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An Indonesian Version of The Instrument for Measuring Knowledge and Attitudes Toward Antibiotic Among the Population in The Whole Country

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ABSTRACT

In Indonesia, programs designed to enhance the precision of antibiotic utilization necessitate specific tools for gauging knowledge and attitudes among the intended population. This research seeks to create a novel instrument customized to suit the specific requirements of the Indonesian populace and evaluate its psychometric characteristics in the context of measuring antibiotic knowledge and attitudes. This study was performed with forward and backward translation, adaptation testing, and a validation phase in which we distributed the instrument link via Google Forms to six major regions in Indonesia. The translation and adaptation phases, any disparities were resolved through consensus. Validity was determined through known group validity, construct validity, and product-moment correlation. Internal consistency among items was assessed using Cronbach's alpha. In the adaptation phase, additional descriptions were added to the 6 items. In the validation phase, 1147 participants were recruited. The a priori hypothesis in the known group validity is supported. We also found three items that did not meet construct validity. Based on the results of exploratory factor analysis, it is better to use four factors with modified domain names based on items that are incorporated in one factor. Based on the results of the validity test using the product-moment correlation for 11 items in the Attitude domain, all items were declared valid. Cronbach's alpha value in the knowledge domain was 0.791 and in the attitude domain was 0.929. Our instrument is valid and reliable for assessing the general public's knowledge and attitudes toward antibiotics in the Indonesian population.

Keywords: Antibiotics, Knowledge, Atiitude, Indonesia, Nusantara

INTRODUCTION

World Health Organization (WHO) reports that microbial resistance to antibiotics has been a global health problem. The WHO report on surveillance of antibiotic consumption stated that the incidence of antibiotic resistance has increased rapidly in Asia, with the highest incidence in Southeast Asia (World Health Organization, 2020; Yam *et al*, 2018]. Self-medication (Rather *et al*, 2017) and inappropriate prescribing (Ventola, 2015) are the main causes of antibiotic resistance. The reason for self-medication is the lack of public knowledge about the dangers of antibiotic resistance (Ayukekbong, 2017). Antibiotic resistance leads to treatment failure, increased length of stay in the hospital, cost of care, and mortality (Friedman, 2016).

Indonesia is one of five countries in the world that experiences abuse and excessive use of antibiotics due to inadequate knowledge about antibiotics (Karuniawati, 2021a). Buying antibiotics without a prescription and self-medication is very common in Indonesia. More than 50% of people have inaccurate knowledge about antibiotics and believe that antibiotics cure viral infections and prevent the disease from worsening (Karuniawati, 2021b).

Basic Health Research from the Ministry of Health of the Republic of Indonesia reported that 86.1% of the population stockpiles antibiotics obtained without a prescription (Permenkes, 2011). Patient belief in the effectiveness of antibiotics and their universal efficacy against all diseases has resulted in their overuse (Michael, 2014; McChollough, 2016). For example, patients believe that antibiotics will help them cope with respiratory viral illnesses, such as the common cold (Karuniawati, 2020). Recent systematic reviews and meta-analyses have reported that antibiotics are used inappropriately by the general population, as seen in behaviors such as buying antibiotics from pharmacies without a prescription, asking doctors for antibiotics, and using antibiotics prophylactically (Duan, 2021).

Therefore, WHO has defined a health strategy to tackle antibiotic resistance which includes health center-oriented and research interventions. Increasing knowledge and changing people's attitudes toward the proper use of antibiotics is important in interventions in the community (Jairoun, 2019). For this reason, intervention programs to increase the accuracy of using antibiotics require special instruments to measure knowledge and attitudes in the target population. Because the data obtained from these instruments are fundamental in assessing the need, planning, and implementation of public health programs, it is important to use reliable and valid instruments (Kimberlin, 2008).

Other studies that measured knowledge dan attitude of students toward antibiotics used previously similar validated questionnaires (Tiong, 2020); however, the cited studies did not include validated questionnaires. Therefore, this study aims to design and validate an instrument for assessing knowledge and attitudes related to the private use of antibiotics by the general public.

MATERIALS AND METHODS

Research Design

This study used a cross-sectional design. Data collection was carried out from September to December 2022. The research was approved by the Research Ethics Committee of the Faculty of Public Health, Hasanuddin University, Makassar, with ethical approval number 11008/UN4.14.1/TP.01.02/2022 on September 20, 2022.

