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Assessment of Health Behavior in the Community using Structural Equation Model (SEM) for Prevention of Pulmonary Tuberculosis (TB)

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ABSTRACT

Aim: Tuberculosis (TB) is a disease caused by the acid-fast bacillus *Mycobacterium tuberculosis*. The spread of disease through inhalation of air droplets infected with *Mycobacterium tuberculosis* bacteria, for example, from a patient's cough to a healthy person who inhales the droplets. TB disease generally attacks the lungs or is known as pulmonary TB but can also attack other organs besides the lungs, such as bones, tissue and the brain; this disease is known as extrapulmonary TB. The impacts and problems that occur due to pulmonary TB are still an infectious disease problem in Indonesia and have not been resolved until now and are a priority program for the Ministry of Health to resolve. This study aimed to assess health behaviour in the community using a structural equation model (SEM) for the prevention of pulmonary tuberculosis (TB). **Methods and tools:** This quantitative study examined structural relationships using structural equation model (SEM) analysis. The population came from 3 subdistricts, namely, Bangetayu Wetan, Tlogosari Wetan and Tlogosari Kulon, with a total sample of 176 respondents selected randomly. **Results:** SEM analysis using the AMOS 22 program revealed a significant effect on attitudes (P value < 0.05); in this case, knowledge (X1), subjective norms (X2), and respondent characteristics (X3) had significant effects on attitudes (X4). Only subjective norms and respondent characteristics have a significant influence on behaviour (Y). The attitude variables do not moderate the effects of knowledge, subjective norms, or personal characteristics on behaviour. **Conclusion:** It is important to maintain cultural values that apply to society because they have a significant influence on TB prevention behaviour in society.

Keywords: Health Behavior, TB Prevention Behavior, SEM.

INTRODUCTION

Tuberculosis (TB) is a disease caused by acid-fast bacilli (BTA) bacteria. *Mycobacterium tuberculosis*. The spread of disease through inhalation of airborne droplets infected with *Mycobacterium tuberculosis* bacteria, for example, from a patient's cough to a healthy person who inhales the droplets [1]. TB generally attacks the lungs or is known as pulmonary TB but can also attack other organs in addition to the lungs, such as bones, tissue and the brain [2].

Infectious diseases are diseases caused by bacterial infections, bacteria, fungi, and parasites that pass from one person to another. One of the infectious diseases caused by bacterial infection is tuberculosis. Tuberculosis is caused by Mycobacterium tuberculosis infection whose healing process takes a long time [3]. Infectious diseases due to viral infections, one of which is coronavirus or Covid-19. Coronavirus (CoV) is a virus that can cause disease with mild to severe symptoms. Two types of coronaviruses that can cause diseases with severe symptoms are Middle East Respiratory Syndrome (MERS-CoV) and Severe Acute Respiratory Syndrome (SARS-CoV) [4].

According to the latest data based on the 2021 Global TB Report from the WHO, 824,000 people and 93,000 people died in Indonesia in 2020, while 384,025 cases or approximately 47% of the total number of cases were discovered; this number decreased by 174,000 cases from the previous year [5]. The decline occurred as a result of the COVID-19 pandemic, which became an obstacle to realizing the TB elimination target. Due to the decline in the reporting of TB cases due to a complete shift in the focus on handling COVID-19, available facilities have become limited [6], [7].There is an association between TB patients and DM cormobid or vice versa. These co-morbidities arise due to high blood glucose levels, which reduces immunity [8].

Central Java Province is one of the regions with the most TB cases in Indonesia [7]. The CNR for TB in 2021 was 110 per 1002,000 people; compared to that in the previous year, there was a decrease of 113 per 100,000 people in the CNR for TB in 2021) [9]. Semarang city is among the 10 districts/ cities in Central Java with the highest TB CNR, at 195.8 per 100,000 people.

These impacts and problems occur because pulmonary TB cases are still an infectious disease problem in Indonesia, have not been resolved until now and are a priority program for the Ministry of Health to resolve. This is due to the incomplete treatment of TB patients, and the community's preventive behavior regarding TB patients is still low. The causes include lack of knowledge, negative attitudes, and sociodemographic factors such as age, age, gender, occupation and level of education [10]. This has resulted in TB cases still not ending to this day.

