GENETIC LITERACY LEVELS AND GENETIC SCREENING ATTITUDES ON MEDICAL STUDENTS IN INDONESIA: A NATIONAL SURVEY

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ABSTRACT

Genetic literacy is an adequate knowledge that personally involves someone to comprehend and actively participate in genetic issues. An individual’s genetic literacy level will influence their decisiveness and attitudes towards reoccurring genetic issues, including genetic screening. This research aimed to discover the relation between genetic literacy levels and genetic screening attitudes of medical students in Indonesia. The data were collected using a cluster sampling method composing of 492 students from 41 universities in Indonesia. Subjects filled the questionnaires, which have undergone validity and reliability test using online modality under local supervisors. Genetic literacy levels were divided into two categories: adequate (>50%) and inadequate (<50%) levels, whereas the genetic screening attitude was categorized into consent and dissent. Of 492 respondents, only 121 people (24.59%) have adequate genetic literacy levels. The study also reports that 262 respondents (60.16%) agreed to the use of genetic screening. Using regression logistic, study found there was no relationship between genetic literacy and attitudes (p>0.05). Disagreements about using genetic screening are more prevalent among female respondents rather than male respondents. The study showed no relationship between genetic literacy levels and genetic screening attitudes of medical students in Indonesia.

Keywords: Genetic literacy levels, genetic screening, medical students, Indonesia

INTRODUCTION

Over the last few decades, the role of genetic technology in health has improved and has significantly impacted individuals and communities. The focus of genetic researches on single-gene disorders is rare. Studies in the genetic field develop into assessments of genetic components in general to detect complex diseases such as cancer, diabetes, osteoporosis, and heart disease ¹.

The genetic susceptibilities that occur will raise the emergence of complex diseases that are problems for individuals or communities. Genes play a role in 9 out of the top 10 causes of death in the United States, including heart disease, cancer, and diabetes. It increases the potential for new approaches to prevention and treatment measures. Technological advances in prevention and treatment and genetic information have led to an increased need for genetic literacy in the community ². The level of one’s genetic literacy will affect a person’s decision-making and attitudes toward genetic issues. Also, genetic literacy may affect a person’s attitudes toward service and genetic-based technology ³.

One such gene-based technology is genetic screening. This technology allows detecting the risk of some genetic disorders from the individual. Besides, genetic screening can also identify the genetically-derived conditions in the fetus or newborn so that the patient can tell whether or not there is a malformation to the fetus and can make a plan or seek more information about the problem. ⁴

Public opinion about genetics is generally reasonable, although it depends on its type of application and its benefits. Overall, the technology that leads to disease detection and treatment is considered valuable. Even for diseases with limited clinical trial usefulness, such as psychiatric disorders, the community responds positively to it. Attitudes toward genetic screening, in which individuals can use the information for their health, are also reacted positively. A study in an Australian region revealed that almost 50% of pregnant women were tested for prenatal diagnosis, prenatal screening (44.9%), diagnostic testing (3.9%), or both (3.2%) ⁵. A comprehensive review of recent prenatal genetic screening trends and testing reported that the number of prenatal screening or testing requests increases every year since the invention of NIPT (non-invasive prenatal testing) ⁶. Indonesia, as one of the biggest countries, has slow development regarding this subject; however, we found the facts that the prenatal testing providers exist but very limited in number and accessibility for ordinary people. Besides, the information and the data concerning this technology in Indonesia are still limited. There is no precise data regarding these issues.
Medical students are expected to adapt and be aware of health technology, including screening properties and should comply with current opportunities. However, some literature states that not all health communities have enough fundamental knowledge about being knowledgeable and willing to adapt to health technology advancements. Insufficient knowledge and awareness can result in gaps in providing adequate services to the community. This study explored the knowledge and attitudes, especially for genetic screening tests from medical students in Indonesia.

**METHODS**

**Study Design**
The study used an analytic observational study with a cross-sectional approach in the middle of 2018. Forty-one universities having a medical program in Indonesia were involved in data collection. The 492 number of respondents achieved from Slovin formula, collected using the cluster sampling method to obtain national coverage area. The universities were then grouped into 4 clusters based on the work area of ISMKI (Indonesian Medical Student Senate Association), and each region has at least 100 people the minimum sample size to be fulfilled to agree with proportional terms.

