

# International Journal of Technology

Volume 8 | Issue 1 | January 2017



[www.wjot.com.au/id](http://www.wjot.com.au/id)

published by Faculty of Engineering, U. Indonesia, Indonesia

## EDITORIAL TEAM

### Editor in Chief

1. Prof. Dr. Yudan Whulanza, Universitas Indonesia, Indonesia

### Managing Editor

1. Dr. Eny Kusriani, Universitas Indonesia, Indonesia

### Members

1. Dr. Ahmad Gamal, Universitas Indonesia, Indonesia
2. Prof. Dr. Akhmad Herman Yuwono, Universitas Indonesia, Indonesia
3. Prof. Dr. Akhmad Hidayatno, Universitas Indonesia, Indonesia
4. Prof. Dr. Anwar Usman, Universiti Brunei Darussalam, Brunei Darussalam
5. Dr. Arnas, Universitas Indonesia, Indonesia
6. Prof. Dr. Arun Kumar Sangaiah, National Yunlin University of Science and Technology, Taiwan, Taiwan
7. Prof. Dr. Bambang Sugiarto, Universitas Indonesia, Indonesia
8. Dr. Cecilia Vale, University of Porto, Portugal
9. Prof. Dr. Dedi Priadi, Universitas Indonesia, Indonesia
10. Prof. Dr. Esah Hamzah, Universiti Teknologi Malaysia, Malaysia
11. Dr. Giuseppe Lo Papa, Teagasc Rural Economy Research Centre, Ireland
12. Prof. Dr. Hamzah Abdul Rahman, Universiti Malaya, Malaysia
13. Dr. Hendri Dwi Saptioratri, Universitas Indonesia, Indonesia
14. Prof. Dr. Heri Hermansyah, Universitas Indonesia, Indonesia
15. Dr. Hng Huey Hoon, Nanyang Technological University, Singapore, Singapore
16. Dr. Imam Jauhari Maknun, Universitas Indonesia, Indonesia, Indonesia
17. Dr. Ismi Rosyiana Fitri, Universitas Indonesia, Indonesia
18. Dr. Johannes Widodo, National University of Singapore, Singapore
19. Prof. Dr. Jong-Taek Oh, Chonnam National University, Korea, Republic of
20. Prof. Dr. Lee D. Wilson, University of Saskatchewan, Canada
21. Prof. Mahmud Sudibandriyo, Universitas Indonesia, Indonesia
22. Dr. Muhamad Asvial, Universitas Indonesia, Indonesia
23. Dr. Muhamad Sahlan, Universitas Indonesia, Indonesia
24. Dr. Muhammad Arif Budiyanto, Universitas Indonesia, Indonesia
25. Prof. Dr. Muhammad Idris Saleh, Universiti Sains Malaysia, Malaysia
26. Dr. Nofrijon Sofyan, Universitas Indonesia, Indonesia
27. Dr. Nyoman Suwartha, Universitas Indonesia, Indonesia
28. Dr. Ova Candra Dewi, Universitas Indonesia, Indonesia
29. Prof. Dr. Prof. Dr. Hideaki Ohgaki, Kyoto University, Japan
30. Prof. Dr. Raimundo Delgado, University of Porto, Portugal
31. Dr. Reza Kia, Sharif University of Technology, Iran (Islamic Republic of)
32. Dr. Roy Woodhead, Sheffield Hallam University, United Kingdom
33. Prof. Rui Calçada, University of Porto, Portugal
34. Dr. Ruki Harwahu, Universitas Indonesia, Indonesia
35. Dr. Sam P. Sinha, Scientific Research & Development, United States
36. Prof. Dr. Simon P. Ringer, University of Sydney, Australia
37. Prof. Sri Harjanto, Universitas Indonesia, Indonesia
38. Prof. Dr. Sutrasno Kartohardjono, Universitas Indonesia, Indonesia
39. Prof. Dr. T. Yuri M. Zagloel, Universitas Indonesia, Indonesia
40. Prof. Dr. Toshio Shudo, Tokyo Metropolitan University, Japan
41. Prof. Yanuar, Universitas Indonesia, Indonesia
42. Prof. Dr. Yung-Hui Lee, National Taiwan University, Taiwan
43. Dr. Yung-Jung Hsu, National Chiao Tung University, Taiwan

### About the Journal

- Editorial Board
- Focus and Scope
- Online Submissions
- Publication Policy
- Publication Ethics and Policy
- Author Guidelines
- List of Reviewers

- Most downloaded papers
- Most cited papers

### Login

#### Username

#### Password

[Register](#)

[Reset Password](#)

LOGIN

### IJTech

p-ISSN : 2086-9614

e-ISSN : 2087-2100

### Journal Metrics



Metrics by SCOPUS 2023  
CiteScore 2023: 2.9  
CiteScoreTracker 2024: 2.1  
Source Normalized Impact per Paper (SNIP): 0.773  
Journal Citation Reports (JCR) 2023: JIF 1.2

### IJTech is indexed in

SCOPUS™

EBSCO

DOAJ DIRECTORY OF OPEN ACCESS JOURNALS

SJR SCImago Journal & Country Rank

INDEX COPERNICUS™

Crossref

Google Scholar



Visitors

ID 234,796	TH 10,713	NG 5,157
IN 59,302	RU 8,291	JP 4,831
SG 37,638	CN 6,186	MA 4,047
MY 23,371	IQ 5,320	VN 3,931
US 16,510	IR 5,299	DZ 3,870