The aim of this research is to create a model of TB prevention behaviour in the community and analyse TB prevention behaviour through the Lawrence Green Model to break the chain of TB transmission and to determine the factors that influence TB prevention behaviour both directly and indirectly. Regarding healthy living habits, healthy living habits will change for the better, by consuming a balanced healthy diet, exercising and sleeping

regularly, checking health conditions more regularly, looking for reliable health insurance, maintaining cleanliness, and using tools or consuming supplements to avoid disease[4].

Methods

Study design

This quantitative study aimed to reveal the existence of a positive and significant functional relationship between knowledge, subjective norms, sociodemographic characteristics and attitudes towards TB prevention behaviour.

Study area, study population and data collection

The study was carried out in the Genuk and Pedurungan Districts (East Semarang) of Indonesia. The sample size was determined, and since the appropriate sample size for SEM is between 100 and 300 samples, a sample of 176 was determined using a simple random sampling technique, and the data were collected using structured questionnaires.

Variable definition

The number of variables examined in this research consists of three types of variables, namely, an independent variable (Exogenous variable), an intermediate variable or moderator variable and a dependent variable (endogenous variable).

Data analysis

A structural equation model (SEM) was used to analyse the data. This involved several stages, i.e., model specification, model identification, model estimation, model testing and model modification. The data were first tested for validity and reliability, and then descriptive analysis and multiple correlation tests were carried out via SEM analysis.

Results of the analysis

As shown in Table 1, there were 132 (75%) female respondents than 44 (25%) male respondents in the present study. Thus, the majority of respondents were female. Images were generated to clarify the results of the analysis. A total of 57 (32.4%) respondents were 17-25 years of age, with the 36-45 age category having the lowest frequency of 23 (13.1%). The majority of the respondents had a senior high school education, 94 (53.4%), while the fewest respondents had a master's degree, 3 (1.7%), and 66 of the respondents were working as private officers (37.5%), while 6 of them (3.4%) were self-employed.

Table 1 Sociodemographic characteristics of the respondents.

Study characteristics	**Frequency (n/N)**	**Percentage (%)**
Sex		
Woman	132/176	75
man	44/176	25
Age in years		
17-25	57/176	32.4
26-35	42/176	23.9
36-45	23/176	13.1
46-55	33/176	18.8
Education level		
Elementary School	23/176	13.1
Junior High School	19/176	10.8
Senior High School	94/176	53.4
Diploma	11/176	6.2
Bachelor's degree	26/176	14.8
Masters degree	3/176	1.7
Occupation		
civil servants	8/176	4.5
Private Officer	66/176	37.5
Self-employed	6/176	3.4
Does not work	20/176	11.4
Others	76/176	43.2

Table 2 shows that people in the city of Semarang have TB infection prevention behaviour in the high category. This is because of the high school education level and the high level of knowledge, subjective norms and positive attitudes in the local community.

Table 2. Cumulative statistical values of the research variables

No	**Variable/Indicator**	**Indicator**	**Category**
1	**Knowledge**	X1	Height
	Concept	$X1_1$	Height
	Fact	$X1_2$	Height
	Procedural	$X1_3$	Height
2	**Subjective Norm**	X2	Height
	Norma	$X2_1$	Height
	Loval Culture	$X2_2$	Height
3	**Respondent Characteristic**	X3	

	Age	$X3_1$	17-25 years old
	Gander	$X3_2$	Woman
	Level of education	$X3_3$	Senior High School
	Occupation	$X3_4$	Private Officer
	TB Contact	$X3_5$	No Contact
4	**Attitudes**	X4	Positive
	Cognitive	$X4_1$	Positive
	Affective	$X4_2$	Positive
	Conatve	$X4_3$	Positive
5	**Health Behaviour**	Y	Height
	Use of Masks	Y_1	Height
	Ethical Behavior of Coughing and Sneezing	Y_2	Height
	PHBS	Y_3	Height
	Immunity Enhancing Behavior	Y_4	Height
	Treatment seeking behavior	Y_5	Height