Research Instrument

Permission to translate the instrument was obtained from Prof. Dr. Syed Azhar Syed Sulaiman (Professor of Clinical Pharmacy in the School of Pharmaceutical Sciences Universitas Sains Malaysia) on 10 January 2022. This instrument previously consisted of 22 items but items have been added to the instrument to suit the current conditions (Covid-19 era) so that bringing the number of items on the instrument to 34 items. This instrument consists of 23 items for the knowledge domain and 11 items for the attitude domain. Each item in the knowledge domain has 3 choices, which are "true", "false" or "not sure". For assessing the participants' attitudes toward the use of antibiotics, the choices used a five-point Likert scale ranging from "strongly agree" to "strongly disagree". The knowledge domain, it is divided into four parts, the role of antibiotics, identification of antibiotics, the dangers of antibiotics, and completion of treatment dose. Correct answers are given a score of 1, while 0 is used for wrong or "not sure" answers. We presented this instrument in Attachment 1.

Participants

The participants are Indonesian citizens who are at least 17 years old and agree to participate in this research. Participants involved in this study were sampled from six main regions of Indonesia, Sumatra, Java, Sulawesi, Kalimantan, 'Bali and Nusa Tenggara', and 'Maluku and Papua'. It is important to underline that the 'research site' in this study refers to the location of the participant domicile (District and Province) as stated in the online link that we have distributed.

Sample size

Our study involved a total of 1147 participants. Calculation of sample size based on research suggests that at least 100 participants should be the minimum for a psychometric study

(Gorsuch, 1983). Other studies recommend that the minimum number of participants involved in a psychometric study is the number of items in the instrument to be validated multiplied by ten. It is also recommended that the minimum sample size in a validation study should be adjusted to 5 to 10 times the number of instrument variables or items to be validated (Krabbe, 2016). Thus, the minimum number of participants for each region included in this study was 340 (34 items×10) and the minimum total number of participants in this study was set at at 850 to 1700 (340×5 to 10x5) participants.

Data Collection

Instrument version 1 after forward and backward translation, the input submitted by the participants was evaluated. After obtaining ethical clearance, during the adaptation phase, we asked for feedback for the initial version involving 40 participants with different levels of education. Feedback was reviewed to develop a final version of the instrument to measure the knowledge and attitudes of the general public regarding antibiotics.

In the validation phase, we distributed online links (Google Form) through several social media from 9 September 2022 to 7 November 2022, which include WhatsApp and Instagram.

Questionnaire development

Translation

The translation phase consists of two stages, which are forward translations and backward translations. First, forward translation was conducted, in which the instruments were translated from English into Indonesian by two professional Indonesian translator; each of whom worked independently. The goal is that translations can be compared if there are ambiguous words when compared to the original and it can also be noted if there are differences in the translation results of the two translators. The version resulting from this step is labelled version 1. Then, a backward translation was performed, and version 1 of the document was re-translated from Indonesian into English by two Native English professionals who are also worked independently; both of whom are native English speakers who are fluent in Indonesian. The main purpose of the backward translation is to ensure that the results of the forward translation are under the original version, which is confirmed by comparing the original instruments with the results of backward translation. The final version of the backward translation is labelled version 2. Whenever differences emerged among the translations, these issues were resolved by consensus.

Adaptation

The instruments were then tested on 40 participants (Beaton, 2000) who were divided into 4 groups where each group consisted of 10 participants representing different levels of education; elementary, junior high, high school, and university levels. This phase aims to collect the participant's feedback on the items in the instrument. The instrument was revised based on the feedback received and the problems raised by the participants.

Validation

The final form of the instrument was validated by 1147 participants in the validation phase. During the validation phase, we distribute the online link for the final Indonesian version through several social media from 11 September 2022 to 7 November 2022, such as WhatsApp and Instagram.

Data Analysis

Translation

The researchers held discussions with supervisors, translators (2 Indonesian translators and 2 native translators), and the Expert Committee to analyze and consolidate the Indonesian translation of the original version of the instrument to gain consensus on inconsistencies and produce instruments for field tests with the 40 participants.

Adaptation

During the adaptation phase, we discussed all participants' suggestions. Next, we compiled and analyzed pilot data for the best word choice and word order in a single sentence (item) by consensus. In this phase, the difficulties experienced by the participants were evaluated based on the participants' reactions and questions about certain items. These items were then revised by the researchers. Next, the feedback of the participants involved in this phase was considered.

