INNOVATIONS

Association between Perception, and Self-Care Practices among Patient with Pulmonary Tuberculosis through Using Health-Belief Model

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Abstract

Background: Tuberculosis (T.B) is considered as a single-agent infectious disease, which is the major source of death around the world. Approximately one third of the world's population is infected with tuberculosis (TB) bacilli and at risk of developing active TB. **Aim:** The present study was carried to investigate association between Knowledge, perception, self-care practices among patient with pulmonary tuberculosis in Port-Said City. **Subject and methods**: A descriptive correlational study was carried out on 600 recent T.B patients whose attending outpatient clinics at Chest Hospital (ALmasah ALbahary) in Port-Said City during four months from the starting of data collection. **Results:** The study revealed Shows that there is a significant correlation were found between total scores patient's self-care practice with their knowledge, p= (0.001). Also (46.7%) of patient's perceived that advantages of pulmonary Tuberculosis treatment are to reduce transmission of disease while (57.2%) beliefs that stop medications according to doctor order. on the other hands, (63.3%) of them balance their diet with protein and fat. finally (86.7%) of them perceived that pulmonary tuberculosis can be cured. **Conclusion:** Based on the results of present study we can concluded that there are lacked of critical knowledge, perception among patients with T.B needed to understand their disease, self-care practice which affect their compliance of T.B. **Recommendations:** There are obvious needs for design health education program to patients with T.B regarding self-care practice to elevate their level of awareness, enhancing beliefs and attitude regarding tuberculosis treatment. Which correct TB knowledge is important for attaining successful treatment out comes.

Key Words: 1.Association 2. Knowledge 3.perception 4 .self-care practices 5.Health –belief model

Introduction

Worldwide, tuberculosis (TB) is the leading cause of death from a single infectious agent. In 2017, about 10 million TB cases were estimated to occur, a third of them were missed, and about 1.6 million died in the same year (**WHO, 2018**). Tuberculosis is more widespread disease in developing countries, in which up to 95% of cases occur. It remains a major confront to global public health in the 21st century. According to WHO statistics 9 million new cases of active tuberculosis and 1.5 million deaths occurring in 2013. One third of the world's population is infected with Mycobacterium tuberculosis. Every year, the disease kills 136,000 people and

affects 630,000 in that region. Finally, it is considered the third most important public health problem in the Egypt. (**Abd El-Aal & Mostafa, 2015**).

Tuberculosis is spread through the air, when people suffering from active pulmonary tuberculosis cough, sneeze, speak, or spit, they expel infectious aerosol droplets 0.5 to 5 μm in diameter. A single sneeze can release up to 40.000 droplets. Each one of these droplets may transmit the disease, as the infectious dose of tuberculosis is very low and the inhalation of just a single bacterium can cause a new infection. (**VKM, Das, Christian& Sezal, 2018**). Furthermore, People with chronic health conditions experience physical and psychological deteriorations, compliance with dietary regimen dependent on family members, hinder the interaction with society, and promote health wellbeing. Thus, barriers related to individual (behavioral, psychological, social and economic factors) (***Fernandes et al., 2016***).

Self-care practices on tuberculosis treatment Adherence to therapies is a primary determinant of treatment success. Poor adherence attenuates optimum clinical benefits and therefore reduces the overall effectiveness of health systems. That is, medicines will not be effective if the clients do not follow prescribed treatment. The nursing supportive-educative nursing system is the conditioning factor, which influences the self-care practices and the results when the client has acquired knowledge. The capabilities of the client will enable the client to be able to make decisions on completion of prescribes treatment for pulmonary tuberculosis (**Almohammadi, Qurashi & Ghaydaa, 2019**).

Pulmonary tuberculosis is still a major health problem in the community. The nurse has remarkable significance regarding the actions of TB control, follow-up the treatment, avoiding abandonment and resistant tuberculosis, as well as, guaranteeing adherence and a successful effect of treatment. (**Guimarães, Amorim, da Silva Ferreira, Barbosa, Farias, & Lopes et al, 2018**). In addition to, self-care strategies are essential because it can donate to the reduction of treatment rejection. (**Fagundez, Perez Eyene, Momo, Biyé, Esono, & Herrador et al., 2016**). In addition, nurses are responsible for providing nursing care to patients and families by designing interactive nursing interventions that can help patients and families optimize self-care agencies to act in their self-care independently.