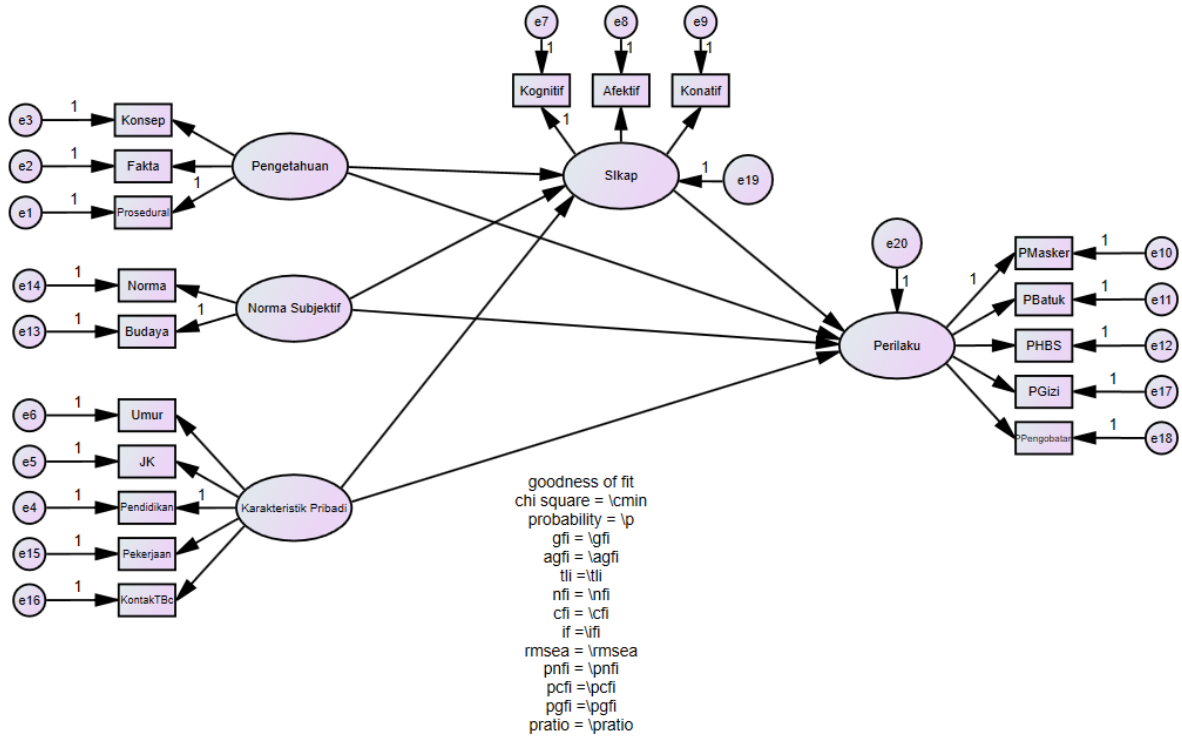

Figure 1. Structural equation model (SEM)

Model feasibility (goodness of fit) testing

The goodness of fit was determined by comparison between the model and the covariance matrix between indicators or observed variables, and the results of goodness of fit testing are shown in Table 3 below.

Based on the results in Table 3, the model was deemed to be fit for further analysis.

Table 3. Model goodness

No	Goodness of Fit	Cut-Off Value	Value	Result
Absolute fit measure				
1	Chi-Square (X2) lebih besar dari df tabel (28.869)	< df tabel	179,837	Marginal Fit
2	Probability (p)	≥ 0,050	0,000	Marginal Fit
3	Goodness of Fit Indices (GFI)	> 0,900	0,902	Good Fit
5	Root Mean Squared Error of Approximation (RMSEA)	≤ 0,050; ≤ 0,080	0,058	Good Fit
Incremental Fit Indices				
1	Adjusted Goodness of fit (AGFI)	≥ 0,900	0,852	Marginal Fit
2	Ticker Lewis Index (TLI)	> 0,900; > 0,950	0.948	Good Fit
3	Normed Fit Index (NFI)	> 0,900; > 0,950	0,905	Good Fit
4	Comparative Fit Index (CFI)	> 0,900; > 0,950	0.962	Good Fit
5	Incremental Fit Index (IFI)	> 0,900; > 0,950	0.962	Good Fit
Persemonious Fit Indices				
1	Parsimony Normed Fit Indices (PNFI)	> 0,500; > 0,600	0,668	Good Fit
2	Parsimony Comparative Fit Indices (PCFI)	> 0,500; > 0,600	0,710	Good Fit
3	Parsimony Comparative Fit Indices (PGFI)	> 0,500; > 0,600	0,596	Good Fit

Based on the results in Table 3 above, a structural equation model (SEM) was obtained after modifications, as shown in Figure 2 below.

