

## RESEARCH STUDY

English Version

OPEN ACCESS

# Nutritionists' Views on Gene-Based Nutrition Services in Indonesia

## *Pandangan Ahli Gizi Tentang Pelayanan Gizi Berbasis Gen di Indonesia*

Sintia Aurilia Putri<sup>1</sup>, Arif Sabta Aji<sup>1,2\*</sup>, Edi Sampurno Ridwan<sup>2,3</sup>, Veriani Aprilia<sup>1</sup>, Ifana Fitria Zulfa<sup>1</sup>, Rina Alfiana<sup>1</sup>, Rafiq Dwita Hafizhah<sup>1</sup>, Alfina Ulfah Farhan<sup>2</sup>, Shelini Surendran<sup>4</sup>

<sup>1</sup>Nutrition Department, Faculty of Health Sciences, Alma Ata University, Bantul, Daerah Istimewa Yogyakarta, Indonesia

<sup>2</sup>Public Health Department, Faculty of Health Sciences, Alma Ata University, Bantul, Daerah Istimewa Yogyakarta, Indonesia

<sup>3</sup>Nursing Department, Faculty of Health Sciences, Alma Ata University, Bantul, Daerah Istimewa Yogyakarta, Indonesia

<sup>4</sup>Faculty of Health and Medical Sciences, University of Surrey, Guildford, UK

### ARTICLE INFO

Received: 07-09-2023

Accepted: 31-12-2023

Published online: 31-12-2023

#### \*Correspondent:

Arif Sabta Aji

[sabtaaji@almaata.ac.id](mailto:sabtaaji@almaata.ac.id)



10.20473/amnt.v7i2SP.2023.269-275

#### Available online at:

<https://e-journal.unair.ac.id/AMNT>

#### Keywords:

Views, Nutritionists, Gene-based nutrition services, Nutrigenetic

### ABSTRACT

**Background:** Cardiometabolic diseases are principal contributors to mortality, morbidity, and healthcare costs. Additionally, many Single Nucleotide Polymorphisms (SNPs) have been associated with cardiovascular health outcomes. Nutrition professionals' perspectives on genetic-based nutritional services play a pivotal role in treating and preventing non-communicable diseases (NCDs).

**Objectives:** This study aims to explore Indonesian nutritionists' viewpoints on gene-based nutrition services.

**Methods:** Employing a qualitative phenomenological approach, six Indonesian nutritionists from key provinces (DKI Jakarta, West Java, Central Java, East Java, and DI Yogyakarta) participated in in-depth interviews. Themes encompassed nutritionists' views on gene-based nutrition's role in NCD prevention, genetics science, and genetic testing understanding. Thematic analysis was performed using Nvivo v.12.

**Results:** Results showed that nutritionists had a substantial understanding of genetics and gene-based nutrition services, despite concerns about test costs. They comprehended gene-based nutrition's role in NCD prevention and acknowledged its significance in preventing NCDs.

**Conclusions:** Within this study, Nutritionists express the importance of gene-based nutrition services in NCD prevention. To enhance engagement, nutritionists are encouraged to communicate genetic testing's value to the community. This dissemination will help advance NCD prevention efforts.

### INTRODUCTION

Cardiometabolic diseases including cardiovascular disease, obesity, hypertension, and type 2 diabetes mellitus are the main causes of mortality, morbidity, and high health care cost. Obesity plays an important role in the development of chronic and non-communicable diseases (NCDs) in Southeast Asia. In Indonesia, the prevalence of NCDs reaches 73% of all mortality where cardiovascular disease contributes 35% followed by cancer (12%) and diabetes (6%)<sup>1</sup>.

Nucleotide polymorphisms (SNPs) are associated with diseases and cardiometabolic traits<sup>2</sup>. Understanding a person's trait variability and improving risk prediction for cardiometabolic diseases can be done better by analyzing the effects of multiple gene variants than single variant approaches. Masruroh (2016) states that lifestyle factors can increase the influence of genetic variants on cardiometabolic traits<sup>3</sup>. In Indonesia, a population-based study involving some ethnic groups focusing on nutrition and genetics called GeNuIne (gene-nutrition interactions) aims to examine interactions between genetic factors and food (nutrigenetics) in cardiometabolic diseases and

their associated traits<sup>4</sup>.

