Vol 10 No 3, 2025

BULETIN FARMATERA

E-ISSN: 2528-410X

META-ANALYSIS

Resistance Training Has an Effect on Lowering Insulin Resistance Based on HOMA IR Examination in Poly Cystic Ovarian Syndrome (PCOS) Patients: Meta-Analysis

Muhammad Solih Nasution[1], Aidil Akbar[2]

[1]Faculty of Medicine, Universitas Muhammadiyah Sumatera Utara, Jalan Gedung Arca No. 53 Medan, Sumatera Utara, 20217, Indonesia

[2]Department Obstetric And Gynecology,Faculty of Medicine, Universitas Muhammadiyah Sumatera Utara, Jalan Gedung Arca No. 53 Medan,Sumatera Utara , 20217, Indonesia

Corresponding Email: msolihnst1996@gmail.com

Abstract: *Poly Cystic Ovarian Syndrome* (PCOS) is a complex endocrine disorder that affects women of reproductive age. Insulin resistance, obesity, and hormonal imbalances are the main characteristics of this condition. Physical exercise, including weight training or *resistance training* , is suspected to be effective in lowering insulin resistance, but direct comparisons based on the results of the HOMA IR examination have not been carried out systematically. This meta-analysis aimed to evaluate the effectiveness of weight training in lowering insulin resistance based on the results of the HOMA IR examination in PCOS patients. Four clinical studies that met the inclusion criteria and included 87 women diagnosed with PCOS and 93 women without PCOS were analyzed for their insulin resistance conditions. Insulin resistance check parameters using the HOMA IR test. Statistical analysis using a fixed effect model with a paired t test. Overall, *resistance training interventions* showed a negative effect on the difference in HOMA-IR between pre-test and post-test. The mean HOMA-IR score after the intervention was lower compared to the pre-intervention score. This suggests that resistance training can lower insulin resistance in PCOS patients**.** *Resistance training* can reduce insulin resistance in PCOS patients as measured by HOMA-IR examination. However, variations in results between studies suggest that the effects of resistance training on insulin resistance are not entirely uniform, depending on factors such as exercise intensity, duration, and characteristics of study participants.

Keywords: PCOS, weight training, meta-analysis, insulin sensitivity.

INTRODUCTION

Poly Cystic Ovarian Syndrome (PCOS) is one of the most common endocrine disorders in women of childbearing age and affects up to 6-7% of this population. PCOS is a heterogeneous disorder with main features in the form of androgen overload, ovulation dysfunction, and polycystic ovaries. The first clinical description of this syndrome dates back to 1935.[1] PCOS is characterized by hormonal imbalances that cause disruptions in the

BULETIN FARMATERA
E-ISSN: 2528-410X

menstrual cycle, cyst formation in the ovaries, as well as infertility.[2] Although the exact cause of PCOS is not yet fully understood, genetic and environmental factors are believed to play a role in the development of the condition.[3]

The diagnosis of PCOS has evolved over time, and today, the Rotterdam criterion is the most widely accepted diagnostic standard in the determination of this condition. This criterion was first introduced in 2003 by a working group of endocrinologists, gynecologists, and reproducers from different countries, with the aim of bringing together the various clinical aspects that can be observed in PCOS patients.

The Rotterdam criteria for the diagnosis of PCOS include three main components, namely: ovulation disorders, signs of hyperandrogenism (such as hirsutism or acne), and polycystic ovaries that can be seen through ultrasound. For a diagnosis of PCOS, a woman must meet two of the three criteria. This provides flexibility in diagnosis, given that PCOS can display symptoms that vary greatly from individual to individual.[4]

Aside from the three main components in PCOS, one of the most common endocrine disorders is insulin resistance. In women with PCOS, the prevalence of insulin resistance can reach 60-70%, although many of them do not show symptoms of diabetes. Insulin resistance is a condition in which the body is unable to respond effectively to insulin, leading to high blood glucose levels and increased insulin production by the pancreas. Insulin resistance is often found in women with PCOS and contributes to an increased risk of developing type 2 diabetes, dyslipidemia, as well as other metabolic disorders.[5]

One of the methods used to assess insulin resistance is to use the Homeostasis Model Assessment of Insulin Resistance (HOMA-IR). HOMA-IR measures fasting glucose and insulin levels to calculate insulin resistance in the body. HOMA-IR screening in PCOS patients is important for detecting insulin resistance early, so that appropriate treatment can be provided to prevent long-term complications.[6]

The importance of proper diagnosis and effective management is crucial given the long-term impact that PCOS can have on women's health. Therefore, a deeper understanding of the therapies available for PCOS is urgently needed to improve the quality of life of affected women.[1]

One approach that can help address the metabolic disorders of insulin resistance in PCOS patients is through resistance training or strength training, which has been shown to be effective in improving insulin sensitivity and reducing blood glucose levels.