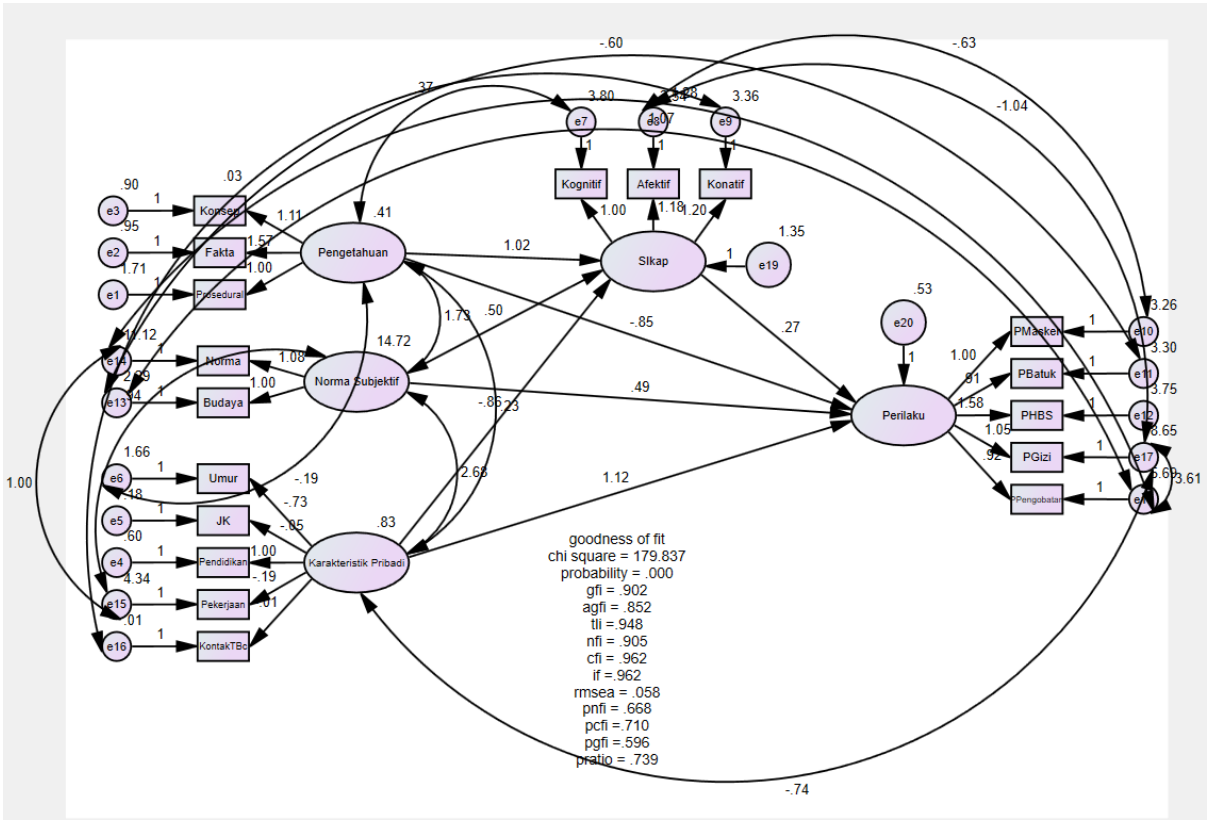

Figure 2. Modified structural equation model (SEM)

Table 4. Regression Weight (Group Number 1-Default Model)

For the relationship between knowledge (X1) and attitude (X4) in Table 4, the p value is 0.027 < 0.05; hence, there is a significant correlation coefficient of 1.022; hence, for every increase in the respondent's knowledge, the attitude will increase by 1.022. The p value for the relationship between subjective norms (X2) and attitudes (X4) will increase by 0.000 < 0.05, with a relationship coefficient of 0.053; therefore, for every increase in the respondent's subjective norms, the attitude will increase by 0.053. The personal characteristics (X3) and attitudes (X4) had p values of 0.02 < 0.05, with a relationship coefficient of -0.857. The relationship between knowledge (X1) and behaviour (Y) has a p value of 0.073 > 0.05 and hence is not significantly related. For subjective norms (X2) and behavior (Y), the p value is 0.000 <0.05, with a correlation coefficient of 0.493, and personal characteristics (X3) and behavior (Y) have a p value of 0.006 < 0.05, with a correlation coefficient of 1.115. The relationship between attitude (X4) and behavior (Y) has a p value of 0.122 > 0.05; hence, it is not significantly related; hence, the attitude of a person does not moderate the relationship between knowledge, subjective norms and personal characteristics on behavior.