Traits associated with genetic markers of obesity are overweight and obese women with a higher risk of developing cardiometabolic risk factors. Nutrition is an important element of health. World Health Organization (WHO) states that nutrition is the main basis for body health and well-being throughout the life cycle<sup>5,6</sup>. The nutritionists' view of gene-based nutrition services plays an important role in the prevention and treatment of NCDs. Moreover, their view of nutrigenetics is important as nutrigenetics provides information on the role of genetics in diet which can accurately predict disease risks through the use of genetic variation data. Nutritionists can identify the optimal diet for each person (personalized nutrition)<sup>7</sup>.

One of the factors supporting preventive measures in NCDs is public knowledge and awareness of gene-based nutrition services. In Indonesia, the problem in gene-based nutrition services is related to exposure to nutrigenetics which has not been widely informed among the public. Besides, studies concerning this topic are limited. Therefore, this present qualitative study focuses

on the nutritionists' views on gene-based nutrition services in Indonesia.

**METHODS**

This qualitative study used a phenomenological approach. Data were collected by conducting in-depth interviews<sup>8</sup> using Zoom Meeting where each interview session was recorded. This study was conducted in June-July 2023 in five provinces in Indonesia, namely DKI Jakarta, West Java, Central Java, East Java, and DI Yogyakarta. These provinces were selected because they already had gene-based nutrition service facilities. Informants in this study received an explanation about the study and signed an informed consent before participating in the interview. This study received ethical approval from the Ethics Commission of Alma Ata University Yogyakarta (No: KE/AA/V/1011148/EC/2023).

This study involved six informants and one key informant selected based on predetermined inclusion criteria. The inclusion criteria were nutritionists working in hospitals or clinics that provide gene-based nutrition services in the selected provinces, at least attending D3 education, having an STR (Registration Certificate), and having or not having experiences in providing gene-based nutrition services. The exclusion criteria were informants who did not complete in-depth interviews. Research informants were obtained from quantitative research data which was part of the concurrent mixed method research distributed via social media such as Instagram and WhatsApp<sup>9</sup>. The determination of the sample used a purposive sampling technique by selecting informants who fit the predetermined criteria. The data collection instrument used a questionnaire.

The size of the sample was based on the saturation of data obtained from the informants. As a key

informant, the nutritionist who provides gene-based nutrition services was also interviewed to obtain additional information and carry out technical triangulation. The in-depth interview questions covered questions about the nutritionists' views of the importance of gene-based nutrition services for preventing NCDs and the importance of understanding genetics science in gene-based nutrition services for preventing NCDs<sup>10</sup>.

This study used preliminary analysis and thematic analysis with Nvivo version 12 software. Qualitative data analysis was carried out interactively and continuously so that the resulting data experienced saturation. Stages in data analysis covered data collection, data reduction, data presentation, and drawing conclusions. The interview results were discussed by the researcher and research assistant to ensure the saturation and completeness of the data. Data processing involved listening to the in-depth interview recordings and then writing down the transcripts. Then, the transcript was read to clarify meaningful statements related to gene-based nutrition services. Then, the results were reported in a narrative text, and concluded and verified<sup>11</sup>. To ensure the credibility of the study, the researcher used triangulation techniques with the key informants. The key informant was a nutritionist who provides gene-based nutrition services in Indonesia<sup>12</sup>.

**RESULTS AND DISCUSSION**

The in-depth interview was conducted with 6 nutritionists from five selected provinces, namely two informants from DKI Jakarta, one informant from East Java, one informant from West Java, and two informants from Central Java. The characteristics of the informants are presented in Table 1 below.

**Table 1.** Characteristics of informant

Informant Code	Province	Gender	Age	Education Level	Institution Type	Status of Provision of Gene-Based Nutrition Services
If 1	DKI Jakarta	Female	29	S2	Type A hospital	Yes
If 2	DKI Jakarta	Female	29	S1	Puskesmas (public health center)	No
If 3	East Java	Female	39	S1	Type B hospital	No
If 4	West Java	Male	26	S1	Primary clinic	No
If 5	Central Java	Female	41	D4	Puskesmas (public health center)	No
If 6	Central Java	Female	26	S1	Gene-based nutrition service clinic	Yes

In terms of age, the informant's age ranges from 26 years - 41 years. Nutritionists who work in hospitals, puskesmas (public health center), and gene-based nutrition service clinics spread across five provinces.

