Management of Tuberculosis in Taiwan:A Look into the Shared Responsibilities of the Government, General Public and Medical Students

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Abstract

Tuberculosis (TB) is a deadly infectious disease worldwide due to its high incidence and mortality rate. Its impact on Taiwan is no exception. This paper aims to examine effectiveness of national policies on TB control, assess public awareness, and evaluate whether involvement of medical students would have a positive effect towards TB control in Taiwan.

Literatures were first reviewed to assess effectiveness of Directly Observed Treatment, Short-course (DOTS). Although there is limited improvement in treatment success in Taiwan, there is an overall positive effect.

Questionnaires designed to assess public knowledge and behaviors revealed inadequate public knowledge about DOTS, which could have led to the lack of distinct success in the national policy.

Healthcare workshops were conducted by medical students, with survey results showing a significant improvement in participants' knowledge. Thus, medical students are recommended to engage in healthcare activities to effectively aid TB control.

Keywords: tuberculosis; directly observed therapy; medical students; health knowledge, attitudes, practice

Introduction and Objectives

Epidemiology and pathological basis.

In recent years, tuberculosis (TB) has been rated as the infectious disease of highest incidence in Taiwan[1,2]. The number of newly reported cases in Taiwan reaches over 13,000 annually, with high risk groups including seniors, diabetics, and AIDS individuals[1]. This is an astounding number when compared to other developed countries[3].

The ease of TB dispersion along with difficulties in controlling makes tuberculosis a serious issue to be confronted. TB is a bacterial infection with strong transmission capabilities through aerosol droplets, and it can be lethal if left untreated. Early symptoms of TB are similar to other milder conditions: coughing, fatigue, weight loss, and loss of appetite. Such conditions often prolong proper diagnosis and treatment, thus increasing the probability of further infection. Efforts to contain the disease are also hindered by the majority (>90%) of the patients being latent carriers, during which period they are asymptomatic and unable to actively transmit the disease[4]. However, as the immune system of the carrier lowers, TB would progress to an active state, and the patient could spread the bacteria to others[5].

Recent TB Treatment and Control Policies.

The treatment plan for TB is a rigorous course of a minimum of six months of continuous antibiotic medications to eliminate *M. tuberculosis*. If the treatment course was ineffective or otherwise terminated prematurely, TB may resurface in the affected individual. Regimens shorter than 6 months are not as effective at preventing relapse as regimens longer than 6 months[6]. Such recurrent TB bacteria may sometimes develop strong drug resistance, known as multi-drug resistant tuberculosis (MDR-TB). Patients with MDR-TB would require stronger medications and much longer treatment procedure for a potential recovery.

To combat the spread of TB, in 2006 the government implemented a detailed plan to halve the incidence rate of TB in Taiwan in the next ten years. The plan includes surveillance programs to monitor influx of potential TB patients, procedures to isolate infected individuals, and evaluation of existing vaccine and medications. Furthermore, significant efforts are dedicated to incorporate the recommended policy from the World Health Organization (WHO): Directly Observed Treatment, Short-course (DOTS). DOTS is an efficient TB control strategy, which objective is to make sure tuberculosis patients are completely cured and given support and care. Health care workers make sure patients take medications regularly, report adverse reactions and side effects, and help patients fully recover from TB.

The DOTS strategy is comprised of five components:

1. Political commitment with increased and sustained financing
2. Case detection through quality-assured bacteriology
3. Standardized treatment with supervision and patient support
4. An effective drug supply and management system

5. Monitoring and evaluation system and impact measurement

Since the implementation of DOTS in 2006, the percentage of patients who were successfully treated improved, but data up to 2008 suggest that Taiwan has yet to reach the acceptable standards of WHO[1,2]. It is likely that DOTS did not reach the standards of WHO in its early implementation because it lacks distinction from normal practices. Comparison of DOTS and self-administered therapy (SAT) concluded no significant difference in cure rate and treatment success rate between the two groups[7].

Nevertheless, cultural influences could have made aforementioned studies unfit to compare with Taiwan. For example, Pakistani hold great stigma towards tuberculosis patients. The reluctance to adhere to DOTS was noted in the high default rate presented (>25%)[8]. Poor economy of various countries may contribute to lower efficacy of DOTS, as they may not have adequate resources to fully support DOTS program. In other cases, however, cultural factors may actually increase a patient's responsiveness to outreach health workers[9].