Finally, the successful treatment adherence and implementation of DOTS in combating against tuberculosis requires the cooperation of all health-clinical team and settings including clinical health networks, hospitals and university centers and private settings. (**Jadgal et al., 2015**), has been associated with improvements in treatment completion and outcomes (**WHO, 2019**).

Significance of study:

Tuberculosis is an important public health problem in the world, more people will die from tuberculosis than in any other disease and almost all deaths from tuberculosis are preventable. (**Tola, Shojaeizadeh, Tol, Garmaroudi, Yekaninejad, Kebede & Klinkenberg, 2016**). Tuberculosis affects the lives of the patients, as well as the patients' family and caretakers. In Egypt, TB is considered the third most important public health problem. According to the latest WHO estimation, the incidence is 14 cases per 100 000 population in the year 2017, (**Ministry of Health and Population, 2017**). However, recent research concluded that noncompliance related to the treatment of TB is due to the priorities and needs of the patients. New mechanisms are required for patient centered care, which enables the patients to cope with the disease efficiently. (**Almohammadi, Qurashi & Ghaydaa, 2019**). Major progress in TB prevention and care followed the widespread implementation of directly observed treatment short-course (DOTS) strategy. Efforts must continue to pursue high-quality DOTS expansion and enhancement

The aim of the present study was carried to investigate association between, perceptions, self-care practices among patient with pulmonary tuberculosis in Port-Said City.

Research Questions:

1. Is there a relation between Perception, and Self-Care Practices among Patient with Pulmonary Tuberculosis through Using Health-Belief Model?

Conceptual Framework:

The health belief model (HBM) remains one of the most widely recognized conceptual frameworks for understanding health behavior and is a cognitive model attempting to identify and predict health behavior. It was applied to understand the determinants of preventive behavior and intention of health seeking. HBM was one of the first models used for TB research, and remains one of the best-known health behavior models, which is widely used in health-related behavior change analysis. The HBM suggests that your belief in a personal threat together with your belief in the effectiveness of the proposed behavior will predict the likelihood of that behavior. Individual perceptions related to such factors as personally perceived susceptibility, perceived severity, perceived benefits of an action, and its barriers represent important predictors of preventive TB behavior. In the field of tuberculosis, researchers have applied HBM to patients screening, treatment, prevention, and health education.

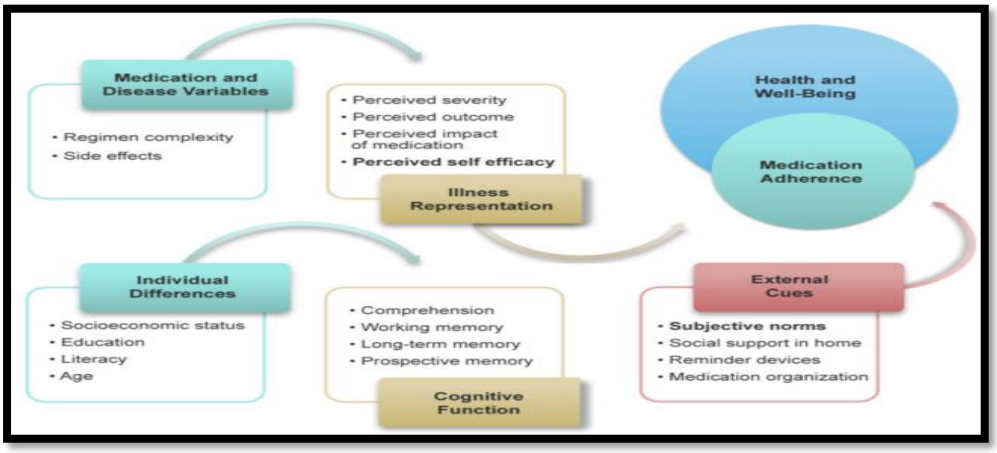

Figure 1: Diagram of Health Belief Model adapted from Glanz *et al.* (2015).