Pageviews: 1,370,149

FLAG counter

JOURNAL ISSUE

Journal Cover	Title	Author(s)	Publication Date (Online)	DOI	Pages
	Advancing Green Growth through Innovative Engineering Solutions	Seeram Ramakrishna, Eny Kusri, Retno Wahyu Nurhayati, Yudan Whulanza	Dec 07, 2023	<a href="https://doi.org/10.14716/ijtech.v14i7.6869">https://doi.org/10.14716/ijtech.v14i7.6869</a>	1402-1407
	The Identification of Challenges in Innovation Ecosystem of West Java, Indonesia Using a Systematic Literature Review	Risty Khoirunisa, Arini Mushfiroh, Ahmad Gamal	Dec 07, 2023	<a href="https://doi.org/10.14716/ijtech.v14i7.6662">https://doi.org/10.14716/ijtech.v14i7.6662</a>	1408-1418
	Cyclic Strain Rate Dependent Low-Cycle Fatigue Behavior of Alloy 617	Rando Tungga Dewa, Aditia Aulia, Seon-Jin Kim, Raja Akbar	Dec 07, 2023	<a href="https://doi.org/10.14716/ijtech.v14i7.6658">https://doi.org/10.14716/ijtech.v14i7.6658</a>	1419-1427
	Finite Element Analysis of Lattice Structure Model with Control Volume Manufactured Using Additive Manufacturing	Ahmad Kholli, Gandjar Kiswanto, Adnan Al Farisi, Jos Istiyanto	Dec 07, 2023	<a href="https://doi.org/10.14716/ijtech.v14i7.6660">https://doi.org/10.14716/ijtech.v14i7.6660</a>	1428-1437
	Developing Machine Learning Model to Predict HVAC System of Healthy Building: A Case Study in Indonesia	Mustika Sari, Mohammed Ali Berawi, Sylvia Putri Larasati, Suci Indah Susilowati, Bambang Susantono, Roy Woodhead	Dec 07, 2023	<a href="https://doi.org/10.14716/ijtech.v14i7.6682">https://doi.org/10.14716/ijtech.v14i7.6682</a>	1438-1448
	A Hybrid Method for The Closed-loop Supply Chain to Minimize Total Logistics Costs	Wangyue Xu, Martino Luis, Baris Yuce	Dec 07, 2023	<a href="https://doi.org/10.14716/ijtech.v14i7.6710">https://doi.org/10.14716/ijtech.v14i7.6710</a>	1449-1460
	Climate Change and Hygrothermal Performance of Building Envelopes: A Review on Risk Assessment	Bona Ryan, David N. Bristow	Dec 07, 2023	<a href="https://doi.org/10.14716/ijtech.v14i7.6666">https://doi.org/10.14716/ijtech.v14i7.6666</a>	1461-1475
	Investigation of Chemical Compounds from Phomopsis Extract as Anti-Breast Cancer Using LC-MS/MS Analysis, Molecular Docking, and Molecular Dynamic Simulations	Husnawati, Kusmardi Kusmardi, Rini Kurniasih, AE Zainal Hasan, Dimas Andrianto, Heddy Julistiono, Bambang Pontjo Priosoeryanto, I Made Artika, Mohd Nazil Salleh	Dec 07, 2023	<a href="https://doi.org/10.14716/ijtech.v14i7.6696">https://doi.org/10.14716/ijtech.v14i7.6696</a>	1476-1486
	Effectiveness Analysis of Insulation and Roof Covering Material in Office Flat Roof	Rossy Armyun Machfudiyanto, Leni Sagita Riantini, Titi Sari Nurul Rachmawati, Ayomi Dita Sarasati, Mochamad Daffa Alfiansyah Rachman	Dec 07, 2023	<a href="https://doi.org/10.14716/ijtech.v14i7.6665">https://doi.org/10.14716/ijtech.v14i7.6665</a>	1487-1495
	Anaerobic Digestion Potential in Traditional Boarding School	Adelia Tsaltsani Bilqis, Ayik Abdullah, Siti Jahroh, Asaduddin Abdullah, Febriantina Dewi, Benny Tjahjono, Inaya Rakhmani, Cindy Rianti Priadi	Dec 07, 2023	<a href="https://doi.org/10.14716/ijtech.v14i7.6699">https://doi.org/10.14716/ijtech.v14i7.6699</a>	1496-1505
	Detection of Atrial Fibrillation using a Feedforward Sequential Model	Jan Michael Santos, Edison Anit, Catherine Manuela Ramos, Nilo Bugtai, Armyon Sy, Nicanor Roxas, Francisco Munsayac	Dec 07, 2023	<a href="https://doi.org/10.14716/ijtech.v14i7.6684">https://doi.org/10.14716/ijtech.v14i7.6684</a>	1506-1516
	Performance Analysis of Ensemble Deep Learning NARX System for Estimating the Earthquake Occurrences in the Subduction Zone of Java Island	Hapsoro Agung Nugroho, Aries Subiantoro, Benyamin Kusumoputro	Dec 07, 2023	<a href="https://doi.org/10.14716/ijtech.v14i7.6702">https://doi.org/10.14716/ijtech.v14i7.6702</a>	1517-1526
	Detection of Low Hydrostatic Pressure Using Fiber Bragg Grating Sensor	Naufal Aliman Madani, Retno Wigajatri Purnamaningsih, Nji Raden Poespawati, Maratul Hamidah, Sasono Rahardjo, Dena Karunianto Wibowo	Dec 07, 2023	<a href="https://doi.org/10.14716/ijtech.v14i7.6714">https://doi.org/10.14716/ijtech.v14i7.6714</a>	1527-1536
	Uncertainty Analysis of Geothermal Development Projects Using Exploratory System Dynamics Modelling and Analysis Method	Irwin Nathanael Hartono, Andri D. Setiawan, Akhmad Hidayatno, Marmelia P. Dewi	Dec 07, 2023	<a href="https://doi.org/10.14716/ijtech.v14i7.6675">https://doi.org/10.14716/ijtech.v14i7.6675</a>	1537-1547
	Effect of Distraction and Driving Behaviour to Traffic Accidents in Jakarta Using Partial Least Squares Structural Equation Modeling (PLS-SEM)	Maya Arlini Puspasari, Safa Talitha Madani, Billy Muhammad Iqbal, Erlinda Muslim, Beryl Putra Sanjaya, Claresta Yasmine Putri Pribadyo, Keishandra Nabila Junistya, Ahmad Ghanny, Danu Hadi Syaifullah, Salsabilla Annisa Arista	Dec 07, 2023	<a href="https://doi.org/10.14716/ijtech.v14i7.6676">https://doi.org/10.14716/ijtech.v14i7.6676</a>	1548-1559
	Reverse Logistics Network Design for Plastic Waste Management in Jakarta: Robust Optimization Method	Romadhani Ardi, Syifa Nurkamila, Dyas Latiefah Citraningrum, Teuku Naraski Zahari	Dec 07, 2023	<a href="https://doi.org/10.14716/ijtech.v14i7.6681">https://doi.org/10.14716/ijtech.v14i7.6681</a>	1560-1569
	Development of Magnesium Diboride Superconducting Wires through Hot Working with Different Initial Filling Density	Satrio Herbirowo, Akhmad Herman Yuwono, Nofrijon Sofyan, Agung Imaduddin, Andika Widya Pramono, Sugeng Supriyadi, Julie Juliewatty Mohamed	Dec 07, 2023	<a href="https://doi.org/10.14716/ijtech.v14i7.6695">https://doi.org/10.14716/ijtech.v14i7.6695</a>	1570-1577
	Association between ADIPOQ (rs1501299) SNP with Insulin Resistance in Indonesian Type 2 Diabetes Mellitus Patients	Donny Nauphar, Robby Irham Maulana Alfaqih, Gara Samara Brajadenta, Tiar M Pratamawati	Dec 07, 2023	<a href="https://doi.org/10.14716/ijtech.v14i7.6691">https://doi.org/10.14716/ijtech.v14i7.6691</a>	1578-1585
	Exploring the Anti-Breast Cancer Potential of Chalcomoracin, Guangsangon E, and Morushalunin: A Computational Analysis of Compounds from Morus sp.	Rani Wardani Hakim, Rizky Clarinta Putri, Wilzar Fachri, Fadilah Fadilah, Desak Gede Budi Krisnamurti, Rizki Fitriani, Euis Hollisotan Hakim, Dewi Wulansari	Dec 07, 2023	<a href="https://doi.org/10.14716/ijtech.v14i7.6707">https://doi.org/10.14716/ijtech.v14i7.6707</a>	1586-1595
	The Effect of Umbilical Cord Blood Serum and Platelet-Rich Plasma Coatings on the Characteristics of Poly( $\epsilon$ -caprolactone) Scaffolds for Skin Tissue Engineering Applications	Retno Wahyu Nurhayati, Auzan Luthfi Laksono, Assyafiya Salwa, Azizah Intan Pangesty, Yudan Whulanza, Wildan Mubarok	Dec 07, 2023	<a href="https://doi.org/10.14716/ijtech.v14i7.6709">https://doi.org/10.14716/ijtech.v14i7.6709</a>	1596-1604
	Effect of Coagulation Bath Composition on Cellulose-Based Polymer Electrolyte Fabricated via Non-Solvent-Induced Phase Separation Method	Christin Rina Ratri, Tegar Budi Aguta, Annisaa Hayya Arundati, Rohib Rohib, Mochamad Chalid, Sotya Astutningsih, Adam Febriyanto Nugraha	Dec 07, 2023	<a href="https://doi.org/10.14716/ijtech.v14i7.6677">https://doi.org/10.14716/ijtech.v14i7.6677</a>	1605-1614