Objectives.

In order to elucidate these conflicting evaluations regarding DOTS in Taiwan, we decided to evaluate the effectiveness of DOTs in Taiwan versus that of other countries through systematic data review. Next, we would hypothesize on the reasons for the nation's limited progress in stemming the spread of TB since the DOTS implementation. To form and validate our hypothesis, we progressed towards several objectives:

1. Understanding the government policy (specifically DOTS) in Taiwan
2. Assessing the knowledge and attitude of the public through questionnaires
3. Determining whether increased awareness and involvement of medical students through healthcare workshops would have positive effects towards TB control

Methods

To reach our objectives, we performed three simultaneous research methods. First was to identify the challenges in Taiwan through paper evaluation to assess whether DOTS implementation affects treatment outcome of TB patients. Another procedure was to interview the Director of STD and TB Prevention of Taiwan CDC to gain an understanding of Taiwan's current challenges regarding TB treatment and prevention. Finally, a survey was conducted to understand social awareness and knowledge of the general public. Additionally, health education workshops were hosted for specific population groups, and the changes in knowledge and attitude are analyzed using a repeat survey after the presentation.

Regarding survey conduction, this paper designed a series of questions fit for statistical analysis to obtain first-hand data from a variety of population groups. The questionnaire consists of three sections that inquire about basic personal information, TB knowledge, and behavior towards TB patients. A pilot study was first performed to test the reliability and validity of said

questionnaire. Professionals in public health, statistical analysis, and TB prevention physician were consulted to evaluate the survey questions. After revisions were performed upon their suggestions, we distributed the questions to a small, known population group (ten medical students, ten non-medical college students) to proceed with our pilot study. From the results of the surveys, we determined the Cronbach's α value, verified the cohesiveness amongst the questions, and prepared the formal survey two types of study.

Study 1: Knowledge and Attitude Assessment for the Six Study Groups

The overall and pair-wise comparisons among the six population groups (senior citizens (SC), elementary students (ES), high school students (HS), college students of non-medical majors(CS), junior medical students (1^{st} and 2^{nd} year - JMS) and senior medical students(4^{th} and 5^{th} year - SMS)) with respect to the percentage of correct answers were assessed by logistic regression analysis. Total knowledge score was computed, and a summary statistics including mean, standard deviation, median, and range were calculated for each study group. Overall and pair-wise comparisons among the six groups with respect to the total knowledge score were evaluated by one-way analysis of variance (ANOVA).

Study 2: Pre- and Post- Health Care Educational Program Evaluation for TB

The same statistical methods described above were applied to each set of the pre- and post- knowledge and attitude test assessments. For this evaluation, three groups (ES, HS, SC) of the earlier six populations participated. The summary statistics for the difference between post- minus pre-test scores were presented for each group. Group comparisons with respect to the difference in post- versus pre-test scores were assessed by analysis of covariance (ANOVA). For each study group, within-group and among-group comparisons were assessed by least square means (LSMeans) along with the corresponding 95% confidence interval (CI) and p-value for the difference between post- and pre-test scores. The p-values for all-possible pair-wise comparisons among the three groups were adjusted by the Bonferroni test. All analyses were performed using SAS software window version 9.0 (SAS Institute, Cary, NC).

Results

Evaluation of efficacy of DOTS in Taiwan.

As the effectiveness of DOTS also depends on cultural and psychosocial factors, the unappealing results observed in Volmink and Garner's report do not necessarily imply that DOTS would not bring a beneficial effect when carried out in Taiwanese community. Studies on the efficacy of DOTS have thus far indicated a positive response in Taiwan.

In a randomized controlled clinical trial, the effect of having a case manager who directly oversaw DOTS in the initial intensive phase was studied. The treatment group with DOTS during the intensive phase significantly outperformed the treatment group without DOTS in terms of treatment success rate (DOTS: 93.7%; non-DOTS: 68.6%). Furthermore, significantly lower adherence

was observed in the group without DOTS (DOTS: 0.0%; non-DOTS: 21.9%)[10]. The results indicated that solely long distance follow-up may be inadequate to enhancing patient adherence and that the DOT component could be influential.

