

## RESEARCH STUDY

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# Current Knowledge of Gene-Based Nutrition Services among Indonesians to Prevent Non-Communicable Diseases

## Gambaran Pengetahuan Masyarakat Terhadap Pelayanan Gizi Berbasis Gen dalam Pencegahan Penyakit Tidak Menular di Indonesia

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### ABSTRACT

**Background:** Non-Communicable Diseases (NCDs) are the primary health issues in Indonesia, with their prevalence increasing each year. The advancement of technology, such as gene-based nutrition services, could offer an alternative approach to prevent NCDs in the present and future.

**Objectives:** This study aims to assess the current level of knowledge regarding gene-based nutrition services among Indonesians for NCD prevention.

**Methods:** A qualitative phenomenological study was conducted across five provinces in Indonesia. In-depth interviews were conducted with ten informants, selected using the snowball sampling technique. The research focused on themes such as understanding gene-based nutrition services, genetic knowledge, and the role of gene-based nutritional analysis in NCD prevention. Thematic analysis was performed using NVivo v.14.

**Results:** The community demonstrated a solid grasp of the concept of genetics and inherited traits. However, they struggled with genetic terminology. Most Indonesians had limited awareness of gene-based nutrition services, although they recognized their benefits in disease detection and dietary management. They also knew that the cost of this inspection was expensive, and individuals expressed concerns about the potential implications of disease risk detection. Participants notably clarified that NCDs are not communicable diseases and can be prevented through gene-based nutritional interventions. Interest in gene-based nutrition services was substantial, yet barriers included cost and facility accessibility.

**Conclusions:** Indonesians generally possess limited knowledge about genetics, gene-based nutrition services, and genetic testing. However, they acknowledge the significance of genetic-based nutrition services in early NCD prevention, as these services can help determine appropriate dietary patterns and lifestyles.

### INTRODUCTION

Quality of Human Resources (HR) greatly influences the development of a nation which can be assessed through educational, economic, and health indicators<sup>1</sup>. In terms of health, national development also aims to increase awareness, willingness, and ability to live healthily for each individual in order to achieve a high level of public health. Public health plays an important role in development as capital for the economy through labor<sup>3</sup>. Indonesia faces the problem of triple burden diseases, including the increasing Non-Communicable Diseases (NCDs)<sup>4,5</sup>.

The 2018 Basic Health Research reported that NCDs become the main health problem with the highest mortality rate. Besides, it reveals the increasing prevalence of NCDs compared to 2013 in people aged 18

years covering high blood pressure (from 25.8% to 34.1%), obesity (from 14.8% to 21.8%), and smoking (from 7.2% to 9.1%). Other NCD prevalence also increase such as cancer (from 1.4 per mile to 1.8 per mile); stroke (from 7 per mile to 10.9 per mile), and diabetes mellitus (from 6.9% to 10.9%) in the population aged  $\geq 15$  years<sup>6,7</sup>.

In Indonesia, the continuously increasing prevalence of NCDs can reduce HR productivity<sup>8</sup>. NCDs are preventable diseases so early detection and appropriate treatment can improve NCD control. Considering the high incidence and mortality rate caused by NCDs, controlling NCDs is crucial. NCDs are a disease that cannot be spread from one person to another and although they can be prevented, early detections are needed to prevent their development<sup>9</sup>. Early detection

and appropriate treatment can result in better NCD control<sup>10</sup>.

Nutrition plays an important role in the prevention and treatment of NCDs<sup>11</sup>. The development of science and technology provides opportunities to prevent disease as early as possible, especially for NCDs. Nutrigenetics is a field of nutritional science that studies the role of genetic factors in a person's diet in order to accurately predict the risk of disease based on genetic variation data<sup>12-14</sup>. Therefore, gene-based nutrition services using a nutrigenetic approach can be an alternative solution to prevent NCDs.

Public understanding and awareness about gene-based nutrition services support NCD prevention efforts. Qualitative studies focusing on knowledge of gene-based nutrition services among nutritionists in Indonesia have not been conducted. However, studies concerning this topic have been concluded abroad involving nutrition students. Therefore, this present qualitative study aims to identify public knowledge of gene-based nutrition services in preventing NCDs in Indonesia.