Subjects and Method

- **Study Design:**

  Descriptive correlational research design was used to conduct this study.

- **Setting:**

  This study was conducted at outpatient clinic of Chest Hospital in Port Said (ALmasah ALbahary) that has been implementing the DOTS strategy. This hospital affiliated from Ministry of Health and Population, which includes 72 beds and 4 rooms with 16 beds and 2 isolated rooms for males and females.

- **Subjects:**

  A convenient (purposive) sample was used in this research to select 600 patients who attending the above mentioned setting. The inclusion criterion includes all tuberculosis patients

who have spent at least two months of their treatment. The exclusion criterion was mental retardation or disabled people that that interface with self-care practice manners.

The **sample size** was calculated for patients from the equation n=z2 pq /d2, where; n =sample size, z=level of confidence=1.96, p=0.5, q=1-p=0.5, d=desired margin of error=0.05.Thus the sample sizes were 600 TB patients

Tool of data collection:

Data were collected using one tool**, which was,** A structured interview questionnaire sheet was modified by the researcher which based on **Ilongo , 2004 Ngang et al , 2007 and Abd ElHameed et al., 2012** and literature review after modified them, it was translated from the English language to the Arabic language by English experts to suit their level of patient's understanding which includes **3 main parts** as follows:

I. **Part: It was concerned with personal** characteristics **data of tubercles patient :** as, gender, age, level of education and income, involved past history of disease, treatment, follow-up appointment schedule etc….

II. Part: Patient's perceptions regarding pulmonary tuberculosis questionnaire

Includes 58 questions to assess patient's perceptions to pulmonary tuberculosis as definition, risk factors, clinical manifestations, treatment regimens, barriers to compliance with their treatment, etc …).

The **Scoring system:** for the questionnaire, Perceptions about TB was assessed using yes/no/don't know each correct response was given a score of (1) and the wrong one or do not know was given a score of (0) giving a total sum score ranged from 0-58 points. On assessment, a median score (=19) was used to divide the knowledge into "Poor" knowledge if the total score ≤ 19 and "Good" for scores above 19.

The total score for all questions related to knowledge was good if the percent score was ≥ 75% and average if the percent score 50- < 75% and poor if less than 50%

Content Validity: It was established by a panel of five experts who will review the tool for clarity, relevance, comprehensive, understandable and applicable, reliability would be tested statistically

Reliability: Was carried out by format (Cronbach's alpha= 0.82).

III. Part: Patient's Self-Care behaviors Likert scale regarding pulmonary Tuberculosis:

Includes 15 questions was used to measure the self-care behaviors patients with pulmonary tuberculosis approaches and manners towards self-care behaviors as whether they were always successful in taking correct classes of (dietary chosen, components of their ideal diet, habits, etc…) .

Scores system

The self-care behavior Likert scale was adapted from **Muhtar's (2013)** questionnaire. It consisted of 25 question items using a Likert scale of 1-5. For positive statements; (sometimes=1), (Usually=2) and (Often=3). In addition, for negative questions; (sometimes=3), (Usually=2) and (Often=1). Moreover, there were a range of scores between 25 and 125.

Reliability: Was carried out with Cronbach Alpha 0.714

IV. Part :Health Belief Model (HBM) (Tola, et al., 2016)

Includes 25 questions about the **HBM** constructs (perceived benefits and barriers, perceived threat, and perceived self-efficacy) e.g. "Timely use of anti-TB drugs will lead to my optimal recovery and health."

Scores system

The points in this part ranged from 1 to 5 for the questions on perceived threat (perceived susceptibility and severity), self-efficacy, and perceived benefits and barriers, and they were assigned to the questions as follows: 0 points for the "completely disagree" through to 5 points for the "completely agree";

Methods of data collection:

This study was covered in four phases: -

Content Validity of tools:

Five experts from medical surgical nursing & medicine professor and community & family health nursing professors in the field had ascertained it. Their opinions were elicited as regards clarity and comprehensiveness of questions.