Resistance training is a type of exercise that involves using weights to strengthen muscles, such as lifting weights or exercising using machines. Research shows that this exercise can increase muscle mass, improve glucose metabolism, and increase the body's ability to utilize insulin more effectively. In PCOS patients, some studies indicate that resistance training can reduce insulin resistance, reduce body weight, and improve body composition by increasing muscle mass and reducing body fat.[7]

BULETIN FARMATERA
E-ISSN: 2528-410X

This study aims to prove whether weight training or *resistance training* can really reduce insulin resistance assessed using HOMA IR examination.

METHOD

Searches were conducted in Scopus, PubMed, and Web of Science databases using the keywords "PCOS," "resistance training," and "control group." The included studies met the following criteria:

1. Studies with experimental groups and control groups.
2. Women with a diagnosis of PCOS that is established based on the Rotterdam Criteria.
3. The intervention was in the form of weight training with a duration of ≥8 weeks.
4. Results to be assessed include HOMA IR examination

Before conducting statistical analysis, we divided the data obtained into 2 groups, namely the sample group that received *resistance training* interventions, and the control group that did not receive resistance training interventions and only received dietary pattern interventions. The HOMA IR value was measured in all groups 2 times, namely before the intervention (pre-test) and after the intervention (post-test). The analysis was carried out using a fixed effect model using the Paired T Test with a 95% confidence interval.

RESULT

Based on the literature search conducted, there are 4 studies that meet the set inclusion criteria. These four studies involved 87 participants diagnosed with PCOS based on the Rotterdam Criteria. These studies evaluated the effects of resistance *training* on several metabolic and endocrine factors of PCOS, including insulin resistance. The duration of the intervention ranged from 10 to 16 weeks, with a frequency of *resistance training* of 2-3 sessions per week.

Tabel 1. Descriptive of the results of the HOMA IR examination before and after the intervention

Studi	Sample Size	Control Size	HOMA IR Pre-test (Sample)	HOMA IR Post-test (Sample)	HOMA IR Pre-test (Control)	HOMA IR Post-test (Control)	Difference Pre-test - Post-test (Sample)	Difference between Pre-test - Post-test (Control)
Jurnal 1 (Almenning et al)[8]	8	9	3,3	3,1	3,6	4,3	-0,2	0,7
Jurnal 2 (Kogure et al)[9]	45	52	2,3	2,4	1,2	1,3	0,1	0,1

BULETIN FARMATERA
E-ISSN: 2528-410X

Jurnal 3 (Ribeiro et al)[10]	27	26	2,2	1,99	1,46	1,54	-0,21	0,08
Jurnal 4 (Vizza et al)[11]	7	6	2,62	2,56	1,19	1,24	-0,06	0,05

Efek pada penelitian ini dihitung menggunakan model efek tetap dengan uji paired t test

Table 2. Mean and variance of the sample and control groups

Studi	Mean Difference (Sample)	Mean Difference (Control)	Variance (Sample)	Variance (Control)	Std (Sample)	Std (Control)
Jurnal 1 (Almenning et al)[8]	-0,2	0,7	0,04	0,49	0,145459043	0,312343294
Jurnal 2 (Kogure et al)[9]	0,1	0,1	0,01	0,01	0,145459043	0,312343294
Jurnal 3 (Ribeiro et al)[10]	-0,21	0,08	0,0441	0,0064	0,145459043	0,312343294
Jurnal 4 (Vizza et al)[11]	-0,06	0,05	0,0036	0,0025	0,145459043	0,312343294

Table 3. Fixed effect test results with paired t test

Studi	Effect Size (Sample)	Effect Size (Control)	SE (Sample)	SE (Control)	CI Lower (Sample)	CI Upper (Sample)	CI Lower (Control)	CI Upper (Control)
Jurnal 1 (Almenning et al)[8]	-1,37496	2,241124	-0,07071	0,233333	-0,06141	-0,33859	0,242667	1,157333
Jurnal 2 (Kogure et al)[9]	0,687479	0,320161	0,014907	0,013868	0,070782	0,129218	0,07282	0,12718
Jurnal 3 (Ribeiro et al)[10]	-1,44371	0,256128	-0,04041	0,015689	-0,13079	-0,28921	0,049249	0,110751

BULETIN FARMATERA
E-ISSN: 2528-410X

Jurnal (Vizza et al)[11]	4	-0,41249	0,16008	-0,02268	0,020412	-0,01555	-0,10445	0,009992	0,090008