Then, their education levels range from D4, S1, and S2. Informants work in hospitals of different types. Informants were nutritionists who have and have not provided gene-based nutrition services.

**Table 2.** Characteristics of key informant

Key Informant Code	Province	Gender	Age	Education Level	Institution Type
KI	East Java	Female	40	Clinical Nutrition Specialist (Sp.GK)	Gene-based nutrition service clinic

The characteristics of the key informants were a Clinical Nutrition Specialist doctor (SPGK) who has provided gene-based nutrition services. She works in a gene-based nutrition service clinic in Jakarta.

### **Theme 1: Nutritionists' views on the importance of gene-based nutrition services for preventing non-communicable diseases (NCDs)**

The results of the interview showed that nutritionist's view of genetic-based nutrition services is important. Further studies on genetic-based nutrition services have been conducted. Gene-based nutrition services play an important role, particularly for health professionals in providing appropriate nutritional consultations and designing nutritional plans according to a person's needs.

*"Yes, it is very important, in nutrition services in hospitals or other fields such as puskesmas, (gene-based nutrition services) have been available." (IF1, 29 years old, female)*

*"It's important because we can better know the patient's disease so there are no mistakes in interventions and so on. However, we have not implemented gene-based nutrition services. Diseases related to genetics are hypertension and DM." (IF1, 29 years old, female)*

The key informant stated, *"In the future, it is important to direct it towards personalized and for therapy, besides nutrition, there is exercise, pharmacology and so on because we don't just give diets, so the diet is only for one person" (KI, 40 years old, female).*

Indeed, genetic-based nutrition services are important but they have not been well realized due to limited facilities and DNA tests for genetic testing. Besides, nutritionists have limited knowledge of gene-based nutrition services. Before providing genetic-based nutritional counseling, nutritionists have to master more in-depth knowledge about the service in order to provide relevant information to clients<sup>13,14</sup>.

### **Benefits of Gene-Based Nutrition Services**

Some informants stated that detailed knowledge of patient health and consistent application of knowledge of gene-based nutrition services will help them provide more health care benefits for patients and the public.

*"It's very useful because we can know in detail about the patient's health" (IF2, 29 years old, female)*

*"If, for example, this knowledge is applied in hospitals, I think the public will be more aware and not be confused about it." (IF3, 39 years old, female)*

*"Nutrigenetic counseling is quite useful, especially for preventive efforts because we know essentially what our body needs." (IF6, 26 years old, female)*

*"The service is more important and useful, because from the diet or the results of the examination, the risk of disease can usually be seen, right? If, for example, someone is predisposed to diabetes, the person*

*can direct her diet to avoid getting sick" (KI, 40 years old, female)*

Gene-based nutrition services are beneficial to prevent NCDs. Genetic testing is important in preventing degenerative diseases with easy and affordable access. Genetic information provides insight into health management which can be utilized to help people take appropriate preventive measures and improve their quality of life<sup>15</sup>.

### **The Importance of Preventing NCDs by Utilizing the Current Gene-Based Nutrition Services**

NCDs are commonly caused by an unhealthy lifestyle, but genetic factors can also play a role in a person's susceptibility to the disease. Early prevention and monitoring of NCDs are important to reduce the burden of disease in the long term. Other health workers can provide clear information about disease risks based on diet and examination so that patients get the right action and adopt a healthy lifestyle to maintain their health which ultimately can reduce treatment costs and complications caused by NCDs<sup>16</sup>.

*"Yes, it's important because it is more detailed and prevention can be done in advance. If a person sees that his mother has cancer. She worries and then wants to check whether she has the same genetic or not." (IF1, 29 years old, female)*

*"It's very important for prevention, we really have to intensify prevention, one of which is by having genetic testing as an anticipation or prevention of diseases." (IF2, 29 years old, female)*

*"It's as gene testing". (IF4, 26 years old, male)*

*"Of course, it is important, because generally, all diseases are genetic (5-10%), including NCDs. 5-10% of stunting is also inherited from parents, it also applies for diseases." (IF5, 41 years old, female)*

*"This service is important because the diet and the results of the examination usually show the risk of disease." (KI, 40 years old, female)*

A previous study by Franzago et al., (2020) revealed that the nutritional aspect was a modifiable factor of a person's lifestyle which can interact with the genome and epigenome to influence health and fertility. Certain genetic variants can influence responses to food components and nutritional needs, and conversely, foods can modulate gene expression in the body so that they can influence the physiological function of organs and tissues in the body<sup>17,18</sup>.