Indicators	Estimate	S.E.	C.R	P value	Standard Estimate
X4 <--- X1	1.022	0.461	2.217	0.027	0.288

X4	<---	X2	0.503	0.116	4.342	***	0.848
X4	<---	X3	-0.857	0.368	-2.33	0.02	-0.343
Y	<---	X4	0.275	0.178	1.545	0.122	0.211
Y	<---	X1	-0.847	0.473	-1.793	0.073	-0.183
Y	<---	X3	1.115	0.403	2.766	0.006	0.343
Y	<---	X2	0.493	0.142	3.469	***	0.639

Discussion

TB Prevention Knowledge and Behavior

The distribution of public knowledge regarding TB is in the high category, namely, 90.9%, which means that public knowledge is sufficient to prevent TB. With good knowledge, it is hoped that this knowledge can be applied to people's attitudes and behaviors in everyday life. This can be seen from the percentage of respondents' answers, which is more dominant than the percentage of wrong answers. Of the three categories of conceptual knowledge, factual knowledge and procedural knowledge, the highest category is knowledge of concepts, namely, 162 or 92%. This indicates that the majority of respondents know more about the characteristics of TB disease in general, including the signs and symptoms as well as the characteristics of the virus.

According to Timothy (2017), knowledge is divided into two types, namely, explicit knowledge and implicit knowledge. Explicit knowledge is information that is easily transferred to other people because it is clear and complete. This knowledge comes from data, documents and files. Moreover, implicit knowledge is information that is difficult to share or transfer to other people. This knowledge comes from thoughts, experience, competence, commitment and actions [11]. Knowledge about personal hygiene is also important because it prevents infection. This can help people live a clean and healthy life. In this way, people can avoid spreading germs to other people [12].

Regarding the analysis of knowledge of TB disease, the results of the analysis show that the majority of respondents' knowledge of COVID-19 is in the high category, namely, 90%, meaning that people already know general things about TB disease, such as signs, symptoms and characteristics of the bacteria. This is in line with research in Semarang city, which shows that public knowledge is in the good category, namely, 82% [13].

Handika (2017) states that several factors influence attitudes, namely, personal experience, the influence of other people who are considered important, the influence of culture, mass media, and the influence of emotional factors. Overall behaviour was found to be adequate, with 73 people (73%). According to Hermanto (2023), there are several factors that influence behaviour, namely, traditions, people's beliefs in matters related to health, and supporting infrastructure for healthy living [14].

Factors that can influence people's knowledge include education; generally, the greater a person's education is, the easier it is to obtain information, and vice versa. A lower education level will influence respondents to obtain information. This is because people with a higher level of education are better able to absorb and assimilate information about tuberculosis, making it easier to carry out efforts to prevent tuberculosis. Moreover, the greater a person's education level is, the more indirectly their health level is affected [15]. Likewise, age can influence a person's knowledge; the older a person's level of maturity is, the more mature they are in thinking.

Knowledge also influences behavior. Educational or educational activities are planned to influence other people, whether individuals, groups or communities, to determine what education stakeholders want [16].

Attitude and TB Prevention Behaviour

The maximum category is the strongly agreeing category, with 96 or 54.5% of respondents agree. Furthermore, 79 or 44.9% of the respondents agreed with the category. These results show that, in general, the attitudes of the people in Semarang city are good. The local community is aware that clean and healthy living habits can prevent disease. People apply coughing and sneezing etiquette to avoid transmitting disease and habitually wash their hands with soap after every cough or sneeze. It is hoped that a good attitude will have an impact on good community behaviour so that it can reduce the morbidity and mortality rates. This is expected to improve the health status of the local community.

The research results showed that the majority of respondents had a positive attitude, namely, 23 respondents (63.9%), and the majority of respondents had a positive attitude, namely, 21 respondents (58.3%). These results are in line with research conducted at the Sumberglagah Leprosy Hospital showing that there is a relationship between family attitudes and behavior to prevent the transmission of pulmonary TB [17]. Likewise, research at the Pulmonary Polyclinic showed that analysis of the relationship between attitudes and behavior showed that 87.7% of respondents had bad attitudes and bad behavior, compared to 53.2% of those who had good attitudes and bad behavior. The statistical test results obtained a p value of 0.000 (<0.05), indicating that the difference in proportions was significant or that there was a relationship between attitudes and behaviour to prevent the transmission of pulmonary TB disease in the Lung Polyclinic [18].