About the Journal

- Editorial Board
- Focus and Scope
- Online Submissions
- Publication Policy
- Publication Ethics and Policy
- Author Guidelines
- List of Reviewers

- Most downloaded papers
- Most cited papers

Login

Username

Password

Register  
[Reset Password](#) [LOGIN](#)

IJTech

p-ISSN : 2086-9614  
 e-ISSN : 2087-2100

Journal Metrics

International Journal of Technology  
 Engineering (miscellaneous)  
 Q2 best quartile  
 SJR 2024 0.35  
 powered by scimagojr.com

Metrics by SCOPUS 2023  
 CiteScore 2023: 2.9  
 CiteScoreTracker 2024: 2.1  
 Source Normalized Impact per Paper (SNIP): 0.773  
 Journal Citation Reports (JCR) 2023: JIF 1.2

IJTech is indexed in

SCOPUS™  
 EBSCO  
 DOAJ DIRECTORY OF OPEN ACCESS JOURNALS  
 SJR SCImago Journal & Country Rank  
 INDEX COPERNICUS™  
 Crossref  
 Google Scholar  
 INDEXED IN EMERGING SOURCES CITATION INDEX THOMSON REUTERS  
 Journal Citation Reports 2023  
 Clarivate Analytics  
 1.2  
 Journal Impact Factor  
 SINTA 1  
 Visitors  
 ID 234,794 TH 10,713 NG 5,157  
 IN 59,302 RU 8,291 JP 4,631  
 SG 37,638 CN 6,186 MA 4,047  
 TW 23,371 IQ 5,320 VN 3,930  
 US 16,510 IR 5,299 OZ 3,870  
 Pageviews: 1,370,138  
 FLAG Counter