### **Nutritionists' Views of Nutrigenetics and Nutrigenomics Sciences**

Nutrigenetics is associated with the interaction between genetics and foods in individual genetic formation or modification. Meanwhile, nutrigenomics focuses on the genetic response or activation in the body due to exposure to food. Nutrigenetics and nutrigenomics play an important role in understanding the complex relationship between food and genetics.

"Nutrigenomics relates to food consumption that forms genetics. Nutrigenomics is like matching our genes with foods, for example, we have food allergies" (IF1, 29 years old, female)

"Nutrigenetics is a condition where the body can process a nutrient, while nutrigenomics is the body's response or the genetic response that occurs when exposed to foods." (IF6, 26 years old, female)

Based on the results of interviews with the key informant interviews, nutrigenetics is a study of how individual genetic variations can influence the body's response to the food and nutrients consumed. "Nutrigenetics is the influence of food on the interaction of genes, while nutrigenomics is how a person's food is influenced by nutrition, genes and how our genetics influence a person's food." (KI, 40 years old, female)

Nutrigenetics and nutrigenomics play an important role in understanding the complex relationship between diet and genetics<sup>19</sup>. Gene-nutrient associations have been identified in a number of lifestyle-related diseases. Moreover, a better understanding of that association can lead to better health outcomes. The success of nutrigenetics greatly depends on both science and patient acceptance. This narrative review provides an overview of the current nutrigenetics landscape about major disease conditions and addresses potential challenges in its implementations<sup>20,21</sup>.

#### **Advantages and Disadvantages of Gene-Based Nutrition Services**

The disadvantages of gene-based nutrition services are a lack of understanding and awareness of gene-based nutrition services and limited access and costs in adopting the service. However, this service has potential advantages in the prevention, diagnosis, and improvement of nutrition<sup>22</sup>.

"The number of disadvantages are higher than the advantages. The disadvantage is that genetics is still new so only one or to people who already talk about it. The advantage is to prevent disease early." (IF1, 29 years old, female)

"The disadvantage is the cost. It is very expensive. Then, the advantage is that we can provide more detailed nutritional counseling." (IF3, 39 years old, female)

"The advantage is that it is personalized for the patient. Thus, the therapy for one patient and another will be different. The disadvantage is the cost. Most services are available abroad so it's expensive and takes a longer time to get the results. Besides, some people are afraid that the sample must be sent abroad. It will be known by foreigners and it is not good because in Indonesia, there are very few who carry out research in this field." (KI, 40 years old, female)

The informant's statement regarding the cost is not surprising. The disadvantage of this gene-based nutrition service is its expensive cost.

"It's the cost as the patient knows that the price is around 2 - 11 million." (KI, 40 years old, female)

The obstacles to implementing gene-based services are limited infrastructure and human resources. Thus, expanding research and collaboration between disciplines to gain a more comprehensive understanding are important. Then, the results of the research can be utilized in clinical practice and improve public's understanding and awareness. Moreover, the other obstacles are limited access and costs in adopting genetic services related to nutrigenetics and nutrigenomics<sup>23</sup>.

#### **Theme 2: The importance of mastering genetic science in gene-based nutrition services for nutritionists**

All informants explained that genetics is a description of the traits recorded in our genetics, covering skin color, physical characteristics, and potential benefits and disadvantages such as allergies. Genetics is the inheritance of traits from parents to children through genes as stated by the following statements.

"Genetics is a description of the traits in our bodies that are recorded in our genetics, for example, skin color to physical characteristics" (IF1, 29 years old, female)

"Genetics is a reaction that occurs in our body" (IF2, 29 years old, female)

"Inheritance of traits from both father's and mother's genes to the child. It is not only about traits but also physical characteristics and potentials that can be detrimental such as allergies" (IF3, 39 years old, female)

"Genetics is one of the genes in the body which is responsible for deriving traits and codification for the formation and development of all body organs covering skin color, hair color, eyes, and types of diseases such as color blindness, asthma, etc." (IF4, 26 years old, male)

"Genetics is a kind of heredity of cells carried by parents which are passed on to children" (IF5, 41 years old, female)

"Genetics is the term for something that is passed down from ancestors, especially from parents." (KI, 40 years old, female)

Genetic and healthy lifestyle factors play an important role in an individual's health. The interaction between genetics and the environment affects the overall quality of life because genetics influences the traits that are passed on to children. The interaction between genetic and environmental factors, such as diet, also plays a role in health. Unfavorable genetic characteristics of parents can affect children's health<sup>24</sup>.