This is because Kaka et al. (2021) assume that behavior that is based on knowledge will be better than behavior that is not based on knowledge. However, it is not certain that someone who has good knowledge will behave well; on the other hand, someone who has less

knowledge will behave less well because, in this case, the behavior itself is influenced by several factors, such as experience, motivation, social facilities and beliefs. In general, a good attitude will be influenced by a person's good knowledge because the greater a person's level of knowledge is, the better their attitude will be in providing feedback or contributing to a problem object. This attitude can also be influenced by several factors, such as experience, different cultures, and individual emotional factors, when responding to a problem [19].

The results of the AMOS SEM analysis show that for the relationship between attitude (X4) and behavior (Y), the p value is 0.122 > 0.05, so it is declared not to be significantly related.

Subjective Norms and TB Prevention Behaviour

A total of 55.1% of the respondents strongly agreed. Furthermore, 23 or 13.1% of the respondents were in the doubt category. These results show that, in general, the subjective norms from the local cultural aspects of the people in Semarang city show high subjective norms towards improving the quality of health. The community continues to maintain the local culture related to health, which has become the customs and daily habits of the community. The local culture of throwing away rubbish in its proper place is a manifestation of subjective norm values to keep the environment clean and healthy to avoid disease. If this local culture continues to be maintained, it is hoped that it can improve the level of environmental health in Semarang city.

These results are in line with research conducted in Kendari City Hospital Lung Clinics, which had a p value of 0.002 (<0.05), indicating that there is a relationship between subjective norms and the intention to adhere to medication in pulmonary tuberculosis patients. According to Meitiana (2017), subjective norms are people’s views that are important for them to carry out certain behaviors; these important people are then used as goals to direct behavior. Subjective norms, which refer to the influence of family, relatives and the social environment, are very influential in the formulation of behavior.

The results of this study show that all respondents have positive subjective norms regarding their intention to adhere to taking medication. This research is supported by research by Adiutama (2021), which has been proven to influence increasing subjective norms on treatment compliance intentions [20] . However, this research contradicts the research of Ulfah (2011), which explains that there is no relationship between subjective norms and treatment compliance intentions [21].

Responden Characteristic (Gender, Education Level, and Age) and TB Prevention Behaviour

These results are in line with research at the Community Health Center, which showed that according to the results of the chi-square test, a p value of 0.004 was obtained because the p value was <0.05, so Ho was rejected, meaning that there was a relationship between the age of the patient and the incidence of pulmonary tuberculosis [22]. Age plays a role in the incidence of TB. The risk of developing TB can be said to be similar to an inverted normal

curve, namely, it is high at first and decreases because after 2 years of age until adulthood, individuals exhibit good resistance to TB. The peak is young adulthood and declines again when a person or group approaches old age. However, in Indonesia, it is estimated that 75% of TB patients are of productive age, namely, 15-50 years [23].

This is because productive age is the age at which a person is at the stage of working or producing something either for themselves or others. Pulmonary tuberculosis is most often found in people of productive age, economically aged approximately 15-49 years. Currently, demographic transmission has increased the life expectancy of elderly people. At an advanced age of more than 55 years, a person's immunological system declines, making them very susceptible to various diseases, including tuberculosis [24].

These results are in line with research conducted by Habibah et al. in Tuah Karya village on 76 respondents, showing that the majority of respondents were female (49, 64.5%). Women who act as wives/mothers are more likely to be at home (Kumurur, 2010) . However, these results contradict research at the Community Health Center, which showed that according to the results of the chi-square test, a p value of 0.199 was obtained because the p value was > 0.05; therefore, Ho was accepted, meaning that there was no relationship between the sex of the patient and the incidence of pulmonary tuberculosis [22]. This is because women are more dominant in taking care of the household, while men, as the main breadwinners in the family, spend more time outside the home.

These results are in line with research in Lamongan Regency, where the results of the chi-square test were 0.026 with a p value <0.05, which means that there is a relationship between education level and compliance with treatment for pulmonary TB patients.

The education level of TB patients will influence their level of knowledge and absorption in terms of preventing transmission and treating TB.15 Patients who have a poor level of knowledge will tend not to undergo treatment because, for them, receiving treatment and not receiving treatment will have the same results. Knowledge can also be influenced by perception, for example, the perception of some sufferers who see events experienced by their own family. Families who are both diagnosed with TB and undergo treatment will still die. In addition, another study reported that the lower a patient’s knowledge and education, the lower his or her awareness of the dangers of the disease to himself or herself and his or her environment, and the lower his or her awareness of receiving complete treatment [25].