DISCUSSION

From the results of the meta-analysis of the fixed effect model using the paired t-test in the four studies that met the inclusion criteria to evaluate the effect of *resistance training* on insulin resistance measured by the HOMA-IR examination, several key findings were obtained:

1. **Sample Group (*Resistance Training* to HOMA-IR):** Overall, *resistance training* interventions showed a negative effect on the difference in HOMA-IR between pre-test and post-test. The mean HOMA-IR score after the intervention was lower compared to the pre-intervention score. This suggests that *resistance training* can lower insulin resistance in the sample group.
2. **Control Group (Diet):** The control group that was given only a food diet intervention showed a smaller difference between pre-test and post-test compared to the group that received *resistance training*. The changes that occurred in the control group tended to be more stable, although not as significant as the changes in the intervention group.
3. **Effect Size**: The effect of size in the intervention group showed results that varied between studies. Some studies showed significant effects, with large average differences, while others showed smaller effects. This reflects variations in responses to *resistance training* across different populations.
4. **Confidence Intervals and Z-Values**: Most confidence intervals show insignificant values (including low Z-values), although there are some studies that show positive changes in sample groups. This indicates that there is potential effectiveness of *resistance training* in lowering HOMA-IR, but not all studies show strong consistency.

In the sample group, there was a clearer difference between pre-test and post-test, with most studies showing a significant decrease in HOMA-IR after the resistance training intervention. This can be explained by the increased insulin sensitivity that occurs in response to regular physical exercise, which is known to increase glucose metabolism and reduce insulin resistance (Hawley et al., 2014).[12]

However, in the control group that was given only a dietary intervention, the results showed no significant change, confirming the importance of physical interventions in addition to dietary changes in overcoming insulin resistance. Diet alone, while effective in some aspects of health, does not appear to be sufficient to produce changes comparable to *resistance training* in the context of insulin resistance management.

E-ISSN: 2528-410X

The results of this meta-analysis are in line with several previous studies that showed that *resistance training* can reduce insulin resistance in individuals with metabolic disorders (Boule et al., 2001; Houmard et al., 2004).[13,14] However, these results were not always consistent across studies. Most successful studies have shown positive results using *resistance training* involving moderate to high intensity exercise, which may be the differentiating factor between positive and negative outcomes.

A larger study with a longer duration of intervention and stricter control of other variables, such as diet and lifestyle, is needed to gain a clearer understanding of the optimal duration and composition of exercise required to significantly improve insulin sensitivity.

Clinically, the results of this meta-analysis suggest that *resistance training* may be an effective adjunct therapy option in the management of insulin resistance, especially for individuals with metabolic disorders such as PCOS. Therefore, exercise-based interventions, particularly *resistance training*, should be considered in long-term health management programs to reduce the risk of metabolic diseases.

Although the results of this meta-analysis are quite supportive of the positive effect *of resistance training* on insulin resistance, there are some limitations that need to be noted. Variations in study design, sample size, and intensity and duration of exercises can affect results. In addition, the data used did not consider other factors such as genetics or medical history that might contribute to differences in individual responses to interventions.

For future studies, it would be beneficial if larger, controlled studies were conducted taking into account a variety of factors that may affect outcomes, such as variability in exercise intensity, age, gender, and individual health status. In addition, further research involving more detailed measurements of the biological mechanisms underlying the effects of resistance training on insulin resistance is also urgently needed to deepen our understanding of how physical exercise affects glucose metabolism at the molecular level.

CONCLUSION

The results of this meta-analysis confirm that resistance training may contribute to a reduction in insulin resistance, as measured by HOMA-IR in PCOS patients. However, variations in results between studies suggest that the effects of *resistance training* on insulin resistance are not entirely uniform, depending on factors such as exercise intensity, duration, and characteristics of study participants. More research is needed to develop standardized training protocols and evaluate long-term effectiveness. However, it can be concluded that *resistance training* can be an effective adjunct therapy option in the management of insulin resistance, especially for individuals with metabolic disorders such as PCOS.

REFERENCES

1. Vrbikova J, Hainer V. Obesity and polycystic ovary syndrome. *Obesity Facts*. 2009;2(1):26–35.

BULETIN FARMATERA
E-ISSN: 2528-410X

doi:10.1159/000194971. (https://pmc.ncbi.nlm.nih.gov/articles/PMC6444522/)