## Association between ADIPOQ (rs1501299) SNP with Insulin Resistance in Indonesian Type 2 Diabetes Mellitus Patients

Donny Nauphar<sup>1\*</sup>, Robby Irham MA<sup>2</sup>, Gara Samara Brajadenta<sup>1</sup>, Tiar M Prتامawati<sup>1</sup>

<sup>1</sup>*Department of Genetics, Faculty of Medicine, Universitas Swadaya Gunung Jati, Cirebon, West Java, 45132, Indonesia*

<sup>2</sup>*Bachelor of Medicine, Faculty of Medicine, Universitas Swadaya Gunung Jati, Cirebon, West Java, 45132, Indonesia*

**Abstract.** Insulin resistance is an important aspect of metabolic endocrine disorder, and adiponectin functions as an insulin-sensitizer. Changes in adiponectin levels are associated with alterations in insulin sensitivity. Insulin resistance results from various variables that contributes to abnormalities in insulin signaling, including a decrease in adiponectin levels. Genetics is recognized as one of the key elements influencing adiponectin levels, with investigations showing that ADIPOQ SNP can impact insulin sensitivity and plasma adiponectin levels. Therefore, this study aimed to examine association between ADIPOQ gene polymorphism in patients with type 2 diabetes mellitus (DM) and insulin resistance level. A case-control study was conducted with 60 participants recruited from Sunyaragi Community Health Center in Cirebon, West Java. Data were collected using fasting blood glucose (mg/dl) and Polymerase Chain Reaction – Restriction Fragment Length Polymorphism (PCR-RFLP). The results showed that the genotype frequency of SNP in the case group was GG = 12 (40%), GT = 16 (53.33%), TT = 2 (6.67%). Meanwhile, in the control group, it was observed to be GG = 18 (60%), GT = 11 (36.67%), and TT = 1 (3.33%). Statistically analysis showed a significant association between +276 G/T polymorphism and type 2 DM. This concluded that individuals with polymorphism are at higher risk of developing type 2 DM.

**Keywords:** Adiponectin; ADIPOQ; Insulin Resistance; SNP

### 1. Introduction

Insulin resistance is a pathological disorder affecting insulin-dependent cells such as skeletal cells and adipocytes, leading to a diminished response to normal levels of circulating insulin. This condition can give rise to various health complications, including hyperglycemia, hypertension, dyslipidemia, endothelial dysfunction, and metabolic disorders such as metabolic syndrome or type 2 diabetes mellitus (DM) (Yaribeygi *et al.*, 2019; Samuel and Shulman, 2016).

Obesity is a risk factor for insulin resistance, particularly in instances of excess fat accumulation. The metabolic effects associated with insulin resistance serve as valuable clinical indicators for identifying this condition (Sung *et al.*, 2018). Gold standard method for its detection include Homeostatic Model Assessment for Insulin Resistance (HOMA-IR), Homeostatic Model Assessment 2 (HOMA2), Quantitative Insulin Sensitivity Check Index

\*Corresponding author's email: [donny.nauphar@ugj.ac.id](mailto:donny.nauphar@ugj.ac.id), Tel.: +62-231-483928, Fax: +62-231-488923  
doi: [10.14716/ijtech.v14i7.6691](https://doi.org/10.14716/ijtech.v14i7.6691)

(QUICKI), serum triglycerides, and the triglycerides to HDL ratio. Additionally, serum blood glucose levels are also used for the measurement.

The main effect of insulin resistance is development of type 2 DM. In this context, increased insulin production acts as a compensatory mechanism, leading to insulin resistance. However, pancreatic beta cells become damaged over time and are unable to meet insulin needs, resulting in hyperglycemia. Insulin resistance also contribute to other disorders such as metabolic syndrome, obesity, cardiovascular disease, nonalcoholic fatty liver disease, and polycystic ovarian syndrome (PCOS) (Condorelli *et al.*, 2017).

According to the International Diabetes Federation (IDF), an estimated 463 million individuals worldwide, aged 20 to 79, were diagnosed with DM in 2019. Southeast Asia ranks third with a prevalence of 11.3%, and Indonesia has approximately 1 million diabetics, as per the 2018 Basic Health Research conducted by (Ministry of Health Republic Indonesia, 2018).

The protein adiponectin, an insulin sensitizer encoded by ADIPOQ gene and released by adipose cells, plays a crucial role in reducing the rate of gluconeogenesis in the liver, enhancing the absorption of glucose, and maintaining insulin sensitivity. Single nucleotide polymorphisms, frequently called SNP, the most common type of genetic variation, can alter the transcription rate of mRNA, influencing protein production. SNP also has physiological impact on protein activity by changing the nucleic acid, thereby altering the type of amino acid produced. Insulin resistance can result from low plasma levels of the hormone adiponectin, influenced by various factors such as genetics, diet, exercise, and abdominal obesity (Moon *et al.*, 2014; Ziemke and Mantzoros, 2010).

Study in diverse population showed that SNP of ADIPOQ gene could influence the transcription rate or alter the amino acid sequence, consequently affecting plasma adiponectin levels and insulin sensitivity. However, this investigation have not been conducted in Indonesian. Despite that adiponectin operates as an insulin-sensitizer indirectly, when it experience a drop in the levels, there will also be a decrease in insulin sensitivity. This significantly plays a role in the formation of insulin resistance among type 2 DM patients. By investigating the alleles, genotype, and potential predisposition to type 2 DM in Indonesians, this study aims to contribute insights that could inform preventive strategies.