However, this result contradicts the results of the chi-square test, which revealed a p value of 0.953 (p >a), indicating that there is no relationship between the education level of TB patients and TB treatment compliance at the Jember Regency Lung Hospital [26].

The act of formal education is the basis for someone to do something, make them understand more, and make sense of something. This can occur because the tuberculosis treatment pattern has its own rules regarding more than one type of medication and a minimum treatment duration of 6 months. This rule makes sufferers feel bored or burdened, and in the middle of treatment, they feel that they have recovered, so they stop taking the medicine

midway (drop out). This condition is very worrying because it can trigger the emergence of resistant germs that threaten global health [27].

Compliance greatly influences TB treatment because patients who are referred for TB therapy procedures and who receive instructions from medical staff will have good therapeutic results. Apart from compliance in seeking treatment at the Lung Hospital, patients must also be precise in taking their medication, both in the dose of medication taken and the time of administration of the medication. Medicines can affect pharmacokinetics, which can cause a loss of efficacy or the emergence of drug resistance. The use of low doses can result in lower than usual peak drug concentrations and lower total drug exposure, while extra doses can result in a risk of toxicity due to higher than usual peak concentrations and total [28].

Respondent compliance with treatment is not the only determining factor in success. Other supporting factors to increase the success of treatment therapy are a good patient lifestyle with clean and healthy behavior, adequate sleep and rest, not smoking and drinking alcohol, completing the patient's nutritional needs, BCG immunization for babies, and maintaining body resistance (immunity). patients because if the immune system is weak, it is easy for bacteria to enter the body. Healthy behaviors such as not spitting carelessly, coughing should be covered with a tissue or handkerchief, using a mask, limited proximity to family, and balanced nutrition [26].

The results of the SEM AMOS analysis show that personal characteristics (X3) on behavior (Y) are known to have a p value of $0.006 < 0.05$, indicating that they are significantly related, with a correlation coefficient of 1.115.

Table 1 shows that most respondents were female, which is in line with research conducted by Utami (2020) in Jakarta [29]. Similarly, research conducted in Semarang city showed that the majority of respondents were women [8]. Most of the respondents had a high school education and were classified as high, which resulted in a good level of knowledge among the public regarding TB. However, residents with low levels of learning do not necessarily lack knowledge because in this era, there is much technology available for accessing data. This research is also in line with research conducted by Putra in 2020 in Bali [30]. According to Nurfadila (2014), the information received by the majority of respondents with sufficient criteria can be influenced by information obtained both formally and informally [31]. From the results of SEM analysis using the AMOS 23 program, it is known that the relationship that has a significant effect is that it has a P value < 0.05; in this case, X1 to X4, X2 to X4, X3 to X4, X3 to Y and X2 to Y. From the description above, it is known that the attitude variable (X4) is not significantly related to the behaviour variable (Y), so that the attitude variable does not moderate the relationship between knowledge, local wisdom and personal characteristics on behaviour.

CONCLUSION

From the results of SEM analysis using the AMOS 22 program revealed a significant effect on attitudes (P value < 0.05); in this case, knowledge (X1), subjective norms (X2), and respondent characteristics (X3) had significant effects on attitudes (X4). Only subjective norms and respondent characteristics have a significant influence on behaviour (Y). The attitude variables do not moderate the effects of knowledge, subjective norms, or personal characteristics on behaviour. It is important to maintain cultural values that apply to society because they have a significant influence on TB prevention behaviour in society.

FUNDING

There was no funding for this study.

DATA AVAILABILITY

The data for this study are not publicly available due to ethical restrictions by the research ethics committee, but the data are available upon reasonable request from the corresponding author.

ETHICAL APPROVAL AND CONSIDERATIONS

Ethical approval was granted by the Komite etik penelitian kesehatan
Poltekkes Kemenkes, semarang, Ministry of Health, Semarang Health Polytechnical Health Research Ethics Committee, with an ethical approval ID of 607/EA/KEPK/2023. Participants/respondents provided written consent, and they were free to leave the research at any stage of the study. The study was conducted in accordance with the Declaration of Helsinki.

COMPETING INTEREST

The authors declare no competing interests.

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