**Data sources and settings**
Subjects filled the questionnaires, which have underwent validity and reliability test (p<0.05 and Pearson correlation >0.8) using online modality using google form format, under local faculty supervisors. Subjects fulfilled questionnaires on the same day at their computer lab facility. The data then were stored and analyzed in principle investigator computer.

**Statistical analysis**
The level of genetic literacy used two-term categories: adequate and inadequate, while genetic screening attitude was divided into consent and dissent attitudes. Literacy category was achieved from the mark of correct answers, with the cut of point 50%. A categorization of the attitude of using genetic screening was based on the median value obtained from the total score of the Likert scale of the 492 respondents. The median value of 74 was then used as the basis for categorizing the attitudes of the utilization of genetic screening. To determine is there any difference in the attitude of genetic screening among levels of literacy groups, the study used chi-square analysis (p<0.05).

**Ethical Approval**
This study has been approved by Ethical Committee of Faculty of Medicine Universitas Jenderal Soedirman Ref Number : 1523/KE/2016

**RESULTS**

From 492 respondents who fill out the questionnaire for this study, there were more female respondents (63.41%) than male (36.59%). Educational status of respondents showed that more preclinical students (77.44%) fill out questionnaires than clinical stage students (22.56%). Most respondents came from region III (31.91%), namely Central Java, Yogyakarta, East Kalimantan, Central Kalimantan and South Kalimantan (Table 1).

**Table 1. Characteristics of the Respondents**

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Frequency</th>
<th>Percentage (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gender</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>180</td>
<td>36.59</td>
</tr>
<tr>
<td>Female</td>
<td>312</td>
<td>63.41</td>
</tr>
<tr>
<td>Age (years)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>&lt;20</td>
<td>264</td>
<td>53.6</td>
</tr>
<tr>
<td>&gt;20</td>
<td>228</td>
<td>46.4</td>
</tr>
<tr>
<td>Student stage</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Preclinical Students</td>
<td>381</td>
<td>77.44</td>
</tr>
<tr>
<td>Clinical Students</td>
<td>111</td>
<td>22.56</td>
</tr>
<tr>
<td>Universities*</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Region I</td>
<td>101</td>
<td>20.53</td>
</tr>
<tr>
<td>Region II</td>
<td>104</td>
<td>21.14</td>
</tr>
<tr>
<td>Region III</td>
<td>157</td>
<td>31.91</td>
</tr>
<tr>
<td>Region IV</td>
<td>130</td>
<td>26.42</td>
</tr>
</tbody>
</table>

* Region I : Sumatera, Region II : West Java, Jakarta, West Kalimantan Region III: Central Java, Yogyakarta, East Kalimantan, Central Kalimantan, South Kalimantan Region IV: East Java, Bali, Nusa Tenggara, Sulawesi, Maluku, Papua.

Most respondents (52.44%) inform that they were very interested in the news and matters in the field of science technology (Figure 1). Figure 2 shows that only 71 (14.43) respondent who report no common disease in their family, and the remain respondents (85.57%) notified to have a family history of passing diseases from generation to generation. Of 492 respondents, only 121 people (24.59%) have adequate genetic literacy levels (Table 2). This level was more
prevalent among female respondents than male respondents. It can be seen from the comparison between respondents and adequate and inadequate genetic literacy levels in each category based on gender (Table 5). The study also reports that 262 respondents (60.16%) agreed to the use of genetic screening. Disagreements about using genetic screening were more prevalent among female respondents rather than male respondents (Table 3). The attitude seems equally distributed among individuals, both inadequate and adequate levels of genetic literacy. The study revealed that there was no relationship between the genetic literacy level and genetic screening attitudes on medical students in Indonesia (Table 4).

Table 2. Level of Respondents Genetic Literacy Between Regions

<table>
<thead>
<tr>
<th>Region</th>
<th>Adequate</th>
<th>Inadequate</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Region 1</td>
<td>19</td>
<td>82</td>
<td>101</td>
</tr>
<tr>
<td>Region 2</td>
<td>21</td>
<td>83</td>
<td>104</td>
</tr>
<tr>
<td>Region 3</td>
<td>46</td>
<td>111</td>
<td>157</td>
</tr>
<tr>
<td>Region 4</td>
<td>35</td>
<td>95</td>
<td>130</td>
</tr>
</tbody>
</table>