Reliability: Was carried out by using Cronbach alpha test = 0.084.

Pilot study:

A pilot study was conducted after the development of the questionnaire and before starting the data collection on 10 % (n=60) of patient's, to test the applicability, feasibility and to ensure easy understandability for ordinary patient's and to explore any unclear points of the study tool. It served to estimate the time needed to complete the questionnaire.

Fieldwork:

The actual fieldwork started at four months from 19th September 2020 until 19th December 2020 a formal letter was issued from the Dean of Faculty of Nursing in Port Said University. Then the directorate of primary health care centers and hospital outpatient clinics approved the study. Informed verbal consent was obtained from all participants to participate in the study and confidentiality was maintained by assuring security and privacy to all participants. The interview lasted an average of 35-40 minutes for each patient with the researchers to obtain the exact meaning from them for three days weekly mainly Saturday, Sunday, and Thursday, each week. Researchers read questionnaires and explained each element simply and briefly for the study sample.

Administrative and ethical considerations:

Official approval was obtained from the ethical research committee at the Faculty of Nursing, Port Said University. In addition to the approval from the director of the outpatient clinics of hospitals. The participants were informed about the purpose of the study, and that their participation was voluntary and they can withdraw from the study at any time. A Verbal consent was obtained from all participants.

Method of data analysis:

Data were analyzed using the Statistical Package for Social Sciences (SPSS), Version 23.0. Qualitative data were described using numbers and percentages. Quantitative data were described using mean and standard deviation for normally distributed data. Comparison between different groups regarding categorical variables was tested using the Chi-square test. Correlations between two quantitative variables were assessed using the Pearson coefficient.

Significance test results are quoted as two-tailed probabilities. The significance of the obtained results was judged at the 5% level.

Results:

Table (1): shows that nearest half of sample (50.8%, 49.2) of sample were male and female respectively (32.8%) in age group above 40 years and (33.8%) were married, (48.8%) have free works, more than one quarter (33.5%) had technical education level of education. finally, (36.2%) of them have treatment from 4-6 months.

Fig 1: source of knowledge was health workers in 61.8% and 20.8% by nurse followed by 15.8% printed media in 0.3% TV and internet among 32% (**Figure. 2).**

Table (2): Revealed that the mean of total scores of patient's perceptions regarding pulmonary Tuberculosis were 4.53 ± 2.49

Table (3): Revealed that there are a statistically significant were found for all items of patient's perceptions p= (0.001) regarding the way of DOTS is conducted at the clinic

Table (4): Revealed that there is a statistically significant difference were found for all items of patient's perceptions of barriers to compliance with DOTS methods p= (0.001).

Table (5): Shows that there are a statistically significant were found for all items of patient's self-care practice p= (0.001) with mean10.66 ± 2.57 of total scores of self-care practices

Table (6): Shows that there is a significant correlation were found between total scores patient's self-care practice with their knowledge, p= (0.001).

Association of Self-Care Behaviour with Health Belief **Table 7** shows perceived benefit ($p < 0.001$), cue to action ($p = 0.001$) and self-efficacy ($p < 0.001$) had a significant direct linear relationship with self-care behaviour, in contrast, perceived barrier ($p = 0.008$) had a significant indirect linear association with self-care behaviour

Table (1): Distribution of studied cases according to their socio demographic data (n=600).

Items	**No.**	**%**
Gender		
Male	305	50.8
Female	295	49.2
Age		
20 – 30	136	22.7
31 – 40	118	19.7
≥40	197	32.8
Mean +SD	149	24.8
Marital status		
Single	187	31.2
Married	203	33.8
Wood wide	52	8.7
Divorced	103	17.2
Separate	55	9.2
Education		
Illiterate	77	12.8

Primary	72	12.0
Secondary	160	26.7
Technical education	201	33.5
University	90	15.0
Occupation		
Un worked / House wife	200	33.3
Free works	293	48.8
Employee	107	17.8
How long is the TB treatment		
3-6 month	173	28.8
4-6 month	217	36.2
6-9 month	137	22.8
9-12 month	73	12.2