## METHODS

This qualitative study used a phenomenological approach. Data were collected by conducting in-depth interviews in person and online with the help of Zoom Meeting. The subjects or informants were Indonesian people who could be met in person and online. The in-depth interview session was conducted in June 2023 focusing on five provinces in Indonesia, namely DKI Jakarta, West Java, Central Java, East Java, and DI Yogyakarta. Those provinces have had gene-based nutrition service providers, namely PT Kalbe Farma and PT Prodia Widyahusada. Informants received an explanation about the study and signed informed consent before participating in in-depth interviews. This study received ethical approval from the Ethics Commission of Alma Ata University Yogyakarta (No: KE/AA/V/1011113/EC/2023).

The inclusion criteria of the informant were people staying in DKI Jakarta, West Java, Central Java, East Java, and DI Yogyakarta provinces and aged over 20 years. They had to have good communication skills and be willing to participate in in-depth interviews. Informant

data were obtained from a quantitative study which was part of concurrent mixed-method research distributed via social media such as Instagram, WhatsApp, Twitter, and TikTok. The selection of informants used a snowball sampling technique, namely informants who filled out the questionnaire were selected sequentially from each province. Then, they were contacted and received an explanation about this study as well as interview schedules. The sample size was determined based on the saturation of data obtained from the informants. Nutritionists who provide gene-based nutrition services as key informants were also interviewed to obtain additional information and to triangulate data. The in-depth interview questions covered questions related to genetics, nutrition services, and gene-based nutritional examinations to prevent NCDs.

Data were analyzed in two stages, namely preliminary analysis and thematic analysis using Nvivo version 14 software. Preliminary analysis was carried out after each session of interview activities. The results of the interview were discussed after completing the activity session by the researcher and research assistant to ensure data saturation and completeness<sup>15</sup>. Thematic analysis used a mixed theme determination deductively and inductively. The first means that the theme was determined at the beginning based on theory or results of previous research, while the second means that the themes emerge through the analyzed data<sup>16</sup>. The theme was determined based on the results of previous studies conducted in 2019 that the success of personalized nutrition greatly depends on public knowledge of gene-based nutrition services<sup>17</sup>. Then, the theme was also determined based on the results of studies conducted in 2021 regarding the importance of a personalized dietary approach for preventing micronutrient deficiencies and metabolic diseases and NCDs<sup>18</sup>. The researcher listened to the results of in-depth interview recordings to write data in the form of transcripts and read them repeatedly to quote meaningful statements related to gene-based nutrition services. The researcher organizes the statements by theme. Then, the researcher wrote a complete description in the form of research results<sup>19</sup>. Themes and sub-themes of this study are presented in Table 1.

**Table 1.** Themes and sub-themes of the study

Themes	Sub-themes
Knowledge related to Genetics	Definition of genetics Inherited traits Genetic terminology
Knowledge of Gene-Based Nutrition Services and Examinations	Definition Advantages Disadvantages Type of examination analysis Inspection sample tools and materials Willingness to follow a personalized diet Willingness to share test results with family
Knowledge about Gene-Based Nutrition Services as Prevention of NCDs	Definition of non-communicable disease Benefits of gene-based nutrition services for NCDs The importance of gene-based nutritional services for preventing NCDs

Themes	Sub-themes
Interest in Carrying Out Gene-Based Nutrition Examination	Plan or interest in carrying out a gene-based nutritional examination

## RESULTS AND DISCUSSION

This study involved 10 informants from 5 selected provinces to participate in in-depth interviews. The

characteristics of the informants including age, education level and occupation, and others are presented in Table 2.

**Table 2.** Characteristics of informants (n=10)

Characteristics	N
Gender	
Male	2
Female	8
Age	
20 years	1
21 years	3
22 years	1
23 years	1
25 years	1
35 years	1
47 years	2
Origin	
DKI Jakarta	2
West Java	2
Central Java	2
East Java	2
DI Yogyakarta	2
Education level	
Senior high school graduated	6
S1	3
S2	1
Employment	
Student	7
Private employee	1
Civil servant	2

Informants were dominated by students (7 people), followed by civil servants (2 people), and private employee. The informant consisted of seven women and two men. The youngest informant was 20 years and the oldest was 47 years.