In accordance with the previous explanation, the focus is specifically on understanding how genetic factors, particularly ADIPOQ gene, affect insulin resistance. The purpose of this study is to examine association between ADIPOQ gene polymorphism in type 2 DM patients and insulin resistance levels in the Indonesian population.

## 2. Methods

### 2.1. Patient Selection

This study was an analytical observational case-control investigation comprising 30 case and 30 control subjects. Ethical approval was received from the Medical Faculty Research Ethics Committee at Swadaya Gunung Jati University (131/EC/FKUGJ/V/2022). The investigation was conducted at the Sunyaragi Community Health Center in Cirebon, West Java and the Faculty of Medicine's Laboratory of Genetics and Molecular Biology. The control group consisted of individuals without type 2 DM diagnosis, while the cases group met PERKENI criteria for type 2 DM within a 3-month period. Exclusion criteria included type 1 DM, cancer, autoimmune illnesses, and subjects on steroid anti-inflammatory medication. After patients have fasted for 8 hours, the fasting blood glucose levels was determined through proper examination.

## 2.2. Nucleic Acid Extraction

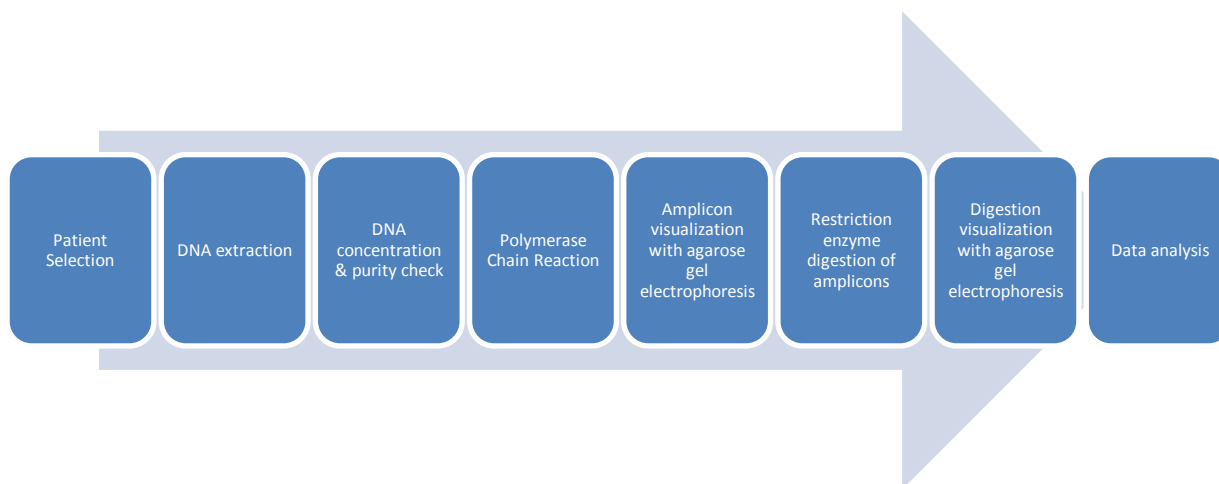
After initial screening of medical records and obtaining informed consent for sampling, 3 mL of peripheral blood was drawn in EDTA for genetic analysis. The TianGen TIANamp Hi-DNA/RNA Extraction Kit was used for blood extraction. The concentration and purity of DNA were assessed using the Maestrogen MaestroNano Pro Spectrophotometer. Finally, extracted DNA was stored at -20°C.

## 2.3. Genetic Analysis

DNA amplification was performed using BioRad T100 thermal cycler with forward primer: 5'-CCT GGT GAG AAG GGT GAG AA -3' and reverse primer: 5'-AGA TGC AGC AAA GCC AAA GT- 3'. The amplification protocol included denaturation at 95°C for 5 minutes, 35 cycles consisting of 95°C for 30 seconds, 65°C for 30 seconds, 72°C for 30 seconds, 72°C for 8 minutes, and ended with 25°C for infinity hold. A 2% electrophoretic gel confirmed the 241 bp PCR product using the BioRad GelDoc EZ Imager, to ensure that DNA has been amplified. After amplification, the product was cut with the BsmI restriction enzyme. Restriction results were analyzed by a 2% agarose gel to observe RFLP. The expected outcomes on the agarose gel were GG (Homozygous Wildtype) genotype cut to 95bp and 146bp, GT (Heterozygote) cut to 95bp, 146bp, and 241bp, and TT (Homozygous Mutant) cut to 241bp.

## 2.4. Data Analysis

The frequency of each genotype was calculated and presented as percentage. To determine association between the independent and the dependent variable, an unpaired t-test of >2 groups was used to compare the genotype at SNP +276 with the average GDP level. Polymorphism at +276 G/T with type 2 DM was evaluated using a contingency test with a 2x2 table to derive odds ratio and p-value.



**Figure 1** Schematic illustration of the workflow of the study

## 3. Results and Discussion

### 3.1. Patient Characteristics

This present study comprised 60 subjects, evenly divided into 30 cases and 30 controls, all meeting the predefined inclusion and exclusion criteria. Both body height and weight were measured with participants dressed in light clothing and without shoes. Obesity was assessed by body mass index (BMI), calculated as weight in kilograms divided by the square of height in meters.

In the case group, 23 subjects fell under the normal body weight category, while 7 subjects were classified as overweight. Approximately 66% of the samples in this group showed increased fasting blood glucose levels. Meanwhile, the control had 10 overweights, and all subjects showed elevated fasting glucose levels (Table 1).