Validation

Validity was measured using known group validity, product-moment correlation, and construct validity. Construct validity (Krabbe, 2016) was analyzed using factor analysis. Known group validity was analyzed using the Mann-Whiney test by comparing the antibiotic knowledge between participants based on two variables, educational level and educational background.

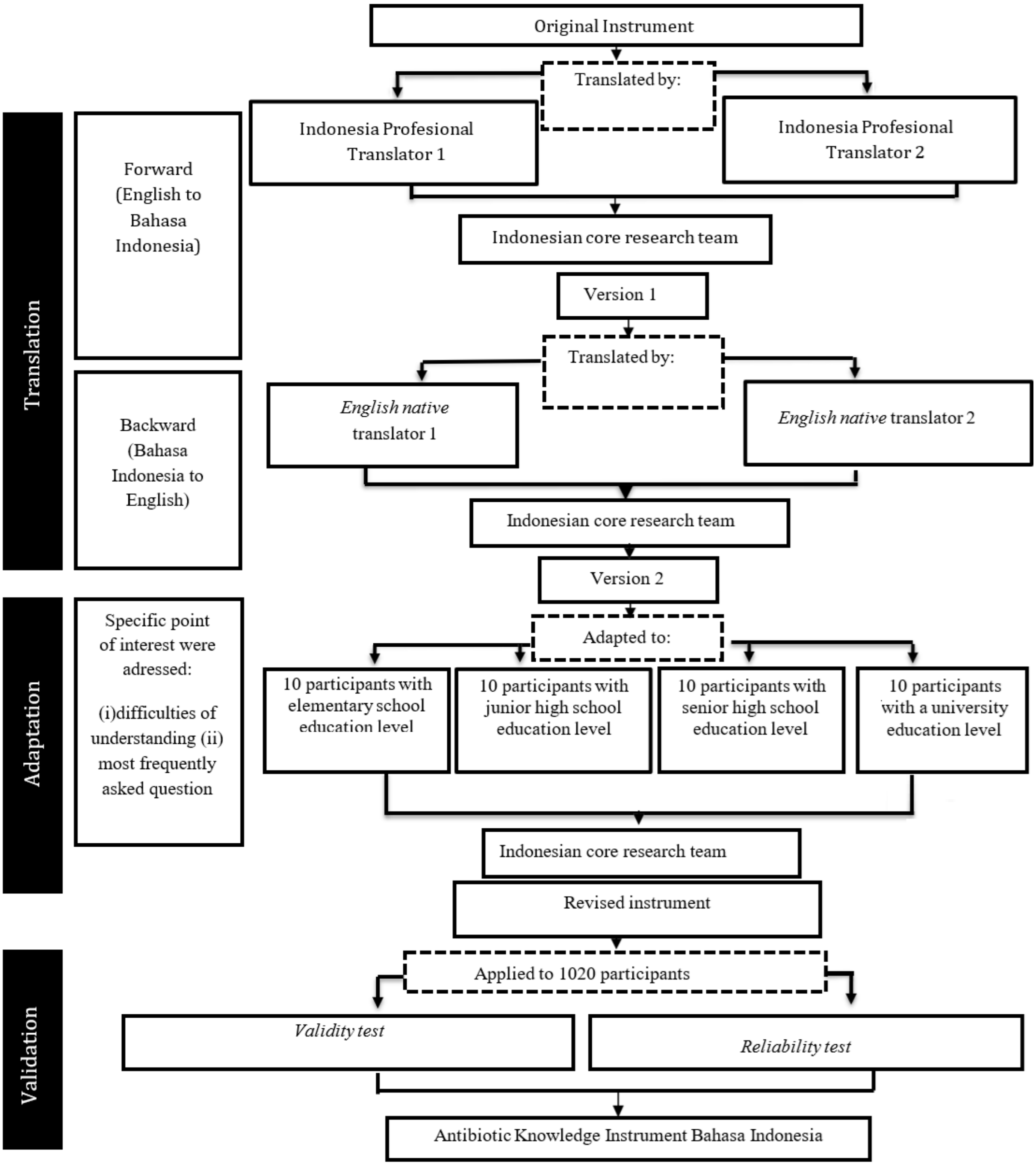

Figure 1. Study procedure.