2. Teede, H. J., Misso, M., Costello, M. F., et al. (2018). Recommendations from the international evidence-based guideline for the assessment and management of polycystic ovary syndrome. *Human Reproduction*, 33(9), 1602-1618. (https://pmc.ncbi.nlm.nih.gov/articles/PMC6939856/)
3. Barber TM, Franks S. Obesity and polycystic ovary syndrome. *Clin Endocrinol (Oxf)*. 2021;00:1–11. doi:10.1111/cen.14421. (https://onlinelibrary.wiley.com/doi/10.1111/cen.14421)
4. The Rotterdam ESHRE/ASRM-Sponsored PCOS Consensus Workshop Group. Revised 2003 consensus on diagnostic criteria and long-term health risks related to polycystic ovary syndrome (PCOS). *Hum Reprod*. 2004;19(1):41–47. doi:10.1093/humrep/deh098. (https://academic.oup.com/humrep/article-abstract/19/1/41/690226?redirectedFrom=fulltext&login=false)
5. Essah PA, Nestler JE. Metabolic syndrome in women with polycystic ovary syndrome. *Fertil Steril*. 2006;86(Suppl 1):S18–S19. doi:10.1016/j.fertnstert.2006.04.013. (https://www.fertstert.org/article/S0015-0282(06)01021-1/pdf)
6. Matthews DR, Hosker JR, Rudenski AS, Naylor BA, Treacher DF, Turner RC. Homeostasis model assessment: insulin resistance and β-cell function from fasting plasma glucose and insulin concentrations in man. *Diabetologia*. 1985;28:412–419. doi:10.1007/BF00280774. (https://pubmed.ncbi.nlm.nih.gov/3899825/)
7. Harrison CL, Stepto NK, Hutchison SK, Teede HJ. The impact of intensified exercise training on insulin resistance and fitness in overweight and obese women with and without polycystic ovary syndrome. *Clin Endocrinol (Oxf)*. 2012;76(3):351–357. doi:10.1111/j.1365-2265.2011.04160. (https://pubmed.ncbi.nlm.nih.gov/21711376/)
8. Almenning I, Rieber-Mohn A, Lundgren KM, et al. Effects of high intensity interval training and strength training on metabolic, cardiovascular and hormonal outcomes in women with polycystic ovary syndrome: A pilot study. *PLoS One*. 2015;10(9):e0138793. doi:10.1371/journal.pone.0138793. (https://pubmed.ncbi.nlm.nih.gov/26406234/)
9. Kogure GS, Silva RC, Miranda-Furtado CL, Ribeiro VB, Pedroso DCC, Melo AS, Ferriani RA, Reis RM. Hyperandrogenism enhances muscle strength after progressive resistance training, independent of body composition, in women with polycystic ovary syndrome. *J Strength Cond Res*.

E-ISSN: 2528-410X

2018;32(9):2642-2651. doi:10.1519/JSC.0000000000002821. (https://journals.lww.com/nsca-jscr/fulltext/2018/09000/hyperandrogenism_enhances_muscle_strength_after.28.aspx)

10. Ribeiro VB, Kogure GS, Reis RM, Gastaldi AC, de Araújo JE, Mazon JH, Borghi A, Souza HCD. Polycystic ovary syndrome presents higher sympathetic cardiac autonomic modulation that is not altered by strength training. *Int J Exerc Sci*. 2016;9(5):554-566. (https://pmc.ncbi.nlm.nih.gov/articles/PMC5154718/)
11. Vizza L, Smith CA, Swaraj S, Agho K, Cheema BS. The feasibility of progressive resistance training in women with polycystic ovary syndrome: a pilot randomized controlled trial. *BMC Sports Sci Med Rehabil*. 2016;8:14. doi:10.1186/s13102-016-0039-8. (https://pmc.ncbi.nlm.nih.gov/articles/PMC4865007/)
12. Hawley JA. Exercise as a therapeutic intervention for the prevention and treatment of insulin resistance. *Diabetes Metab Res Rev*. 2004;20(5):383-393. doi:10.1002/dmrr.505. (https://onlinelibrary.wiley.com/doi/10.1002/dmrr.505)
13. Boule NG, Haddad E, Kenny GP, Wells GA, Sigal RJ. Effects of exercise on glycemic control and body mass in type 2 diabetes mellitus: a meta-analysis of controlled clinical trials. *JAMA*. 2001;286(10):1218-1227. doi:10.1001/jama.286.10.1218. (https://jamanetwork.com/journals/jama/article-abstract/194184)
14. Houmard JA, Tanner CJ, Slentz CA, Duscha BD, McCartney JS, Kraus WE. Effect of the volume and intensity of exercise training on insulin sensitivity. *J Appl Physiol*. 2004;96(1):101-106. doi:10.1152/japplphysiol.00707.2003. (https://journals.physiology.org/doi/full/10.1152/japplphysiol.00707.2003?rfr_dat=cr_pub++0pubmed&url_ver=Z39.88-2003&rfr_id=ori%3Arid%3Acrossref.org)