### Theme 1: Knowledge of Genetics

Based on the results of interviews, knowledge about genetics is still low. The informant could explain the meaning of genetics and inherited traits but did not understand genetic terms. Some informants stated that genetics is the inheritance of traits from parents to offspring, resulting in genetic variation. This is in line with the theory which states that this science studies how hereditary characteristics (heredity) are passed on to children and grandchildren, as well as the possible variations<sup>20</sup>. This means that the informant has quite good knowledge about this concept. Interviewed informants were coded (IF, age, and gender). Some statements of informants during the interview can be seen below.

*"I think genetics is something that will later inherit traits from genes, for example, children will*

*inherit their parent's genes and so on."* (IF 9, 25 years old, female)

*"It's highly influenced, yes, influenced by the father and mother, either behavior or disease that will later be inherited or attitude, character (hereditary traits are influenced by genetics)." (IF 22, 47 years old, male)*

The key informant explained that genetics is a science that studies heredity or the inheritance of traits as stated below.

*"... in simple terms, genetics is a study that studies heredity, that is, what is inherited from our parents including traits, characteristics, and looks, as well as the body's metabolism works, etc., they are all influenced by genetic factors..." (KI, 26 years old, female)*

All informants agreed that inherited genetic traits covered physical traits such as skin color, hair shape, and face shape, while non-physical traits were intelligence and behavior as well as disease as stated by the following informants.

"... maybe the kids are twins or they have white skin, brown(skin), straight hair, curly and wavy hair, and something like that, or even maybe albino." (IF 4, 20 years old, female)

"Maybe it's from innate traits, for example, a person's characteristics are from the parents, for example, they have a temperamental character, have one kid, two kids, maybe one of them can inherit traits like that, then from the physical, for example, their parents have curly hair, the kids will also have curly hair. Then, related to disease, for example, if parents have hypertension, the kids can also inherit a history of hypertension." (IF 7, 21 years old, female)

The key informant stated that inherited traits include attitudes, traits, and body metabolism as stated below.

"What is inherited is probably what we have discussed earlier, for example, our attitude, character, hair color, eyes, physical shape, metabolism, function, appetite, and passions are all influenced by genes. Studies reveal that passion is also influenced by genetics, how our bodies are more intolerant and sensitive can be influenced by genes." (KI, 26 years old, female)

Some informants argued that the inheritance of traits occurs through a genetic combination of both parents. Each individual receives half of its genetics from the mother and half from the father, forming genetic variations in the offspring. These variations produce unique combinations of genes affecting a person's physical traits and characteristics. This refers to the theory that states that genetic variation is a variant in the appearance of individuals due to genetic differences, where each individual carries a different type of gene and is passed on to their offspring<sup>21</sup>. The informants' knowledge confirmed the importance of genetic factors in determining the traits passed on to offspring such as skin color, hair type, and disease susceptibility. Heredity theory states that genetics is a determinant factor in individual development. Heredity is the totality of individual characteristics inherited from parents through genes, including the physical and psychological potential possessed since the fertilization<sup>22</sup>.

Informants had a low knowledge of genetics. Some mentioned them such as chromosomes, deoxyribonucleic acid (DNA), genotype, and phenotype. However, they could not explain it precisely, as revealed in the following interview quotes.

"I know a lot about genetics such as DNA, RNA, double helix, then chromosomes, cells, proteins, that's what I remember." (IF 1, 21 years old, female)

"Hmmm, what is DNA, what is RNA, I have forgotten about them. It has been a long time since I studied them, maybe in high school." (IF 1, 21 years old, female)

"I've heard of it but don't understand (RNA)." (IF 10, 22 years old, female)

The statement above indicates that the informants cannot explain genetic terminology precisely. Some of them did not know about chromosomes, alleles, and genotypes. This is in line with a study conducted in 2012 in Durham City, North Carolina where the participants obtained higher scores on questions related to the inheritance of traits and causes of disease (94.6%) than questions related to terms about genes, chromosomes, and cells (78.6%)<sup>23</sup>. The low level of knowledge regarding the terminology of genetics is because not all people receive information and learn about this topic.