In one clinical trial carried out in Hualien County, Taiwan, between January 2004 and December 2006, the treatment success rate (89.3%) using DOTS in combination with a 62-dose treatment program was significantly higher than the treatment success rate for new smear-positive cases of the country in the years 2004-2006, when DOTS had not been applied to all TB patients. In this study, all patients underwent a treatment program consisting of three phases, and their 26-week course of treatment was directly observed at their home or workplace by either nurses or community health worker[11] (Table 1).

In another pilot study in Kinmen County between 2004 and 2005, every new TB patient in Kinmen, Taiwan was given a choice to participate in DOTS. A higher treatment success rate was observed in patients in the DOTS program (DOTS: 83.3%; non-DOTS: 45.5%)[12].

A quantitative analysis of all newly reported sputum smear positive cases in the years 2005 and 2006 in Taiwan also showed a significant improvement with DOTS implementation. A follow-up of the patients 12 months after the initiation of treatment showed that within sputum smear positive patients, there was a significant difference in treatment success rate when the patients are supervised by DOTS (DOTS: 75.1%; non-DOTS: 51.6%)[13].

Knowledge and attitude assessment of six populations.

While DOTS brought beneficial outcomes in assisting patients, the limited progress in treatment success necessitates the act of finding how to improve. To validate the hypothesis that public knowledge and attitude of TB is not at appropriate standards, which led to inefficiency of DOTS and other TB preventative measures, knowledge and behavior assessments were performed among six population groups.

In the knowledge assessment comparison, significant difference of scores among the 6 groups was noted. Out of a total of 1120 surveys conducted, the mean total knowledge score was lowest in ES, while SMS had the highest rank among the 6 groups. Groups CS, HS, and JMS have scores of no noticeable difference amongst them (ES < SC < CS = HS = JMS < SMS: $p < 0.0001$) **(Table 2)**.

For the attitude assessment comparison, there were significant differences in the total behavior scores among the six groups. The mean attitude score was lowest for SMS and JMS, with no apparent difference between them. Groups ES and SC shared the highest attitude rank among the 6 groups (SMS = JMS < CS = HS < ES = SC: $p < 0.0001$) **(Table 3)**.

Comparison of pre- and post- test scores from healthcare education.

In addition to assessments in knowledge and behavior of the general public, another survey was conducted to evaluate the effects of public health workshops. Three population groups (ES, HS, SC) were asked to complete

another survey and have their responses evaluated. Significant improvement of survey scores in both knowledge and attitude sections from before and after the healthcare workshop on TB was observed ($p < 0.0001$). The pre-test score in knowledge was highest in HS, followed by SC, and lowest in the ES group. Post-test scores revealed that the HS group improved most significantly thus maintained its top rank amongst the three population groups. However, there was no distinct difference in the post-test scores between SC and ES groups (HS > SC = ES) **(Table 4)**.

The attitude portion of the pre- and post-test comparisons revealed significant improvement of post-test score for all 3 groups combined ($p < 0.001$). Upon comparison of improvement between each group, the pre-test score was highest in SC, which was followed by ES and lowest in the HS group (SC = ES > HS). Comparison of post-test scores revealed a similar outcome with SC scoring better than HS. In terms of amount of improvement, all three groups advanced equally (SC = HS = ES) **(Table 5)**.

Discussions

The Challenges of DOTS in Taiwan.

In the studies performed in Taiwan thus far, there has been a significant positive effect by DOTS. A steady increase in the treatment success rate has been observed over the years. WHO has set a goal to surpass a case detection rate of 70% and a treatment success rate of 85%. While Taiwan has done well by reaching 81% in case detection in 2007, there is still room for improvements in terms of treatment success. When compared with several developed countries, Taiwan has a significantly lower treatment success rate[1]. A compilation of findings from literature and interview with Dr. Chin-Hui Yang from CDC of Taiwan has identified the following factors:

Insufficient resources for DOTS: Although the government has increased both its budget and outreach workers to support DOTS, there has been few non-governmental organizations (NGO) participating. Currently, the only known NGO supporting DOTS is the Taiwan Anti-Tuberculosis Association. Increased collaboration with more local hospitals would provide patients with easier access to medication and education[13].