Differences in the level of antibiotic knowledge were assessed using normality first. If the data had good normality, then the ANOVA test would be continued; if not, then the Kruskal Wallis test would be continued. If the Kruskal Wallis result was significant, a post hoc analysis would be carried out using the Mann-Whitney test.

Construct validity was measured using exploratory factor analysis (EFA). We determined the number of factors that could be maintained based on the original instrument domain. If this parameter had different recommendations regarding the number of factors to be maintained, other considerations were applied where the factor must have at least 3 items (Krabbe, 2016). The reference value for factor loading is 0.4, which reflects the strong relationship between each item (Krabbe, 2016). Internal consistency was measured by the Cronbach α reliability test, and a Cronbach α greater than 0.7 was considered a reliable instrument. Statistical analysis in this study employed the Statistical Program for Social Sciences (SPSS) software version 26.0.

RESULTS AND DISCUSSION

Characteristics of Participants

A total of 1147 participants were recruited from six regions in Indonesia in the validation phase. All the participants sociodemographic characteristics were in the productive age range, dominated by women (Table I).

Translation

Differences between translators were detected in the translation of certain items. We also discussed the most appropriate wording and sentence structure based on the formal Indonesian style, where some differences were found between translators. However, the differences between translators are only limited to the choice of word that actually have the same meaning as the original version.

Adaptation

After collecting feedback from the participants in the adaptation phase, some improvements in sentence structure or word choice were made (Table II). Six items were adjusted. Language patterns were adjusted by changing the choice of words or providing examples so that the context of the item can be interpreted correctly by the participants.

Participants with a basic education level who evaluated the initial version of the translated instrument indicated that they were confused in choosing a five-point Likert scale in the attitude domain and they thought that the instrument provided was a 'test' for them, so they felt afraid to answer with their knowledge. They also wanted a more detailed explanation of some of the statements in the instrument that made us provide examples or change the choice of words in the instrument. For example, they were not familiar with the Penicillin class of drugs. So, the researchers gave examples of the most commonly used penicillin class of drugs, which is Amoxicillin. In the domain of antibiotic identification, some participants experienced difficulty in answering because they did not know the name of the drug, but when the drug indication was mentioned, they would understand the statement in the question. So, we added an indication to the statement that contains the name of the drug. While some participants with university education level asked for statements in the domain of knowledge "Antibiotics can cure all infections", in their understanding, there are various infections caused by microbes.

Validation

Based on known group validity, because of non-normal distribution, the Mann-Whitney U test and Kruskal-Wallis test were run to assess differences in mean scores of the knowledge between participants with health science education background and education level. In the domain of antibiotic knowledge participants with health science education backgrounds (2.45±0.55), undergraduate (2.46±0.555), and postgraduate (2.80±0.401), had significantly higher antibiotic knowledge than those without a health science educational background (1.98±0.543), and high school education level (1.84±0.363). Whereas in the attitude domain, participants with educational backgrounds in health sciences (1.90±0.297), undergraduate (1.91±0.285), and postgraduate (1.98±0.138) have a wiser attitude in using higher compared to participants without an educational background in health sciences (1.78±0.414) and high school education level (1.74±0.437) (Table III).

In EFA, based on the Eigenvalues, six factors are formed, but two factors only have two items, while each factor consists of at least three items. Therefore, we determined the number of factors which is four factors according to the original version of the instrument. We use the Principal Component Analysis method with oblique rotation (Promax). The purpose of the rotation is to simplify the initial factorization and to obtain a solution that keeps as many variables and factors as possible from each other until a simpler structure is found (Krabbe, 2016).

The Promax (oblique) rotation gives better results than the varimax (orthogonal) rotation by producing four factors among which the items are fairly evenly divided. The percentage variance (eigenvalues) explained by these four skewed factors are 19.1%, 9.5%, 5.2%, and 5.0%. The total percentage of variance explained by the four extracted slant factors is 38.8%.