#### **Genetic Diversity**

In terms of genetic diversity, an informant explained that human genetic diversity arises through marriage or intermarriage and differences in individual traits inherited from parents.

"Genetic diversity is variation in humans through marriage or different characteristics." (IF1, 29 years old, female)

"Hereditary inheritance of traits from both the father's and mother's genes." (IF3, 39 years old, female)

"Genetic diversity is the study of heredity, that is, what is inherited from our parents." (IF6, 26 years old,

female)

Based on the explanation above, genetic diversity is a particle that forms the body and is inherited by parents, or can be influenced by marriage.

*"Well, the term of genetic is, well, I forgot about this term. It's like something that is passed down from our ancestors. Yes, we got it from our parents, but we also continue to carry it. So, what is in us may not necessarily be found in our parents, but they can be in our ancestors and vice versa."* (K1, 40 years old, female)

Genetics influences various aspects of humans, including physical traits, intelligence, and predisposition to certain diseases. However, environmental and lifestyle factors play a role in the development of traits and diseases<sup>25</sup>.

### Genetic Inheritance

The informants explained that the inheritance of traits in humans through genetic factors covered various aspects such as physical characteristics (skin color, hair, and eyes), diseases (diabetes, thalassemia, and heart disease), intelligence, blood cell shape, organs (pancreas), and other diseases (color blindness and asthma).

*"Inheritance of traits, for example, I have black skin, maybe my child has a chance of having black skin too. And if I have a food allergy, my child will have the same chance of hereditary diseases such as diabetes, thalassemia, heart disease."* (IF1, 29 years old, female)

*"It can be related to physics or intelligence, and diseases such as hypertension, diabetes, thalassemia."* (IF2, 29 years old, female)

*"Potential for diseases such as diabetes, allergies, obesity, and malnutrition."* (IF3, 39 years old, female)

*"The skin color, hair color, eyes, and types of diseases such as color blindness, asthma and others."* (IF4, 26 years old, male)

All the statements above are in line with the key informant's statement. *"Starting from physical appearance such as hair, eye color, risk of diseases such as diabetes, nutritional metabolism and even the aging process."* (K1, 40 years old, female)

Inheritance of traits occurs through a process that involves a combination of genetics and the characteristics of parents and ancestors. Besides, the informants explained that the inheritance of traits through genetic factors includes various aspects such as physical traits (skin color, hair, and eyes), certain diseases (diabetes, thalassemia, and heart disease), intelligence, blood cell shape, organs (pancreas), and other diseases (color blindness and asthma). The inheritance of traits through genetics can influence various aspects such as physical traits, intelligence, and predisposition to certain diseases, but environmental and lifestyle factors also play a role in the development of traits and diseases<sup>26</sup>.

### The Influence of Genetic on Health and Nutrition

Concerning the influence of genetics on health and nutrition, a person with a genetic history of certain diseases is at risk of developing diseases. However, the risk can be minimized by adopting a healthy lifestyle. This is because genetics influences the traits passed on to children. The interaction between genetic and environmental factors, such as diet, also plays a role in health. Unfavorable genetic characteristics of parents can affect children's health. In other words, genetic factors and a healthy lifestyle play an important role in a person's health and the interaction between genetics and the environment affects the overall quality of life.

*"The influence of genes on health problems is that genes carry traits that will be passed on to children."* (IF3, 39 years old, female)

*"In terms of genetic influence, first, it affects a person's quality of life because genetics has an impact on the development of a disease, for example, if gene A and gene B are given the same nutritional intake, it will have a different impact"* (IF4, 26 years old, male)

*"Understanding nutrigenomics and nutrigenetics can help us be more aware of the impact of food on our bodies and adjust our diet to suit our genetic needs. So, what we eat will influence on our body, so we need to consider what to consume to stay healthy"* (K1, 40 years old, female)

Concerning the influence of genetics on health and nutrition, a person with a genetic history of certain diseases is at risk of developing the diseases but the risk can be minimized by adopting a healthy lifestyle. This is because genetics influences the traits passed on to children. The interaction between genetic and environmental factors, such as diet, also plays a role in health<sup>27</sup>.