Delayed diagnosis and treatment: Increased transmission and infection could arise with delayed diagnosis and treatment procedures. Between 2002-2006, 24.9% of the TB patients experienced delayed diagnosis (>9 days between first medical examination to final diagnosis) and 20.3% experienced delayed treatment (>2 days before initiation of treatment after confirmed diagnosis)[14, 15]. Thus, raising awareness and vigilance of first-line physicians is essential for improved diagnosis and treatment procedures.

Improper medication: While WHO has defined a standardized treatment regimen with specific antibiotics, some patients continue to use non-standardized drugs, or take incorrect dosages[13]. This may increase treatment failure rate. Specification of current treatment protocols should be reinforced with physicians and healthcare workers. Appointment of local TB specialists

could also provide timely consultations.

Non-standardized monitoring system: Inappropriate interaction between outreach worker and patient could also affect treatment outcome. Healthcare workers having improved understanding of the treatment program could better deal with the various side effects caused by anti-tuberculosis medications, thus improving treatment success rate. Aside from education, outreach workers should also increase communication with physicians to quickly relay patient concerns.

Low adherence to medication or refusal of participation in DOTS: Patients may stop taking medication once the symptoms alleviate, or they would reduce the dosage to lessen the side effects (gastrointestinal upset) of anti-TB drugs[10]. Also, patients could find it troublesome to have daily visit from healthcare workers, and some patients prefer to conceal their illness[12]. A better understanding of the TB treatment plan through health education would improve the adherence issue.

Uneven demographic distribution of TB population in Taiwan: In Taiwan, more than 50% of TB patients are seniors of age 65 or older. Many of these patients pass away due to non-TB related factors but are considered as treatment failures. Furthermore, a substantial number of TB patients are of aboriginal background and are located in remote areas. Such patients have issues of delayed treatment due to a scarcity of medical resources in the location they reside[15].

Evaluation of survey questions of the six population groups.

SMS have a more thorough and broader knowledge of TB as they have received the highest total score and have outperformed other groups in each question. JMS*[1], CS, and HS show no significant difference in their understanding because of the similar educational background on the subject. SMS also have a better knowledge of the current policy as they would have acquired relevant information from courses on public health. A greater percentage of HS know about the current policy than CS and JMS, possibly because of increased campaign against TB at school in response to recent TB outbreaks in Taiwan. Most SC had lived through the mid-20th century when TB was one of the most lethal diseases of the time, and they were therefore knowledgeable about TB concepts that can be acquired through life experience, such as transmission path and symptoms.

SC hold the most positive attitudes toward TB, while SMS are the least alert to potential threats of TB and are the least likely to take active preventative measures when they themselves have infectious disease. Our results show that SC normally do not pay attention to the length of their coughs. Knowing that SC is a high-risk group of TB in Taiwan, this is a concern to current TB prevention policy, which recommends ordering a sputum test for TB infection when coughs last longer than 3

[1] *According to Taiwanese medical education curriculum, courses in Med I and Med II are mainly basic sciences and general education. Courses on public health and infectious diseases are taught during Med III.

weeks. SC should therefore be a focus target of public health education. After interviewing several medical students and college students, we discovered that these groups of students have a greater confidence about their health conditions, believing that they would not contract the disease despite knowing the consequence of infection. They therefore are less active about taking volitional preventative measures. This result agrees with a previous study which shows a negative correlation between age of adolescents and tendency to wear facemask during a pandemic.

ES are active and willing to participate in disease prevention measures, even though their knowledge could be weak. This demonstrates that Taiwan's education curriculum has successfully raised a correct concept of disease prevention with younger students. Knowledge that are directly related to prevention measures (transmission mechanism, better prevention methods) should be emphasized with these younger students to help them more effectively protect themselves and others.

Effectiveness of health education.

By comparing the effectiveness of health education across different groups, we have found that health education brings more positive impacts to HS than to ES and SC. This can be attributed to the better ability of HS to learn through lecture-style education method. We recommend incorporating more dynamic interactions in the health education programs delivered to elementary school students and seniors.