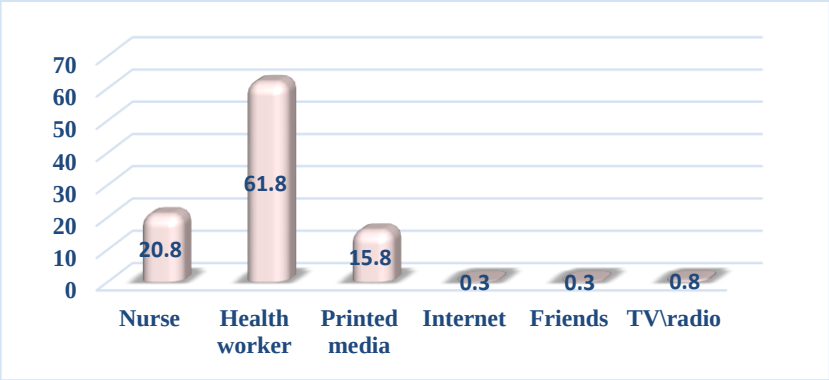

Fig 1: Source of information

Table (2): Distribution of studied cases according to their perceptions regarding Pulmonary Tuberculosis (n=600).

Items	**No.**	**%**
Meaning of Tuberculosis		
Yes	351	58.5
No	55	9.2
Do not know	194	32.3
Causes of Tuberculosis		
Virus	5	0.8
Bacteria	334	55.7
Don't know	261	43.5
Signs and symptoms		
Anorexia	98	16.3
Fever and swatting	85	14.2
Generalize weight loss	28	4.7
Coughing and sneezing	69	11.5
All of the above	320	53.3
Modes of transmission		
Direct contact	81	13.5
Coughing and sneezing	393	65.5

Body secretions	126	21.0
Can stop on TB treatment without finishing the course		
Yes	116	19.3
No	264	44.0
Do not know	220	36.7
Can stop taking drugs feels better		
Yes	107	17.8
No	274	45.7
Do not know	219	36.5
Can stop taking their drugs when they stop coughing		
Yes	76	12.7
No	306	51.0
Do not know	218	36.3
Total mean scores of perceptions		
Min. – Max.	0.0 – 8.0	
Mean ± Sd.	4.53 ± 2.49	

Table (3): Distribution of studied perceptions regarding way DOTS is conducted at the clinic (n=600).

	Disagree		**Agree**		**Strongly agree**		χ^2	**p**
	No.	**%**	**No.**	**%**	**No.**	**%**		
Satisfied with personal attention	171	28.5	375	62.5	54	9.0	263.910*	<0.001*
Attended to early	135	22.5	395	65.8	70	11.7	295.750*	<0.001*
Shortage of staff	143	23.8	384	64.0	73	12.2	266.170*	<0.001*
Long queues	187	31.2	315	52.5	98	16.3	118.990*	<0.001*
Drugs available all the time	141	23.5	368	61.3	91	15.2	217.930*	<0.001*
Having separate clinic/stigma	94	15.7	375	62.5	131	21.8	233.110*	<0.001*
Education about DOTS treatment strategy	106	17.7	367	61.2	127	21.2	210.270*	<0.001*

χ^2: Chi square test *: Statistically significant at $p \leq 0.05$

Table (4): Distribution of barriers affect compliance with DOTS method as the patients is perceived (n=600).

	Never		Sometimes		Always		χ^2	p
	No.	%	No.	%	No.	%		
Length of the treatment period	83	13.8	266	44.3	251	41.8	103.230*	<0.001*
Number of tablets taken at once	92	15.3	325	54.2	183	30.5	137.890*	<0.001*
Having to travel frequently to collect drugs	171	28.5	263	43.8	166	27.7	29.830*	<0.001*
Being observed like children de-motivating	157	26.2	279	46.5	164	27.3	46.930*	<0.001*
Stigma everyone gets to know that one has TB	148	24.7	283	47.2	169	28.2	52.770*	<0.001*
Wait for hours before one is attended to	169	28.2	267	44.5	164	27.3	33.730*	<0.001*
Feeling too sick.	146	24.3	285	47.5	169	28.2	55.510*	<0.001*

χ^2: Chi square test *: Statistically significant at $p \leq 0.05$

Table (5): Distribution of studied patients according to their self-care behaviors (n=600).