Table I. Characteristics of the Participants from 6 Regions in Indonesia

Variable	Total	%					
	n (%)	Jawa (n = 203)	Sumatera (n = 109)	Kalimantan (n = 82)	Bali and Nusa Tenggara (n = 36)	Sulawesi (n = 412)	Maluku and Papua (n = 305)
Overall	1147 (100)	17.7	9.5	7.1	3.1	35.9	26.6
Age, n = 1147							
17-30 years	938 (81.8)	71.9	81.7	68.3	86.1	87.9	83.3
31-40 years	147 (12.8)	15.8	14.7	12.2	5.6	10.0	15.1
41-50 years	52 (4.5)	9.4	2.8	17.1	8.3	2.2	1.3
>51 years	10 (0.9)	3.0	0.9	2.4	0	0	0,3
Gender							
Female	890 (77.6)	72.4	75.2	80.5	80.6	77.4	81.0
Male	257 (22.4)	27.6	24.8	19.5	19.4	22.6	19.0
Education Level							
High School	360 (31.4)	29.0	30.3	31.7	41.7	33.7	27.9
Bachelor’s degree	527 (45.9)	46.9	34.8	57.3	33.3	44	49.5
Masters	260 (22.7)	24.1	34.8	11.0	25.0	22.4	22.6
Health Educational Background							
Yes	882 (76.9)	60.5	64.7	90.2	63.9	75.9	87.9
No	265 (23.1)	39.5	35.3	9.8	36.1	24.1	12.1
Marrital Status							
Not married	853 (74.4)	63.0	63.2	57.3	75.0	81.6	75.7
Married	283 (24.7)	34.0	36.8	41.5	25.0	18.2	23.0
Divorces	11 (1.0)	3.1	0	1.2	0	0.2	1.3
Smoking History							
Not Smoking	1050 (91.5)	88.3	97.1	85.4	86.1	93.7	90.8
Smoking	60 (5.2)	7.4	2.9	8.5	8.3	3.4	6.3
Quitting (Ever smoked)	37 (3.2)	4.3	0	6.1	2.8	2.8	3.0
History of Alcohol Consumption							
No	1079 (94.1)	88.9	91.2	95.1	91.7	94.7	96.4
Yes	18 (1.6)	1.2	1.5	1.2	0	1.4	2.3
Quit (Ever consumed)	50 (4.4)	9.9	7.4	3.7	8.3	3.8	1.3
Living Environment							
Province	439 (38.3)	35.2	32.4	35.4	30.6	51.4	21.6
District	288 (25.1)	29.6	19.1	32.9	25.0	21.7	27.5
Subdistrict	208 (18.1)	19.1	17.6	18.3	27.8	14.0	23.3
Village	212 (18.5)	16.0	30.9	13.4	16.7	13.0	27.5
Occupation							
Bachelor Student/Profession	503 (43.9)	32.0	52.3	41.5	27.8	45.1	30.0
Master/Doctoral Student	28 (2.4)	3.4	4.6	0	2.8	3.2	0.7
Officials	209 (18.2)	17.7	11.9	30.5	16.7	16.5	20.0
House wives	26 (2.3)	3.9	3.7	6.1	2.8	0.7	1.6
Entrepreneur	49 (4.3)	4.9	7.3	1.2	2.8	4.9	3.0
Lecturer	26 (2.3)	23.1	4.6	1.2	0	2.7	1.0
Farmers	4 (0,3)	0.5	0	0	0	0	1.0
Contract Employee	38 (3.3)	2.5	3.7	2.4	8.3	3.2	3.6
Unemployed	59 (5.1)	3.9	0,9	1.2	8.3	5.1	8.2
Career Woman	24 (2.1)	2.5	0	1.2	2.8	2.2	2.6
Teacher	10 (0.9)	1,0	0,9	1.2	8.3	0.7	0
Soldier	1 (0.1)	0	0,9	0	0	0	0
Private Employees	151 (13.2)	23.2	6.4	12.2	16.7	14.1	7.5
Casual Laborer	13 (1.1)	1.0	1.4	0	0	1.2	1.3
Retired	1 (0.1)	0	0	1.2	0	0	0
Student	1 (0.1)	0	0	0	0	0.2	0