Table 3. Distribution of Genetic Literacy Levels and Genetic Screening Attitudes according to the gender (n=492)

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Gender</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Female</td>
</tr>
<tr>
<td>Genetic Literacy Levels</td>
<td></td>
</tr>
<tr>
<td>Adequate</td>
<td>80 (16.26%)</td>
</tr>
<tr>
<td>Inadequate</td>
<td>232 (47.15%)</td>
</tr>
<tr>
<td>Genetic Screening Attitudes</td>
<td></td>
</tr>
<tr>
<td>Consent</td>
<td>151 (25.41%)</td>
</tr>
<tr>
<td>Dissent</td>
<td>161 (38.01%)</td>
</tr>
</tbody>
</table>

Figure 1. Survey on Interest in News and Things in Science Technology
Figure 2. Distribution of common disease in the family

Table 4. The Relation Between Genetic Literacy Levels and Genetic Screening Attitudes on Medical Students in Indonesia

| Genetic Literacy Levels | Attitudes | |               | Total | p-value |
|-------------------------|-----------|------------------|-------|
|                         | Dissent   | Consent          |       |       |        |
| Inadequate              | 176 (35,77%) | 195 (39,63%)    | 371 (75,40%) | 0,59  |
| Adequate                | 54 (10,98%)  | 67 (13,62%)     | 121 (24,60%) |       |
| Total                   | 230 (46,75%) | 262 (53,25%)    | 492 (100%)    |       |

DISCUSSION

Scientists doubt the idea of applied genomics to public health services. Doctors also feel that the integration of genomes to their practices is still in the distant future. There is limited information regarding how the development of genetics nowadays has shaped public opinion on genetics. Understanding an individual’s attitude and trust can become a guide in communication efforts by explaining the misunderstanding and discrepancy in knowledge.

Table 1 shows that male is fewer than female. This phenomenon happens to all medical faculties in Indonesia. According to the latest data, female dominate the proportion of gender in Indonesian medical faculty. The distribution of medical faculties in Indonesia is most common in the western part of Indonesia. Table 1 consists of 4 regions, but it is not evenly divided proportionally between eastern and western Indonesia. Representatives of eastern Indonesia were East Kalimantan, Nusa Tenggara, Sulawesi, Maluku, and Papua.

Out of 492 respondents, there are 371 people (75,41%) with inadequate genetic literacy levels. Previous studies of genetic literacy levels in other countries show a little bit different results. A recent study conducted among the public in the Netherlands reveals that 57% of respondents have insufficient genetic knowledge. In addition, according to a survey in the United States, 57.6% of respondents were familiar with genetics; however, on the difficult questions regarding genetics, only 22.2% of respondents answered correctly.

Compared with other previous data, Indonesia’s genetic literacy levels, especially in medical students, show a lower level. There were only 24.60% of 492 respondents who have an excellent genetic literacy level. Several factors can be proposed as the main problem of this issue. One of the causal factors is the lack of education programs regarding genetics. According to the research conducted in the United States and several other countries, the lack of education regarding health service work candidates’ genetics becomes a significant factor that limits genetics’ integration to health services. This specific deficiency consists of the amount and...
the content type in the education curriculum and knowledge related to genetics and the expertise of doctors, nurses, and other professional health services workers when they enter the practice clinic. 

The Indonesian Doctor Competency Standard mentions that the lessons related to single genes disorders such as haemophilia, albino, phenylketonuria, thalassemia, and other chromosomal disease are marked as a ‘good’ to know. It indicates that the portion of genetic lessons in medical education in Indonesia is still minimal. However, many common polygenetic diseases such as hypertension, diabetes mellitus, asthma, and allergies are taught on clinical attention, not deep into the genes causality. The presentation of genetic lessons compared to all material in the preclinical curriculum is only 2.9-5%. This fact may play a role in why genetic literacy is limited.

The medical curricula in Indonesia are divided into four competencies. The first standard is to enable the medical student to recognize clinical symptoms and know how to obtain more information on diseases. In standard 2, general practitioners are expected to make clinical diagnoses based on physical examinations and supports. Management of the diseases on competency standard one and two will be referred to the appropriate specialist and subspecialists. Standard 3 and 4 contain diseases that students must be able to manage and give appropriate therapy. It may degrade the interest and awareness of general medical students to study genetic diseases in-depth because they are not required to provide therapy for genetic diseases. The limitation process of learning genetic will be directly proportional to the level of one’s genetic literacy.