	Sometimes		Usually		Often		χ^2	p
	No.	%	No.	%	No.	%		
Always successful in taking correct drugs	291	48.5	209	34.8	100	16.7	91.810*	<0.001*
Able to keep scheduled appointments to collect drugs	290	48.3	222	37.0	88	14.7	105.640*	<0.001*
Always take your drugs at once	306	51.0	175	29.2	119	19.8	92.110*	<0.001*
Always swallow your drugs under supervision	351	58.5	148	24.7	101	16.8	176.530*	<0.001*
Ever stopped taking your drugs	333	55.5	182	30.3	85	14.2	156.190*	<0.001*
Always have an adequate diet	333	55.5	159	26.5	108	18.0	139.170*	<0.001*
Total scores of Self-Care behaviors								
Min. – Max.	8.0 – 16.0							
Mean ± SD.	**10.66 ± 2.57**							

χ^2: Chi square test *: Statistically significant at $p \leq 0.05$

Table (6): Correlation between total scores of self-care behaviors & total scores of knowledge among patients with pulmonary tuberculosis (n=600).

	Total Scores of perception	
	r	p
Total Scores of Self-Care behaviors	**0.210***	**<0.001**

r: Pearson coefficient *: Statistically significant at p ≤ 0.05

Table 7. Linear regression Association of self-care behavior with Health Belief

Self-care behavior				
Health Belief	**Pearson 's correlation**	**Beta**	**95% CI**	***p* value**
Perceived susceptibility [a]	-0.045	-0.000305	-0.001, 0.000266	0.294
Perceived severity [a]	0.004	0.000066	-0.001, 0.002	0.930
Perceived benefit [a]	0.150	0.001	0.000, 0.001	<0.001**
Perceived barrier [b]	-0.113	-0.295	-0.513, -0.077	0.008**
Cue to action	0.145	0.148	0.063, 0.233	0.001**
Self-efficacy [a]	0.301	0.001	0.000631,0.001091	<0.001**

**p<0.01(2tailed)
p<0.05 (2-tailed)
a Using power 2 transformation
b Using square root transformation

Discussion:

Tuberculosis is one of the communicable diseases that still contributes substantially to the worldwide disease burden and is still a major health threat worldwide. Today, tuberculosis is still one of the major public health problems in many places in the world especially in Africa and Asia. The aim of this study was to evaluate the effect of counseling on self-care management among adult patients with pulmonary tuberculosis (T.B). **(Pinto, de Carvalho Lira, Fernandes, Beraldo, da Silva Sobrinho, da Silva, & Villa, 2016).** Regarding socio-demographic characteristics, the present study revealed that the nearest half of the sample was male and female. More than one quarter was in an age group above 40 years and was married; the majority of them follow Muslims religious, nearest half of them have free works, more than one quarter had tertiary level of education and obtained their tuberculosis treatment from 4-6 months. These findings go in the same line with **Fagundez, Perez Eyene, Momo, Biyé, Esono, & Herrador et al., 2016**

Concerning patient's with pulmonary T.B knowledge, the current study revealed that the mean of total scores of patient's knowledge regarding pulmonary Tuberculosis were 4.53 ± 2.49. This finding goes in the same way with Kigozi, Heunis, Engelbrecht, van Rensburg, & van Rensburg, **2017** who highlighted on the role of patient's knowledge and awareness and emphasis on discovering the context of knowledge and treatment gap among patients suffering from TB, in South Africa. Furthermore, **Eltabey, 2016** clarified that patients who had limited knowledge about TB were more likely to delay seeking care. In Egypt, the media played a major role where the main source of information about TB delivered by health staff of chest settings.

