found that metabolic syndrome was related to family heredity through the paternal route and could be the basis for the pathogenesis of PCOS in an individual.[14] Each individual has a different amount and sensitivity of insulin receptors which makes hyperinsulinemia not always cause the same symptoms in every individual. This could be the reason why students who were physically inactive did not have the risk of PCOS and the opposite.

Based on Table 4, it was found that 75% of overweight students and 60% of obese students had a risk of PCOS. These results are in line with a study conducted by West, *et al*. in 2014, and Ng in 2017,Itriyeva in 2022 stating that women who are overweight and obese had a representation of hyperandrogenism, irregular menstruation, and acanthosis nigricans.[15–17] Adolescents with excessive fat and hyperandrogenism have 50% lower peripheral insulin sensitivity than normal-weight adolescents.[18] This result is also in accordance with the theory by Cerf in 2013, stating that in a state of obesity, free fatty acids of the blood increase causing disturbance of insulin receptors, thus pancreatic beta cells compensate by increasing insulin production. This increase causes hyperinsulinemia and hyperandrogenism that influence each other.[19]

Based on Table 5, it was found that 68.6% of the students had excess BMI and 54.2% were performing a sedentary lifestyle. The results of the logistic regression test showed that there was a statistically significant relationship between excess BMI and sedentary lifestyle with an increased risk of PCOS. The p-value = 0.000 ($p < 0.001$) in excess BMI and p-value = 0.004 in the sedentary lifestyle. From these results, it could be concluded that both excess BMI and sedentary lifestyle have a significant relationship with the increased risk of PCOS because it had $p < 0.05$. Based on the results of the OR, it was found that an overweight person has a 16.2 folds higher chance of having a risk of PCOS than an individual with a normal BMI. Someone with a sedentary lifestyle has a 6.3 folds higher chance of having a risk of PCOS than a physically active individual.

This is similar to a previous study, adolescents with PCOS have a greater BMI than adolescents with normal BMI.[18] Adolescent girls with PCOS have been detected to have metabolic abnormalities such as a 50% reduction in peripheral tissue sensitivity to insulin, proven insulin resistance, and compensated hyperinsulinemia.[18] Therefore, adolescents who have clinical signs of a risk of PCOS are expected to see an obstetrician and gynecologist early to prevent further metabolic disorders

such as type 2 diabetes mellitus. Weight loss, maintaining ideal body weight, and metformin can be used to improve the metabolic system and hormone regulation in adolescents with PCOS.[20]

Conclusion

There was a significant relationship between sedentary lifestyle and an increased risk of PCOS and overweight and an increased risk of PCOS. Overweight increases the risk of PCOS in adolescents by 16.2 folds higher than normal weight, which is higher than the effect of sedentary lifestyle on the increased risk of PCOS, which is 6.3 folds higher than physically active adolescents.

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Conflict of Interest

The authors declared there is no conflict of interest.

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