### The Importance of Mastering Genetic Science for Nutritionists in Nutrition Service Practices

All informants agreed that awareness and knowledge about nutrigenetics and nutrigenomics are important for nutritionists.

*"It is important, to develop nutrition services, nutritionists must be aware that the world is changing."* (IF1, 29 years old, female)

*"Yes, it is very important."* (IF2, 29 years old, female)

*"It's important, it's very important."* (IF3, 39 years old, female)

*"Maybe, it is very important, if we already know the diagnostic history of the client, we can also add genetic history, we can overcome complications and provide more precise care."* (IF4, 26 years old, male)

*"It's very important, sometimes I want to take part in a seminar but I cannot."* (IF5, 41 years old, female)

*"The development of times requires it, it's called medical science because it will continue, so whether you like it or not, we need to master it."* (K1, 40 years old, female)

Nutritionists' views of gene-based nutrition services play an important role in the prevention and

treatment of NCDs. The advanced development of science and technology allows early detection of diseases in the body which can be done through genetic testing<sup>28</sup>.

### CONCLUSIONS

Nutritionists' knowledge of gene-based nutrition services as prevention for NCDs is quite good. They understand about NCDs and the benefits of gene-based nutrition services for preventing NCDs. They also have good knowledge of genetic science in gene-based nutrition services. They agree that the cost of gene-based nutrition services is considered expensive and they also get worried that many people are not familiar with this service. Therefore, nutritionists need to carry out outreach to the public about the importance of the benefits of genetic testing to prevent NCDs to attract the public interest in gene-based nutrition services.

### ACKNOWLEDGMENTS

The author highly appreciates the supervisor for guiding the implementation of this study and all informants for their participation in this study. The author also appreciates the student's thesis group entitled "Views and Roles of Nutritionists in Gene-Based Nutrition Services in Indonesia: A Mixed Method Study."

### Conflict of Interest and Funding Disclosure

The author declares that this study does not have any conflict of interest and this study is personally funded.