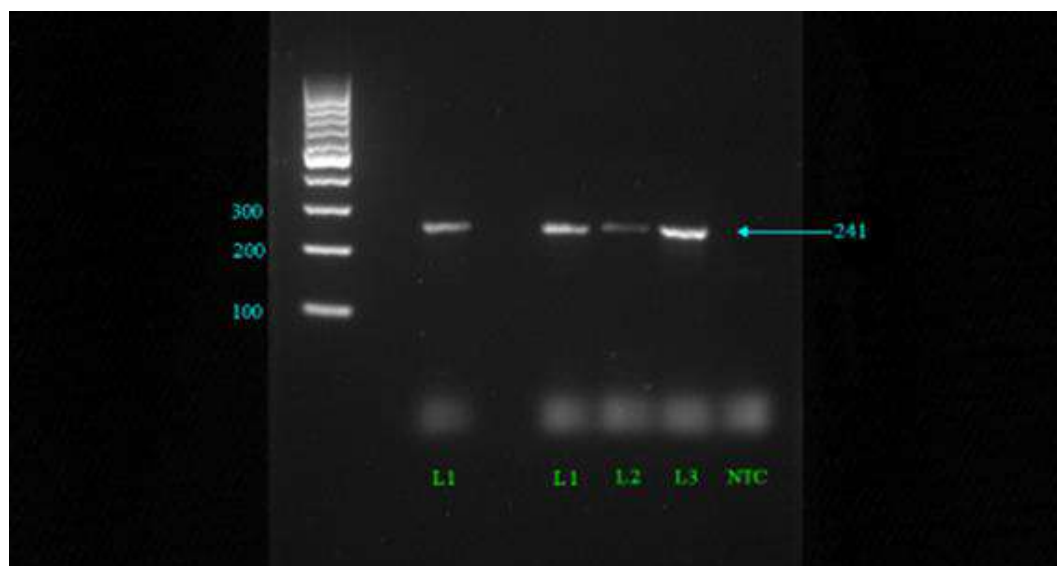
**Table 1** Subject Characteristics based on age, sex, weight, height, BMI, and fasting glucose

	Case (n)	Control (n)	%
<b>Age</b>			
30-40	1	5	10%
41-50	5	10	25%
51-60	9	5	23.3%
61-70	10	5	25%
>71	5	5	16.7%
<b>Sex</b>			
Male	11	9	33.3%
Female	19	21	66.7%
<b>Weight (kg)</b>			
45-50	3	1	6.7%
51-60	8	8	26.7%
61-70	10	17	45%
71-80	8	4	20%
81-85	1	0	1.6%
<b>Height (cm)</b>			
150-160	6	4	16.7%
161-170	20	24	73.3%
171-175	4	2	10%
<b>BMI</b>			
Underweight	0	2	3.3%
Normal	23	18	68.4%
Overweight	7	10	28.3%
<b>Fasting Glucose</b>			
Normal	10	0	16.7%
Abnormal	20	30	83.3%

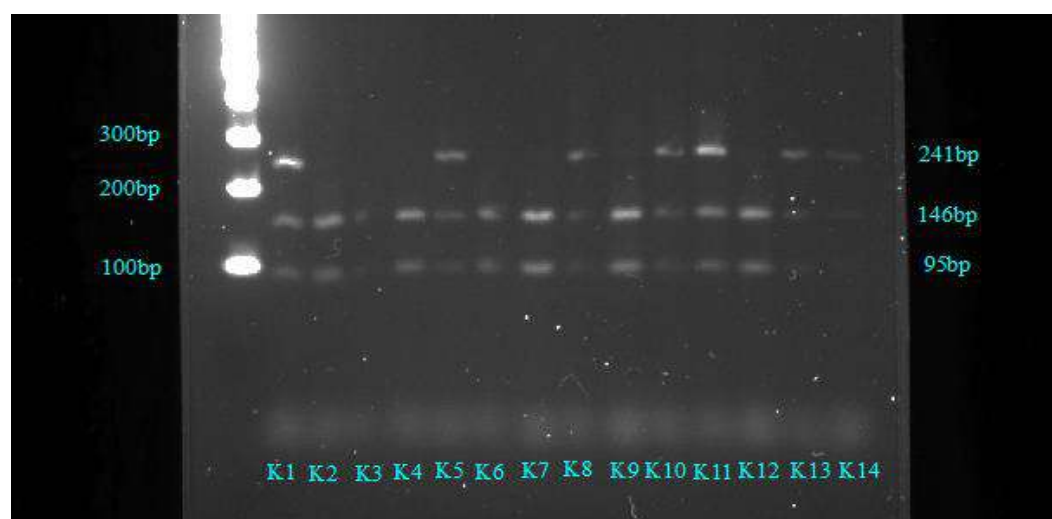
### 3.2. Genotypic Data

The results of PCR amplification are presented in Figure 2 (a), showing a band at 241bp from L1-L3, which corresponded to control sample 1-3 and non-template control (NTC) respectively. The results of the restriction enzymes were shown in Figure 1b. Furthermore, the uncut band at 241bp showed the presence of G allele, while cut bands at 146bp and 95bp showed the presence of T allele. In Figure 2 (b), subject K1 had bands at 241bp, 146bp, and 95bp, signifying the GT genotype.

Insulin resistance is an important aspect of metabolic endocrine disorder. Adiponectin functions as an insulin-sensitizer and changes in its level will also lead to alteration in insulin sensitivity. Insulin resistance occurred as a result of various factors leading to abnormalities in insulin signaling, one of which is a decrease in adiponectin levels. Genetics is one of the elements influencing adiponectin levels. Several studies showed that ADIPOQ rs1501299 +276 G/T SNP increased the possibility of developing type 2 DM and insulin resistance (Yu *et al.*, 2018; Frankenberg, Reis, and Gerchman, 2017; Prakash *et al.*, 2015).