## Theme 2: Description of Public Knowledge of Gene-Based Nutrition Services

The community's knowledge regarding gene-based nutrition services is low. They said that they had just heard of it. Some others explained that this service is a nutrition service based on a person's genetic information to determine the type of gene and detect disease. The process involves genetic testing and the results are interpreted by a nutritionist in order to form a diet according to the individual's genetic characteristics.

"To be honest, I just found out about gene-based services. Maybe, in big hospitals, it has already existed, but not all people know about it." (IF 2, 47 years old, male)

"In my opinion, gene-based nutritional services mean that nutritional services will be based on a person's genetics, for example, a person obtains a counseling session from a nutritionist who will later provide gene-based nutritional services so that the intervention will be based on that genetic type." (IF 9, 25 years old, female)

"...the nutritional care is obtained from the results of genetic testing. The gene is tested first, then nutritionist or other competent health worker will translate the results of the test like that." (IF 1, 21 years old, female)

"Based on my own understanding, gene-based services provide services such as to look for the best genes, the best offspring, the hereditary disease, and then to find out whether there is a problem with one of the parties." (IF 2, 47 years old, male)

However, the key informant defined gene-based nutrition services as services to find out the genes in the body and how these genes influence nutritional needs, for example, vitamin D, folic acid, and other nutrients. The goal is to provide nutritional recommendations according to a person's genes as stated below.

"Concerning the principle of gene-based nutrition services, usually we want to know the genes that appear in our bodies and their domination, the effect on the body, let's say vitamin D, folic acid, and others. If they tend to be low, usually we will give suggestions to increase their level. However,

*the dosage that we recommend cannot be given directly." (KI, 26 years old, female)*

Gene-based nutrition services cover DNA testing which can be a data source for nutrigenetic and nutrigenomic analysis processes later. They are commonly known as Nutritional Genomics. Some informants did not fully understand nutrigenetics. They could only mention it as the link between nutrition and diet and its impact on genes. Other informants stated that nutrigenetics is related to how genes respond to nutrition as stated below.

*"Usually it relates to nutrition." (IF 2, 47 years old, male)*

*"Nutrigenetics is more about regulating the dietary patterns of a person." (IF 4, 20 years old, female)*

*"I'm a bit confused about nutrigenetics. It is nutrition on the genes? Or it's like the impact of nutrition on genes..." (IF 5, 23 years old, female)*

*"... nutrigenetics is how our (genes) respond to a nutrient..." (IF 1, 21 years old, female)*

The majority of informants were unfamiliar and could not explain the analysis process using nutrigenomics. Some thought that nutrigenomics was more specific than nutrigenetics as stated below.

*"Never heard of it" (IF 10, 22 years old, female)*

*"Yes, as I said earlier, not all people know about this service." (IF 2, 47 years old, male)*

*"Perhaps nutrigenomics is more specific than nutrigenetics." (IF 3, 21 years old, male)*

The key informant argued that nutrigenetics is how our body responds to nutrients, while nutrigenomics is how food or nutrients influence the body or genetics.

*"Nutrigenetics is more about how our body works, a study that studies our body's metabolism of nutrients. Oh, it's the role of genotype in absorption or perhaps enzymes that influence how our body processes a nutrient which can be influenced by genes..." (KI, 26 years old, female)*

*"...whereas nutrigenomics is the opposite, for example, the role of one food ingredient or the role of nutrient in influencing the profile of genetics or the condition of our body, in simple terms, it might be like that." (KI, 26 years old, female)*

Public knowledge of gene-based nutrition services is low. Most informants did not understand the meaning of gene-based nutrition services, nutrigenetics, and nutrigenomics. This is in line with a study conducted in Quebec in 2019 in which the majority of participants were not familiar with the term "nutrigenetics" (82.7%)<sup>24</sup>. Indeed, some could explain that this service is based on a person's genetics through genetic testing to provide

nutritional recommendations according to needs. A previous study conducted in 2018 explained that gene-based nutrition services or personalized nutrition are services that use information on a person's genetic characteristics to prepare nutritional recommendations according to the person's needs<sup>25</sup>. As stated earlier, public knowledge about nutrigenetics and nutrigenomics is still low as most informants cannot precisely explain them. This is because this topic is not familiar to the public. Based on a theory in the Nutrigenomics and Nutrigenetics textbook, nutrigenetics is a science or analysis based on the relationship between genetics influencing nutrition. Meanwhile, nutrigenomics is the study of nutrition affecting genes<sup>26</sup>. Only a few informants could explain the meaning of nutrigenetics correctly.