The post-test results on knowledge of TB show that HS performed significantly better than ES and SC, although no significant difference in attitude improvement was observed between the groups. A correlation coefficient test indicates that there is no significant correlation between having a good attitude and equipment of knowledge. We conclude that attitude does not improve over a short period of time, and this agrees with previous studies[16-18].

From our results, outreach health education programs delivered by medical students are an effective method to effectively raise public awareness of TB, and we should encourage medical students to commit to similar programs **(Figure 1)**.

Summary and recommendation.

Although by the time this paper is completed, our TB healthcare programs have not yet been extended to medical students, studies have shown that educational interventions on healthcare workers are a feasible and beneficial addition to the DOTS strategy[19-23]. Our finding that medical students are passive to taking preventative measures and less alert to the potential dangers of infectious disease also calls for the necessity to implement these interventions, either through medical school curriculums or through practical physician education. Training should improve the physicians' awareness to suspect the disease and to deliver prompt and standardized treatment that adheres to governmental standards.

The results of our survey also indicated that most people may conceal information when their family members

contract TB, which is consistent with prior studies that investigate stigma associated with TB[24]. Previous research has identified "fear for infection" as the main reason for stigma, and we should take this into consideration when we design our health education materials[25].

This study has demonstrated the positive efficacy of health education programs led by medical students. We propose medical students to become engaged in the following initiatives to help raise public attention on TB:

1. Health education programs
2. Film screenings and talks
3. Collaboration with student organizations to deliver healthcare materials to remote areas

Application of TB-related activities through social networking (ex. Facebook) to raise public awareness

Conclusions

The current study explores the status of TB prevention and treatment in Taiwan from three perspectives: government, general public, and medical students. Reviews from literature and interview demonstrate an overall positive impact of DOTS to treatment outcome. The existing obstacles, however, have led us to investigate the awareness and attitude of general public as well as the beneficial outcome of health education led by medical students. Our results indicate that medical students of Taiwan (JMS, SMS) are well educated in treating tuberculosis as a disease, but they seem to lack proper behaviors to prevent the spread of infectious diseases such as TB. Therefore, further education to emphasize the importance of correct public health behavior is highly recommended. In contrast, ES and SC appear to have appropriate prevention behaviors. However, they lack detailed knowledge of TB itself. Such deficit in understanding can be remedied through educational health workshops hosted by medical students or health care professionals. The promising success of our health education programs encourages the continuous involvement of medical students in hosting educational seminars in society. Such experiences would benefit both the medical students as well as the society.

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Study	Hsieh 2007	Su 2007	Lin 2011
Time of study	May 2002 - Jul. 2003	Jan. 2004 - Dec. 2005	Jan. 2004 - Dec. 2006
Location	Taipei City	Kinmen County	Hualien County
Study type	Randomized controlled clinical trial	Cohort studies	Case series
Randomization	Stratified randomization	No randomization	No randomization
Sample size	96 (32: 32: 32)	23 (12: 11)	84
DOT supporter	case manager	nurse, outreach worker	hospital staff, nurse, outreach worker
Treatment success	(1) DOT during intensive phase & in-hospital education: 93.7% (2) in-hospital education: 68.6% (3) no intervention: 68.6%	(1) DOTS: 83.3% (2) non-DOTS: 45.5%	All patients received DOTS: 89.3%

Table 1. Recent studies on the efficacy of DOTS in Taiwan

Table 2. TB knowledge assessment[ǂ]