### REFERENCES

1. Alsulami, S. *Et Al.* Interaction Between The Genetic Risk Score and Dietary Protein Intake on Cardiometabolic Traits in Southeast Asian. *Genes Nutr* **15**, (2020).
2. Gholami, F., Rasaei, N., Samadi, M., Yekaninejad, M. S. & Keshavarz, S. A. Hubungan Skor Risiko Genetik dengan Faktor Risiko Kardiometabolik : Studi Cross-Sectional. 1–10 (2022).
3. Masrurroh, A. Pengaruh Status Gizi, Konsumsi Pangan dan Fasilitas Belajar terhadap Prestasi Belajar Matematika. *Formatif: Jurnal Ilmiah Pendidikan MIPA* **6**, 220–232 (2016).
4. Karina, Harry Freitag Luglio Muhammad Dian Caturini Sulistyoningrum Rio Jati Kusuma Anggi Laksmi Dewi Iffa. *Nutrigenomik dan Nutrigenetik Bagi Mahasiswa Gizi*. (Gajah Mada University Press, 2021).
5. Szakály, Z. *Et Al.* Consumer Acceptance of Genetic-Based Personalized Nutrition in Hungary. *Genes Nutr* **16**, (2021).
6. Fallaize, R., Mcready, A. L., Butler, L. T., Ellis, J. A. & Lovegrove, J. A. An Insight Into The Public Acceptance of Nutrigenomic-Based Personalised Nutrition. *Nutr Res Rev* **26**, 39–48 (2013).
7. Fadli, M. R. Memahami Desain Metode Penelitian Kualitatif. *Humanika* **21**, 33–54 (2021).
8. Hafizhah, R. D. Hubungan Pengetahuan Tentang Pelayanan Gizi Berbasis Gen terhadap Keterlibatan dan Kepercayaan Diri Tenaga Gizi Di Indonesia. (Universitas Alma Ata, 2023).
9. Hafizhah, R. D. Hubungan Pengetahuan Tentang Pelayanan Gizi Berbasis Gen terhadap Keterlibatan dan Kepercayaan Diri Tenaga Gizi Di Indonesia. (Universitas Alma Ata, 2023).
10. Mgencouns, E. T. *Et Al.* The Expectations and Realities of Nutrigenomic Testing in Australia : A Qualitative Study. 670–686 (2021) Doi:10.1111/Hex.13216.
11. Sugiyono. *Metode Penelitian Kuantitatif, Kualitatif dan R & D*. (Alfabeta, 2006).
12. Mudrajad Kuncoro. Validitas dan Reliabilitas Data Penelitian Kualitatif A. *Penelitian Kualitatif* **LII**, 203 (2013).
13. Mulyani, R., Fatimah, F. S. & Sarwadhamana, J. Kualitas Pelayanan dan Kepuasan Pasien Rawat Jalan Pengguna Jaminan Sosial Kesehatan. *Jurnal Kesehatan Masyarakat Indonesia* **17**, 66–72 (2022).
14. Kurniasih, H., Purnanti, K. D. & Atmajaya, R. Pengembangan Sistem Informasi Penyakit Tidak Menular (PTM) Berbasis Teknologi Informasi. *Jurnal Teknoinfo* **16**, 60 (2022).
15. Wulandari, C., Ahmad, L. & Saptaputra, S. Faktor yang Berhubungan dengan Pemanfaatan Pelayanan Kesehatan Di Uptd Puskesmas Langara Kecamatan Wawonii Barat Kabupaten Konawe Kepulauan Tahun 2016. *Jurnal Ilmiah Mahasiswa Kesehatan Masyarakat Unsyiah* **1**, 183311 (2016).
16. Jannah, M. Dan K. Z. P. Pengaruh Genetik Anak Usia Dini. *Bunayya: Jurnal Pendidikan Anak* **7(2)**, 53–63 (2021).
17. Franzago, M., Santurbano, D. & Vitacolonna, E. Genes and Diet in The Prevention Of Chronic Diseases in Future Generations. (2020).
18. Beckett, E. L., Jones, P. R., Veysey, M. & Lucock, M. Nutrigenetics—Personalized Nutrition in the Genetic Age. *Explor Res Hypothesis Med* **2**, 1–8 (2017).
19. Ariana, R. *Nutrigenetik Rekomendasi Kebutuhan Energi dan Zat Gizi Makro Berbasis Genetik untuk Layanan Personalized Nutrition*. (2016).
20. Beckett, E. L., Jones, P. R., Veysey, M. & Lucock, M. Review Article Nutrigenetics — Personalized Nutrition in The Genetic Age. **2**, 109–116 (2017).
21. Principles, B. E., Pusat, P. & Unggul, E. *Nutrigenetik*. Vol. 11510 (2022).
22. Elsamanoudy, A., Mohamed Neamat-Allah, M., Hisham Mohammad, F., Hassanien, M. & Nada, H. The Role Of Nutrition Related Genes and Nutrigenetics in Understanding The Pathogenesis of Cancer. *J Microsc Ultrastruct* **4**, 115 (2016).
23. Alathari, B. E., Sabta, A. A., Kalpana, C. A. & Vimalaswaran, K. S. Vitamin D Pathway-Related Gene Polymorphisms and Their Association with Metabolic Diseases: A Literature Review. *J Diabetes Metab Disord* **19**, 1701–1729 (2020).
24. Aji, A. S. *Et Al.* A Genetic Approach to Study The Relationship Between Maternal Vitamin D Status and Newborn Anthropometry Measurements: The Vitamin D Pregnant Mother (VDPM) Cohort Study. *J Diabetes Metab Disord* **19**, 91–103 (2020).
25. Surendran, S. *Et Al.* A Nutrigenetic Approach for Investigating The Relationship Between Vitamin

- B12 Status and Metabolic Traits in Indonesian Women. *J Diabetes Metab Disord* **18**, 389–399 (2019).
25. MARTONO, B. Keragaman Genetik, Heritabilitas dan Korelasi Antar Karakter Kuantitatif Nilam (Pogostemon Sp.) Hasil Fusi Protoplas. *Jurnal Penelitian Tanaman Industri* **15**, 9 (2020).
26. Aji, A. S. *Et Al.* Impact of Maternal Dietary Carbohydrate Intake and Vitamin D-Related Genetic Risk Score On Birth Length: The Vitamin D Pregnant Mother (VDPM) Cohort Study. *BMC Pregnancy Childbirth* **22**, 1–11 (2022).
27. Kaufman-Shriqui, V., Salem, H., Boaz, M. & Birk, R. Nutrigenetics: Findings from The 2019. *Nutrients* **12**, (2020).