The community agreed that gene-based nutrition services can detect disease early so that they can regulate good eating patterns and ultimately prevent disease and minimize health expenditure in the future.

*"It has many benefits, for example, controlling your diet and knowing the disease for more optimal disease prevention." (IF 3, 21 years old, male)*

*"...if we talk about the benefits, I think there are a lot. I mean, for example, our eating arrangements, eating patterns, and diets are already based on the results of genetic tests, which means that those are 100 percent suitable for us." (IF 1, 21 years old, female)*

*"...perhaps in the future, it will reduce medical costs, so we can detect the disease earlier as prevention and minimize chronic problems." (IF 8, 35 years old, female)*

The key informant argued that the benefits of gene-based nutrition services were providing a deeper understanding of the risks of individual health conditions, helping patients to be more alert to these risks so that prevention can be carried out, knowing specifically about genetics which can provide additional information for nutritional education and nutritional care.

*"The benefit is knowing better the health risks and for patients, they can know more about the disease and be more vigilant." (KI, 26 years old, female)*

*"It's useful especially for preventive efforts because we know what our body's typical condition, so the consultations can be more optimal to know what we need to improve." (KI, 26 years old, female)*

*"The benefit is knowing what our nature is like, so it can become additional information for nutritional care" (KI, 26 years old, female)*

The public believed that gene-based nutrition services have disadvantages in terms of high costs and anxiety about test results as stated below.

*"...because not all hospitals have this service, so it seems like this service is relatively expensive,*



*maybe in terms of costs because it's still limited in certain hospitals." (IF 6, 47 years old, female)*

*"... well, the disadvantage, maybe afraid or worried that it will be expensive." (IF 3, 21 years old, male)*

*"...the maybe it makes us worry after taking the test." (IF 5, 23 years old, female)*

Moreover, the community was aware of the benefits of gene-based nutritional services, such as early disease prevention and detection. It is in line with a previous study conducted in India in 2017 that nutrigenomics helps evaluate individual nutritional needs based on individual genetic profiles and help cure and prevent chronic diseases<sup>27</sup>. However, the disadvantage of this service, namely high costs can hinder accessibility and acceptance among the wider community. This can be an obstacle for those who have financial limitations or do not have access to health facilities. This contradicts a previous study conducted in Europe in 2016 that 30% of participants are willing to pay more for gene-based nutrition services. Most of them even prepared to pay 150% more for diet counseling to get recommendations according to their genetic characteristics<sup>28</sup>. Besides, there is anxiety and worry about genetic test results and uncertainty about the results. People may worry about discovering unwanted genetic information or having serious health problems. This is in line with a study conducted in Durham City, North Carolina in 2013 in which 16% of respondents were worried about the consequences of testing for their chances of getting a job<sup>23</sup>.

The results of the interviews revealed that some informants agreed that gene-based nutritional examinations used the Polymerase Chain Reaction (PCR) tool with the tested samples of blood and saliva.

*"Maybe it uses PCR..." (IF 3, 21 years old, male)*

*"Oh, as far as I know, the body fluids use blood or saliva." (IF 1, 21 years old, female)*

Some informants knew that gene-based nutritional tests use PCR tools and blood and saliva samples. PCR is a basic technique in various fields of genetic research, including nutrigenetics and nutrigenomics. PCR is used to analyze genetic polymorphisms related to nutrition and the body's response to food. Blood and saliva are commonly used samples in genetic analysis as they contain DNA that can be extracted for genetic testing<sup>26</sup>. The community knowledge about the use of these tools and samples may still be limited to general information.

All informants were willing to follow a personalized diet based on genetics as it is considered very beneficial for health. Besides, they were willing to adjust their diet according to recommendations and were willing to share the results of the examination with their family. Thus, when there are undesirable results, they can take preventive measures immediately.