Table II. Adaptation phase

No	Original Version	Final result of translation Forward: Version 1 Backward: Version 2 (applied to 40 participants at adaptation phase)	Result of adaptation phase Version 3 (applied to 1147 participants)
3.	Antibiotics can cure all infections.	Antibiotics can cure all infections	Antibiotics can cure all bacterial infections (we clarified by adding the word 'bacterial' because some participants with university-level education asked what the scope of 'infection' meant)
	Identification of antibiotics	**Identification of Antibiotics**	
1.	Penicillin is an antibiotic.	Penicillin is an antibiotic.	Penicillin is an antibiotic. For example, Amoxicillin, and Ampicillin (we added examples of penicillin class drugs such as Amoxicillin and Ampicillin because the participants were more familiar with these drugs than the names of the drug classes)
2.	Aspirin is a new generation of antibiotic.	Aspirin is a new generation of antibiotic.	Painkillers such as Aspirin are new-generation antibiotics *(Aspirin/acetylsalicylic acid are drugs used as antipyretics, analgesics and in low doses as antiplatelets. Participants did not know Aspirin, but if explained the indications for these drugs, then participants would understand better. Most participants knew the name of the drug but forget/don't know the indication).*
4.	Diphenhydramine is not an antibiotic.	Diphenhydramine is not an antibiotic.	Allergy medications like Diphenhydramine (Diphenhydramine) are not antibiotics. (We add indications for Diphenhydramine because some participants with basic education levels do not know which drug Diphenhydramine belongs to).
	Adverse effect of antibiotics	**Side effects of antibiotics**	
1.	Overuse of antibiotics can cause antibiotic resistance.	Overuse of antibiotics can cause antibiotic resistance.	Using antibiotics that are not needed, can cause bacteria to become resistant to the antibiotics used (we clarified that the word 'overuse' is meant to use antibiotics that are not needed)
5.	No antibiotic resistant will occur if given together with 2-3 other medications instead of using alone.	No antibiotic resistant will occur if given together with 2-3 other medications instead of using alone.	If you use antibiotics together with other drugs, then antibiotic resistance will not occur.

Table III. Known-group validity

Variable	Knowledge		Attitude	
	Kruskal-Wallis test		Kruskal-Wallis test	
	Mean ± SD	*P*-Value	Mean ± SD	*P*-Value
Having educational background in health sciences				
No	1.98 ± 0.54	*p*<0.001a	1.78 ± 0.41	*p*<0.001a
Yes	2.45 ± 0.55		1.90 ± 0.29	
Education level				
Bachelor	2.46 ± 0.55	*p*<0.001a	1.91 ± 0.28	*p*<0.001a
Post graduate	2.80 ± 0.40		1.98 ± 0.13	
Up to senior high school	1.84 ± 0.36	*p*<0.001b	1.74 ± 0.43	*p*<0.001b

[a.] Kruskal-Wallis analysis showed that the difference between background in health sciences and education level were significant (*p*<0,001)

[b.] A post hoc analysis showed that the difference between these three educational levels were significant (*p*<0,001)

The factor labelling for Antibiotic Knowledge is based on a careful examination of the items that are most present in one domain (Table IV). Factor 1 appears to represent the domain 'harm of antibiotics and use of antibiotics during Covid-19', with 4 of the 8 items being items from the domain harm of antibiotics' and 3 items addressing the use of antibiotics during Covid-19 belonging to this domain. Factor 2 represents 'antibiotic identification'. Factor 3 represents the 'features of the antibiotic' domain, and factor 4 represents the 'role of the antibiotic' domain. Based on the product-moment correlation, a research instrument is declared valid if each statement item on the instrument can express something that the instrument will measure. To assess the validity of statement items in a measuring instrument, product-moment correlation can be used by correlating the score of each statement item with the total score. There are two methods to determine whether an item is valid or not. First, an item on the instrument is said to be valid if the r-xy is greater than the r-table. The value of the r-table can be obtained from the value of degrees of freedom (df) = n-2 (n = sample size). Second, an item is said to be valid if the correlation value is greater than or equal to 0.3 ($r \geq 0.3$) (Andreas, 2018). The number of participants in this study was 1147. So, the df value (1145) was obtained with a significance of 5% and the value of r-table = 0.05. Based on the results of the validity test on 11 items in the Attitude domain, the r-xy value was0.364-0.671 and all items were declared valid because the r-xy was greater than the r-table (0.05) (Table V).

Reliability

Internal consistency for each domain is high. The highest Cronbach score is in the attitude domain (Supplementary Data). This shows that both domains have good reliability.

The new validated instrument is adapted from the original instrument to suit the local communities in Indonesia. We validated this instrument based on research by Oh *et al*, 2011, whose instrument was developed based on the literature reported. However, there is no validation process in it (Filipetto *et al*, 2008; Parimi *et al*, 2002; You *et al*, 2008). The results of our study show that the Antibiotic Knowledge and Attitude Instrument is a reliable and valid instrument for use in the Indonesian population. However, after the validation test with factor analysis, there was 1 statement item with factor loading and there were 2 items with factor loading below 0.4.