Other factors that can cause low levels of genetic literacy are the lack of awareness and health workers’ interest in studying genetics. According to a recent survey, it is found that awareness, experience, opinion, and readiness of a doctor in health care in answering questions about genetic examinations is still low. Povel and friends report that only 15% of 382 respondents are ready to discuss the topic with their patients about genetics background. Doctors from the other studies also believe that studying genetic diseases is unproductive for primary health care. Other surveys conducted by third and fourth-grade medical students in the United States and Canada show that only 26% is studying genetics as part of formal clinical education. In comparison, over 50% lack the necessary competence to apply genetic theory in the field of patient care.

However, there are exciting data findings in Indonesia; Figure 1 shows that more than half of the respondents (52.44%) express a great interest in news and matters in the field of science technology, but on the other hand, 371 respondents (75.40%) from the regions have a low level of genetic literacy. Interest in a topic is generally followed by the individual’s ability in that issue, but some studies mention inversion. The cause is related to the time of attraction. At the early step, cognitive abilities are minimal until the attraction is continued by attempting to delve into the topic and reach a significant level of knowledge. We assume that the respondents' high interest has not been followed by an effort to be more knowledgeable.

The report found there were no differences in genetic screening attitudes between any genetics literacy levels in Indonesia’s medical students (Table 4). The relationship between a person’s knowledge and the attitude toward using genetic screening or genetic technology shows more complex results than expected. In general, knowledge of less science will result in less positive attitudes toward genetics science utility. If people can be more educated about science, such as genetics, they will give a better response or attitude toward scientific technology, such as genomic development. However, it cannot be separated from other factors that can affect a person’s attitudes toward the use of genetic screening.

Attitudes toward a person’s genetic screening may vary based on age, gender, and education level, as in the Theory of Planned Behavior. The theory suggests that background factors such as age, gender, ethnicity, socioeconomic status, mood, personality traits, and knowledge can influence an individual’s attitude toward something. Overall, based on some studies, a young person will show a higher interest in genetic screening and have a more positive attitude. Males can also have more positive genetic screening attitudes because, in the decision-making process, males are more willing to take risks and prefer analysis. At the same time, female often involve intuition and personal emotions in the decision-making process. Research conducted in Australia indicates that female have a better knowledge of genetics. The data shows that females have better genetic literacy rates than males. Conversely, males have more positive attitudes toward genetic screening (Table 3).

The study reports that almost all families of respondents have experienced genetically inherited diseases, with a total of 421 respondents (Figure 2). This experience can positively affect a person’s attitude toward genetic screening, primarily if the family refers to the doctor and gets examinations to perform diagnosis. Literature mentions that having a family member with inherited diseases will make another family more aware of screening approaches.
Other people’s experiences and opinions can be another factor that can influence the use of one’s genetic screening, according to one component in the Theory of Planned Behavior. Other people’s opinions, especially doctors and other health workers, can help a non-expert understand complex genetic information and become an ideal source for making decisions about genetic screening. Respondents may also involve their social experiences in shaping their beliefs, apart from the knowledge they have.

In general, the community shows a positive attitude toward genetic researches and the latest genomic technology. However, this positive attitude is quite complicated and is influenced by beliefs about genetic research, the benefits of screening or genetic examinations, clinical benefits, and the field of genetic technology, for example, medical applications and cloning. Indonesian society, in general, has a close bond with traditions and customs that are still strong. Their belief still influences the acceptance of new technology in their customs and community leaders. A small part of society, more open and accepting new inventions or technologies with more rational.

The study reports that respondents show high awareness of genetics and fairly good attitudes toward genetic screening. Respondents also know the functions and benefits of different genetic screening types to provide a positive attitude even if they do not have adequate genetic literacy. Students’ views on the capabilities of genetic technology and screening in health are beneficial to supporting health in the future. However, such beliefs are not accompanied by sufficient literacy. Values as medical students that study various health topics will make students tend to gain a positive attitude about health-related topics, including genetic screening. According to Theory Planned Behavior, social values will affect the formation of individual attitudes towards certain topics.

CONCLUSION

There was no relationship between knowledge and genetic screening attitudes in the medical student of Indonesia.

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Ethical Statement
Conflict of Interest

The authors declare that they have no conflict of interest in manuscript development and submission.

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