Regarding patients with pulmonary T.B perceptions and beliefs of their treatment and barriers to compliance with DOTs methods, the present study revealed that there is a statistically significant difference was found for all items of patient's perceptions of barriers to compliance with DOTS methods. Moreover, nearest half of them perceived that the advantages of pulmonary Tuberculosis treatment are to reduce transmission of disease and beliefs that stop medications according to doctor order and the majority of them perceived that pulmonary tuberculosis could be cured. This finding goes in the same line with There were significant correlations among barriers of compliance with treatment , family support, and self-care which family support and patient's habits is considered as influencing factors on self-care in TB patients (**Cho & Kwon, 2013**)

In Africa, **Fagundez, Perez Eyene, Momo, Biyé, Esono, & Herrador et al., 2016,** recommended that early identification and treatment is considered as the most efficient method to control TB. On the other hand, Non-adherence to treatment regimen among patients with T.B is a difficult, dynamic phenomenon with a wide range of barriers that impacting on treatment-manners.

In Iran, **Jadgal, Nakhaei, Alizadeh, Zareban &Sharifi , 2015**, necessitated on educating people based on the Health Belief Model (HBM) has powerful effects on their knowledge, self-care approaches, and manners among patients with pulmonary tuberculosis and recommended the audiovisual media especially among illiteracy based on Health Belief Model to those patients regarding changing their attitude , perception , self-care practices which affected their personal hygiene and health behavior .

In Nigeria, Guimarães, Amorim, da Silva Ferreira, Barbosa, Farias & Lopes, **2018** stated that the level of non-adherence to anti-TB drugs among TB patients in Arab Minch governmental health institutions is high it could be related to several factors as time consuming during waiting at the health facility, the distance to the health facility, and fear of drug side effects. The other determinants such as educational levels, bad habits, treatment supporter, and monthly income. While in India, Kumar et al., 2018 reported that poor living conditions, malnutrition, shanty housing and overcrowding are the main determinants for wide spread of T.B.

In china, **Xu,** Markström, Lyu & Xu, **2017** found that appropriate educational strategies and simplified media are required as a tool for health-care providers to help rural TB patients adapt and compliance with their treatment regimen

Regarding patient's self-care practice, the present study revealed that there are a statistically significant were found for all items of patient's self-care practice with mean10.66 ± 2.57 of total scores of self-care practices. Additionally, there are a significant correlation were found between total scores patient's self-care practice with their knowledge. These findings supported with **Sadipun, Dwidiyanti & Andriany, 2018** who necessitated on that self-care practice strategies and family well-being are vital factors to develop physical and health well-being among tuberculosis patient. Consequently, treatment regimens, which integrate those factors, are important to enhance self-care practices among those patients. As well as**, Pinto, de Carvalho Lira, Fernandes, Beraldo** & **da Silva Sobrinho, et al., 2016,** emphasized on implementing educational intervention programs which affect the level of knowledge and self-care practice among patients with pulmonary T.B .

In Iran, **Zare, Asadi, Vahedian Shahroodi & Bahrami-Taghanaki, 2016,** discovered a significant relationship between the self-care practices, self-efficacy, perceived barriers, and

interpersonal influences in smear-positive tuberculosis patients and suggested implementing appropriate health promotion strategies model for effective interventions and enhancing self-care manner among these patients.

Conclusion

From the foregoing discussion, we can conclude that there is a lack of critical knowledge, the perception among patients with T.B needed to understand their disease, self-care practice, drug adherence that affects their compliance with T.B. In addition, our results highlight the importance of self-efficacy in TB treatment adherence.

Recommendations

There are obvious needs for design health education program to patients with T.B regarding self-care practice, drug adherence, to elevate their level of awareness, enhancing beliefs and attitude regarding tuberculosis treatment. Which correct TB knowledge is important for attaining successful treatment outcomes.

Further Research:

A prospective cohort study must be carried to establish the association between knowledge and self-care practices regarding tuberculosis treatment. This can form a basis for developing a protocol mentioned above since it can show the trend of the effects of therapy. The finding may enable healthcare providers to anticipate and intervene in a timely and effective manner.

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