In Indonesia, at the validation phase, we used Known Group Validity, Product-moment Correlation, and factor analysis using Exploratory Factor Analysis (EFA) method. We used these two methods because apart from confirming the factors formed based on the original version, we also explored the factors formed based on items collected in one factor. Therefore, in the Indonesian version, a new structure of the instrument was developed, in which we added an explanation of the domain name which was different from the original version, and formed four factors arranged in the following order: 'harm of antibiotics and use of antibiotics during Covid-19', 'identification of antibiotics', 'characteristics of antibiotics', and 'role of antibiotics'. Good internal consistency was obtained in the knowledge domain for 22 items and attitudes, 0.791 and 0.929 respectively.

Table IV. Factor Loadings of the Antibiotic Knowledge Instrument Bahasa Indonesia for the four extracted factors with Principal Component Analysis and Promax Rotation (n = 1147)

Item	Domain	Description	Four extracted factors			
			1	2	3	4
22	STD	During Covid-19, it is compulsory to take/ finish taking antibiotics for 3-5 days especially for lung infections	0.728			
17	DA	Side effects will be less if antibiotics are given together with other medicines to treat Covid-19	0.658			
18	DA	Antibiotic resistance (immunity) will not occur if given together with 2-3 other medicines instead of taken alone	0.613			
19	DA	Diarrheoa usually occurs when taking antibiotics	0.584			
11	IA	Diphenhydramine is not an antibiotic	0.481			
23	STD	Generally, antibiotics are taken for 3-5 days	0.467			
6	RA	Antibiotics can cure Covid-19 infections	0.455			
16	DA	All antibiotics do not cause side effects	0.370			
13	IA	Antibiotics in the Hospital are usually more expensive than antibiotics in the Pharmacy				
10	IA	Paracetamol is considered as an antibiotic		0.698		
20	STD	The use of antibiotics can be stopped if symptoms have improved		0.653		
4	RA	Antibiotics can be used as a reliever for/to reduce pain		0.629		
5	RA	Antibiotics are used to stop fever		0.613		
2	RA	Antibiotics can be used to treat viral infections		0.400		
12	IA	Antibiotics usually come in capsule or tablet form			0.611	
14	DA	Excessive use of antibiotics can cause antibiotic resistance			0.577	
21	STD	The effectiveness/benefit of antibiotics will be reduced if not all the antibiotics prescribed by a doctor are taken (are not finished)			0.538	
8	IA	Penicillin is an antibiotic			0.525	
15	RA	Antibiotics can cause allergic reactions			0.425	
7	RA	Antibiotics can cure many diseases				0.711
1	RA	Antibiotics are medicine that can kill bacteria				0.620
3	RA	Antibiotics can cure all infections				0.607

DA Dangers of Antibiotics; IA, Identifications of Antibiotics; RA, Role of Antibiotics; STD, Stopping Treatment Dosages

Table V. Results of the product moment correlation validity on the items at Attitude Domain

Statements	r-xy	r-table	Conclusion
When I have the flu/get cold, I would take antibiotics to help me get better faster When I have the flu/get cold, I would take antibiotics to help me get better faster	0.671	0.05	valid
I expect that my doctor would prescribe antibiotics if I get common flu	0.574	0.05	valid
I usually stop taking an antibiotic when I start feeling better	0.595	0.05	valid
If a member of my family was sick, I would usually give them my antibiotics	0.651	0.05	valid
I usually keep a stock of antibiotics at home for emergencies	0.461	0.05	valid
I will use any leftover antibiotics for respiratory disease/shortness of breath	0.557	0.05	valid
I will take antibiotics according to the instructions on the label	0.493	0.05	valid
I will usually look at the expiry date of an antibiotic before taking it	0.491	0.05	valid
I usually take antibiotics at meal times	0.364	0.05	valid
If my family got Covid-19, I would ask them to take antibiotics at home	0.410	0.05	valid
I would go and buy antibiotics anywhere to guard my stock at home especially during the Covid-19 pandemic	0.492	0.05	valid