*"Of course, when patients come to carry out nutrigenetic nutrition services, they have a purpose, such as getting diet recommendations, well, if we don't practice the recommendation, it will be a loss. They are beneficial for our health." (IF 4, 20 years old, female)*

*"Hmm, talking about willingness, of course, I am willing to as I mentioned at the beginning, if it's based on genetics, that's what's inside us, so there's no need to try another diet. But if it's to be applied every day, well, we must be consistent and committed. Talking about willingness, definitely, I am willing to." (IF 1, 21 years old, female)*

*"Hmm, of course. We definitely share the same genetic code with our family, which is similar and identical. Maybe the genetic test results could be useful for other family members, whether it is good or bad, for example, being found to be intolerant to a food or even a risk factor for other diseases, it will be more beneficial for other family members" (IF 1, 21 years old, female)*

*"Of course, yes, because my family knows my condition so that when planning my future life, someone will definitely get married, we can communicate with each other, we can also prevent unwanted things" (IF 10, 22 years old, female)*

The majority of informants were willing to follow a personalized diet according to their genetic profile as it was believed to be beneficial for health, regulate eating patterns according to recommendations, and meet individual needs. This is in line with a previous study conducted in 2019 in Quebec that the majority of participants were ready to adopt a personalized diet based on genetic testing<sup>24</sup>. They were also willing to share test results with families so that when the test results are undesirable, they can take preventive measures immediately. They shared the test results with families to ensure that families have relevant information about genetic conditions that may be affecting their health. This can help families to better understand the potential risks involved and take appropriate measures. This is in line with a study conducted in Finland in 2020 that the majority of participants (89%) would prefer to share their genetic information with their family members<sup>29</sup>.

### **Theme 3: Public Knowledge of Gene-Based Nutrition Services as Prevention of NCDs**

The interview results indicated that the public's understanding of non-communicable diseases is good. They argued that NCDs are diseases that cannot be transmitted through contact between individuals, unlike infectious diseases.

*"Non-communicable diseases are diseases that are not transmitted by viruses, and perhaps non-communicable diseases come from habits, our daily lifestyle, and or from genetics or are passed down from generation to generation." (IF 4, age 20 years old, female)*

*"Non-communicable diseases are diseases that are not transmitted by one person to another person, for example, hypertension, stroke, heart disease or a disease that arises due to an unhealthy lifestyle"* (IF 9, 25 years old, female)

The key informant defined non-communicable diseases as diseases that usually arise due to lifestyle and genetic factors.

*"NCDs are diseases that arises due to lifestyle. Maybe cholesterol or maybe diabetes and so on. Well, it's not just because of lifestyle but it can be because of genetic factors"* (KI, 26 years old, female)

Based on the interview results, the informants were aware of risk factors for non-communicable diseases related to genetic and lifestyle factors. It is in line with a previous study conducted in Ogan Ilir, South Sumatra in 2015 that respondents who had parents with a history of NCDs had a 1.23 times higher risk of suffering from NCDs than those with parents who do not have a history of NCD<sup>30</sup>. The public is aware that NCDs can be hereditary or genetic so they can increase the risk of developing certain diseases. Global Status Report on Non-Communicable Diseases in 2022 reveals that risk factors for NCDs cover smoking habits, lack of physical activity, and unhealthy eating patterns which can cause increased blood pressure, blood sugar, and fat<sup>31</sup>. The public was also aware that NCDs can arise due to bad lifestyle. This means that the public has a good understanding of the importance of a healthy lifestyle such as a good diet, sufficient physical activity, and avoiding smoking. A combination of genetic factors and a bad lifestyle can cause NCDs. Thus, gene-based nutritional examination is crucial to detect types of genes and diseases early. A study conducted in 2017 reported that gene-based nutritional screening can prevent and treat NCDs by predicting individual risk and creating a personalized diet<sup>32</sup>. Early preventive measures and proper diet can help a person prevent NCDs based on genetic factors.

Gene-based nutrition services are useful for preventing NCDs. Informants agreed that this service could detect disease early and help prevent it through dietary regulation.