(a)



(b)

**Figure 2** (a) PCR amplification results and (b) Restriction Enzyme digestion results. Figure 2(a) showed the PCR amplification result of 241bp prior to enzyme restriction (L1, L2, L3) and a non-template control (NTC) was added as a negative control. Figure 2(b) showed bands after restriction enzyme digestion where K1-K14 are control cases. K1 showed bands of 241bp, 146bp, and 95bp, which means one allele was cut by the restriction enzyme and the other was not, showing G and T allele and GT genotype

Despite +276 G/T SNP being a silent mutation, it converts G nucleotide base to T without altering the amino acid composition of the protein generated by ADIPOQ gene. Studies showed that ADIPOQ +276 G/T SNP affected adiponectin levels. Individuals with T allele have lower adiponectin levels and index of insulin resistance, despite lack of alteration in the protein (Yu *et al.*, 2018; Frankenberg, Reis, and Gerchman, 2017; De Luis *et al.*, 2017; Prakash *et al.*, 2015). This study aims to contribute to the existing body of knowledge by investigating association between the adiponectin gene, insulin resistance, and type 2 DM through fasting blood glucose levels.

The results of this study showed that the control had less polymorphism +276 G/T (21.7%), where the case group had more at 33.3%, as presented in Table 2. Examining the genotype frequencies of SNP +276 G/T in the case group indicated 12 (40%) GG, 16 (53.33%) GT, and 2 (6.67%) TT genotypes. Meanwhile, the control group had 18 (60%) GG,

11 (36.67%) GT, and 1 (3.33%) TT genotype, as presented in Table 3. It was also discovered that the case group had a lower frequency of GG genotype than the control, accompanied by a higher frequency of GT and TT genotypes.

**Table 2** Allele frequency distribution

Allele	Cases		Control	
	n	%	n	%
G	40	66.7%	47	78.3%
T	20	33.3%	13	21.7%
Total	60	100%	60	100%

**Table 3** Genotype frequency distribution

Genotype	Cases		Control	
	n	%	n	%
GG	12	40%	18	60%
GT	16	53.33%	11	36.67%
TT	2	6.67%	1	3.33%
Total	30	100%	30	100%

The results are similar with those of studies conducted in Chinese, Iranian, and Japanese population (Alimi, Goodarzi, and Nekoei, 2021). The analysis of SNP+276 G/T, with a p-value of 0.001, showed a significant association between SNP and the incidence of type 2 DM in Indonesian population. It was also shown that individuals with polymorphism had a 2.5 times higher risk of developing type 2 DM, as shown in Table 4.

### 3.3. Genotypic and Phenotypic Correlation

**Table 4** Genotypic Association between ADIPOQ SNP and Type 2 DM.

Allele	Case (n)	Control (n)	OR	p-value
GT/TT	18	12	2.5	0.001
GG	12	18		

**Table 5** Association between ADIPOQ SNP and mean Fasting Blood Glucose Levels

Genotype	Case (n)	FBG ± SD (range) (mg/dl)	p-value
GG	12	124 ± 112 (110-342)	0.054
GT	16	230 ± 108 (116-460)	
TT	2	127 ± 26 (110-144)	

The results were not in line with studies in the Arab and Korean population, where no association between SNP was identified, with a p-value of 0.69 (Nam *et al.*, 2018). However, they were in line with the Japanese and Chinese population with a p-value of 0.002 (Zhao *et al.*, 2016). Due to various demographics and the limited number of samples, variations from earlier investigations may occur. Previous genetics studies in Indonesia underscored differences in genetic makeup compared to more established populations (Nauphar, Wahidiyat, and Ariani, 2022; Pratamawati, Alwi, and Asmarinah, 2022). Therefore, it is advised that future investigations should be conducted using a wide number of samples. In addition to showing a 2.5 times higher risk in individuals with T allele, allele analysis at SNP+276 G/T showed a significant connection between the gene variant and the incidence of type 2 DM, as shown in Table 4.

No significant differences were observed between the genotypes of +276 G/T polymorphism in ADIPOQ gene in the case group with fasting blood glucose levels. A p-value of 0.054 was discovered in the statistical analysis, showing that there was no statistically significant difference between the 3 types of genotypes examined (Table 5). In the study by

(Al-Daghri *et al.*, 2012), similar results regarding association between GDP levels and genotype were obtained, with a p-value of 0.59.

This study has a primary limitation, stemming from the absence of plasma adiponectin level data, which could influence insulin resistance levels. Furthermore, the HOMA-IR examination, typically used for assessing type 2 DM levels, was not applied in this investigation. Consequently, a direct link between SNP +276 G/T and insulin resistance cannot be established. It is important to note that other genes, such as GLUT4 and IRS, had stronger connections to insulin resistance and type 2 DM.

#### 4. Conclusions

In conclusion, approximately 60% of participants in this study who had type 2 DM experienced a polymorphism of +276 G/T. In the case group, the distribution of SNP +276 G/T genotype was 12 (40%), 16 (53.33%), and 2 (6.67%) with GG, GT, and TT genotype, respectively. In the control group, the breakdown was 18 (60%), 11 (36.67%), and 1 (3.33%) for GG, GT, and TT genotype concerning SNP +276 G/T genotype. Statistical analyses showed a significant association between the +276 G/T polymorphism and type 2 DM. However, the odds ratio value suggested that individuals with +276 G/T polymorphism were 2.5 times more easy to have developed type 2 DM. To present a more comprehensive understanding of the predisposed risk in the Indonesian population, future studies should include a larger number of subjects in this demographic to determine allele frequencies accurately.