The first factor tends to focus on 'The Dangers of Antibiotics and the use of Antibiotics during Covid-19', except for 1 item, which is "Diphenhydramine (Diphenhydramine) is not an antibiotic". There are three items from the antibiotic hazard domain in the original instrument (Oh *et al*, 2011) and three items discussing Covid-19 are incorporated in this factor and have the highest factor loading so they become the first statement in this instrument. We assume that because this study was conducted during the Covid-19 pandemic so that these items were easier for the participants to answer. Meanwhile, the second factor explains the identification of antibiotics. This factor is composed of three items from the Antibiotic Role domain and two items from the Antibiotic Identification domain. We decided to name this factor 'antibiotic identification' because Factor 4 is also composed of 3 items from the antibiotic role domain. We assume that items such as "Antibiotics can relieve pain/inflammation" and "antibiotics are used for fever" are the dominant knowledge in identifying antibiotics in Indonesian society.

The instrument adaptation phase showed that adding a few words or examples to explain the context of each item was very beneficial for the participants' understanding. This approach has also been applied in other adaptation and validation studies in Indonesia (Arifin, 2017). Our results show that our adaptation test has expanded the use of the instrument to wider general population compared to previous studies that used the instrument only for a certain district (Karuniawati, 2020).

For construct validity, after discussions with the Expert Committee (Beaton, 2000), we decided to retain 1 item whose factor loading did not appear and 1 item which had a factor loading below 0.4, while one other item was omitted. For items whose factor loading does not appear: 'Antibiotics are usually more expensive than other drugs', the Expert Committee considers that this statement is still needed. However, it needs to be reformulated in terms of sentence structure so that it is more general and understandable as the price of antibiotics in each health facility varies depending on the dosage form; in the hospital, there are injection antibiotics at a higher price. For the statement 'Anti-pain such as Aspirin is a new generation antibiotic' (item 9) whose factor loading is below 0.4, we decided to omit this item because the statement is a 'distractor' which does not measure one's knowledge. Finally, the item 'All Antibiotics do not cause side effects' is maintained but the wording in the sentence needs to be corrected. Apart from these reasons, another consideration is that if the three items are omitted it will reduce the value of the reliability of statements in the knowledge domain. Based on this situation, we recommend monitoring the participants during the application of this instrument in future research.

The results of known group validity showed that participants with a higher education level and a health science educational background had significantly higher antibiotic knowledge than participants with a lower educational level and without a health science educational background. Similiarly, in the domain of attitudes about antibiotics, participants with a higher education level and a health science educational background, have a wiser attitude toward the rational use of antibiotics than participants with a lower educational level and without a health science educational background. These findings support the a priori hypothesis and known group validity.

The findings of this study could be used the baseline for the future development of more effective public education initiatives to improve knowledge and attitudes regarding antibiotic use among the general public. These findings could be an excellent platform for researchers to identify which areas need to be prioritized, create appropriate materials for education, and choose the most suitable education methods so that the interventions given will be more focused, more on target, and more effective. The respondents' knowledge and attitude show gaps regarding antibiotics role, antibiotics access, antibiotics use, and intention or reason for antibiotics use. Therefore, these areas should be made priority considerations in further educational programs.

Our research has strengths and limitations. This study it is the first instrument validation research (translation, adaptation, and validation) of knowledge and attitudes with more than 1,000 participants from all the main islands in Indonesia. The data were obtained from six main regions in Indonesia. The study also provides evidence of validity and reliability in the range of the participants' educational backgrounds from low to high educational backgrounds. The limitation of this study is that because the instrument was distributed using online links, there is a potential for participant bias that people with low education and poor literacy levels will not participate in it. This is indicated by the fact that most of the participants were people with bachelor's degrees, while only 31.4% of the participants had an educational background up to high school. Because people with poor literacy may have lower knowledge about antibiotics, our findings may be slightly overestimated by the true public knowledge about antibiotics. It is recommended that the further studies are proposed to use instruments in paper form and target participants with low literacy levels, especially those who are not connected to the internet.

CONCLUSION

Based on the psychometric analysis, the Indonesian Language Antibiotic Knowledge and Attitude Instrument is a valid and reliable instrument for assessing the level of knowledge and attitudes of the general public toward antibiotics in the Indonesian population. We encourage the use of this standardized instrument in future research and its use as a reference for measuring antibiotic knowledge.

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CONFLICT OF INTEREST

The authors have indicated that they have no conflict of interest with regard to the content of this article.

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