*"...later, after finding the results of the genetic test, for example, whether the risk factors are high or low, the preventive measure and diet management can be more targeted to prevent further complications."* (IF 1, 21 years old, female)  
*"Yes, we can find out earlier about our disease, perhaps including prevention and treatment."* (IF 6, 47 years old, female)

The key informant stated that gene-based nutrition services are more effective prevention of NCDs. Nutrigenetic data provide detailed insight into body condition which can be utilized to regulate

nutritional aspects based on genetic characteristics. This helps prevent NCDs in a more personal and specific way.

*"I think that this is very important. If, for example, we have nutrigenetic baseline data, we know what our body is like, and it can be useful to prevent NCDs. Well, we need to consume a nutritious diet, a balanced diet with vegetables, and so on, or need to practice physical activities. Yes, that's true, but if we had more in-depth data about nutrigenetics, we would know better which one to be increased or reduced."* (KI, 26 years old, female)

The informant agreed that gene-based nutrition services are important for preventing NCDs, especially for long-term health but it was hampered by the high cost and unfamiliarity with this examination. Some informants believe that a healthy lifestyle is sufficient.

*"Maybe it's important for long-term health, even though we don't know how it will be, we know what to do such as to improve our diet and so on."* (IF 3, 21 years old, male)

*"I think it's very important, but yes, there may be a problem with the cost. Maybe for the lower middle class, for example, if we want to go to gene-based services, we'll think about it again and again because there's a cost constraint."* (IF 2, 47 years old, male)

*"Yes, it's important, but if it's not done, I don't think it's a problem either. I mean, we have to just live a healthy life because not everyone can get a test like that. I mean, it's better to prevent it."* (IF 5, 23 years old, female)

The informant argued that this examination was important to prevent NCDs and long-term health. However, the obstacles were high costs for low and middle economic classes and a lack of knowledge. Lack of knowledge about these services affected adoption and societal acceptance of the service. Some informants agreed that by adopting a healthy lifestyle, genetic testing is not a primary need. A healthy lifestyle remains a key factor in preventing NCDs and maintaining long-term health.

#### **Theme 4: Interest in carrying out gene-based nutritional examination**

The informants were quite interested in gene-based nutritional examinations because they are useful in managing diet and preventing disease. However, it is hampered by expensive costs as stated by some informants.

*"Yes, maybe there is a plan, but maybe it's more about a diet pattern."* (IF 2, 47 years old, male)

*"I don't want to do it now because of limited costs unless someone wants to pay it for me."* (IF 1, 21 years old, female)

*"If I have enough money, yes I want it. With the support from my parents, maybe I will do it."* (IF 4, 20 years old, female)

Gene-based nutritional examinations are quite popular among the public as they can provide personal and specific information about a person's nutritional needs based on genetic profiles. Besides, it is beneficial to detect disease early based on genetic risk factors allowing appropriate preventive measures such as adopting a healthy diet. This can minimize the risk of non-communicable diseases and improve the quality of life. This is in line with a previous study conducted in Durham City, North Carolina in 2013 conducted in 2013 in which 52% of participants were interested in genetic testing and 45% were very interested in genetic testing. The majority of informants responded positively to the aims of genetic research and the use of genetic testing for disease detection<sup>23</sup>. Then emotional and practical support from the family can be a determining factor in a person's decision to get a gene-based nutritional examination. Even though it is popular, its high cost becomes an obstacle for the community to take the test. Therefore, it is important to make the services more affordable by providing adequate financing options.

### CONCLUSIONS

The informant has quite good knowledge about genetics. They understand that genetics is the inheritance of traits from parents to offspring and the inherited traits cover skin color and face shape, but they do not understand genetic terminology. The informant's knowledge of gene-based nutrition services is low as most of them cannot explain gene-based nutrition services in detail. However, they understand that the service can detect disease and regulate diet. The disadvantages of the service are its expensive cost and worry about bad test results. The informant's knowledge about gene-based nutrition services as an effort to prevent NCDs is quite good. They can explain that NCDs are a type of disease that is not transmitted from one individual to another individual. They admit that this test is important to detect NCDs early so that they can take preventive measures early. The informant has a high level of interest in this test, but the problems are the cost and the availability of facilities.

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### 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 by the author.

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