#### Acknowledgments

The authors are grateful to the Universitas Swadaya Gunung Jati 2022 Internal Research Fund for funding this study.

#### References

- Al-Daghri, N.M., Al-Attas, O.S., Alokail, M.S., Alkharfy, K.M., Hussain, T., Yakout, S., Vinodson, B., Sabico, S., 2012. Adiponectin Gene Polymorphisms (T45G and G276T), Adiponectin Levels and Risk For Metabolic Diseases in an Arab Population. *Gene*, Volume 493(1), pp. 142–147
- Alimi, M., Goodarzi, M.T., Nekoei, M., 2021. Association of ADIPOQ rs266729 and rs1501299 Gene Polymorphisms And Circulating Adiponectin Level with the Risk of Type 2 Diabetes in a Population of Iran: a Case-Control Study. *Journal of Diabetes and Metabolic Disorders, Journal of Diabetes & Metabolic Disorders*, Volume 20(1), pp. 87–93
- Condorelli, R.A., Calogero, A.E., Di Mauro, M., La Vignera, S., 2017. PCOS and Diabetes Mellitus: From Insulin Resistance to Altered Beta Pancreatic Function, a Link in Evolution. *Gynecological Endocrinology*, Volume 33(9), pp. 665–667
- De Luis, D.A., Izaola, O., De La Fuente, B., Primo, D., Ovalle, H.F., Romero, E., 2017. Rs1501299 Polymorphism in the Adiponectin Gene and Their Association with Total Adiponectin Levels, Insulin Resistance and Metabolic Syndrome in Obese Subjects. *Annals of Nutrition and Metabolism*, Volume 69(3–4), pp. 226–231
- Frankenberg, A.D.V., Reis, A.F., Gerchman, F., 2017. Relationships Between Adiponectin Levels, the Metabolic Syndrome, and Type 2 Diabetes: A Literature Review. *Archives of Endocrinology and Metabolism*, Volume 61(6), pp. 614–622
- Ministry of Health Republic Indonesia, 2018. Basic Health Research 2018. Ministry of Health Republic Indonesia

- Moon, H.U., Ha, K.H., Han, S.J., Kim, H.J., Kim, D.J., 2014. Adiponectin, Visceral Fat in Insulin Resistance and Secretion. *Endocrinology, Nutrition Metabolism*, Volume 34(1), pp. 1–12
- Nam, J.S., Han, J.W., Lee, S.B., You, J.H., Kim, M.J., Kang, S., Park, J.S., Ahn, C.W., 2018. Calpain-10 and Adiponectin Gene Polymorphisms in Korean Type 2 Diabetes Patients. *Endocrinology and Metabolism*, Volume 33(3), pp. 364–371
- Nauphar, D., Wahidiyat, P.A., Ariani, Y., 2022. Molecular Study in Identifying Genotypes to Phenotypes Relations of Transfusion-Dependent Thalassemia Patients in Cirebon, West Java. *International Journal of Technology*, Volume 13(8), pp. 1726–1734
- Prakash, J., Mittal, B., Awasthi, S., Srivastava, N., 2015. Association of Adiponectin Gene Polymorphism with Adiponectin Levels and Risk for Insulin Resistance Syndrome. *International Journal of Preventive Medicine*, Volume 8(6), p. 31
- Pratamawati, T.M., Alwi, I., Asmarinah., 2022. Methylenetetrahydrofolate Reductase (MTHFR) C677T and A1298C Gene Polymorphism as Risk Factors for Essential Hypertension. *International Journal of Technology*, Volume 13(8), pp. 1622–1629
- Samuel, V.T., Shulman, G.I., 2016. The Pathogenesis of Insulin Resistance: Integrating Signaling Pathways And Substrate Flux. *Journal of Clinical Investigation*, Volume 126(1), pp. 12–22
- Sung, K.C., Lee, M.Y., Kim, Y.H., Huh, J.H., Kim, J.Y., Wild, S.H., Byrne, C.D., 2018. Obesity and Incidence of Diabetes: Effect of Absence of Metabolic Syndrome, Insulin Resistance, Inflammation And Fatty Liver. *Atherosclerosis*, Volume 275, pp. 50–57
- Yaribeygi, H., Farrokhi, F.R., Butler, A.E., Sahebkar, A., 2019. Insulin Resistance: Review of the Underlying Molecular Mechanisms. *Journal of Cellular Physiology*, Volume 234(6), pp. 8152–8161
- Yu, K.T., Maung, K.K., Thida, A., Myint, T., 2018. Single Nucleotide Polymorphism at +276 g>T of the Adiponectin Gene and Plasma Adiponectin Level in Myanmar Type 2 Diabetic Patients. *Journal of the ASEAN Federation of Endocrine Societies*, Volume 33(2), pp. 160–164
- Zhao, F., Mamatyusupu, D., Wang, Y., Fang, H., Wang, H., Gao, Q., Dong, H., Ge, S., Yu, X., Zhang, J., Wu, J., Song, W., Wang, W., 2016. The Uyghur Population and Genetic Susceptibility To Type 2 Diabetes: Potential Role for Variants in CAPN10, APM1 and FUT6 Genes, *Journal of Cellular and Molecular Medicine*, Volume 20(11), pp. 2138–2147
- Ziemke, F., Mantzoros, C.S., 2010. Adiponectin in Insulin Resistance: Lessons From Translational Research. *American Journal of Clinical Nutrition*, Volume 91(1), pp. 258–261