	Number (%) of Subjects Providing Correct Answer to Each Item							
Knowledge Assessment Item	**(1) SC[o] (N = 78)**	**(2) HS (N = 158)**	**(3) ES) (N = 54)**	**(4) CS (N = 278)**	**(5) JMS (N = 351)**	**(6) SMS (N = 201)**	**All Groups Combined (N = 1120)**	**Among Groups Comparison P-value[a]**
1. Transmission path	66 (84.62%)	131 (82.91%)	16 (29.63%)	245 (88.13%)	328 (93.45%)	197 (98.01%)	983 (87.77%)	<0.0001*
Ranking	**ES < SC = HS = GS <JMS< SMS**							
2. Symptoms	71 (91.03%)	138 (87.34%)	20 (37.04%)	254 (91.37%)	326 (92.88%)	195 (97.01%)	1004 (89.64%)	<0.0001*
Ranking	**ES < HS= SC = GS =JMS< SMS**							
3. Treatment	34 (43.59%)	106 (67.09%)	16 (29.63%)	139 (50.00%)	211 (60.11%)	154 (76.62%)	660 (58.93%)	<0.0001*
Ranking	**ES = SC=GS < JMS=HS < SMS**							
4. Risk groups	1 (1.28%)	35 (22.15%)	4 (7.41%)	92 (33.09%)	160 (45.58%)	155 (77.11%)	447 (39.91%)	<0.0001*
Ranking	**SC =ES < HS <GS < JMS< SMS**							
5. Prevention	59 (75.64%)	136 (86.08%)	24 (44.44%)	243 (87.41%)	315 (89.74%)	191 (95.02%)	968 (86.43%)	<0.0001*
Ranking	**ES <SC=HS =GS < JMS< SMS**							
6. Policy	5 (6.41%)	68 (43.04%)	5 (9.26%)	28 (10.07%)	39 (11.11%)	113 (56.22%)	258 (23.04%)	<0.0001*
Ranking	**SC=ES = GS =JMS<HS < SMS**							
Total Score of Knowledge Assessment Mean ± SD Median (Minimum, Maximum)	3.026 ± 0.939 3 (1, 5)	3.886 ± 1.432 4 (0, 6)	1.574 ± 1.722 1 (0, 5)	3.601 ± 1.253 4 (0, 6)	3.929 ± 1.155 4 (0, 6)	5.000 ± 1.118 5 (0, 6)	3.857 ± 1.439 4 (0, 6)	<0.0001*

Ranking of Total Score	**ES < SC < GS = HS =JMS< SMS**		

[o] **SC:** senior citizens**; HS:** high school students**; ES**: elementary school students**; CS:** college non-medical school students**; JMS:** junior medical students, year 1 and 2**; SMS:** senior medical students, year 4 and 5**.**

[ᵠ] Including only pre-test assessment for Senior citizen, high school , and elementary school students. There were 6 items for knowledge assessment with a maximum total score of 6

[a] p-value for among group comparison in the % of subjects providing correct answer to each item was based on chi-square test.

p-value for overall among group comparison in the total knowledge score was based on one-way analysis of variance adjusted by Bonferroni test for all possible pair-wise comparisons

* Significant: p-value < 0.05.

Table 3. TB attitude assessment[ᵠ]

Attitude [a] Assessment Item	**Mean ± SD Median (Minimum, Maximum)**							
	(1) SC[o] (N = 78)	**(2) HS (N = 158)**	**(3) ES (N = 54)**	**(4) CS (N = 278)**	**(5) JMS (N = 351)**	**(6) SMS (N = 201)**	**All Groups Combined (N = 1120)**	**Among Groups Comparison P-value[b]**
1. TB is a disease still requiring to be worried in Taiwan nowadays	4.53 ± 0.60	4.30 ± 0.70	4.26 ± 0.94	4.13 ± 0.73	3.87 ± 0.74	4.05 ± 0.79	4.09 ± 0.77	<0.0001*
	5 (3, 5)	4 (2, 5)	5 (2, 5)	4 (2, 5)	4 (1, 5)	4 (1, 5)	4 (1, 5)	
Ranking	**JMS< SMS= GS = ES = HS< SC**							
2. I would put mask on whenever I have cough	4.54 ± 0.57	3.78 ± 0.86	4.11 ± 1.04	3.64 ± 0.92	3.42 ± 0.94	3.48 ± 0.94	3.65 ± 0.96	<0.0001*
	5 (3, 5)	4 (2, 5)	5 (1, 5)	4 (1, 5)	3 (1, 5)	4 (1, 5)	4 (1, 5)	
Ranking	**JMS= SMS< GS = HS <ES < SC**							

3. When I have cough, I would pay attention to the duration and whether there is sputum or mucus produced	4.45 ± 0.60 4.5 (3, 5)	4.01 ± 0.89 4 (2, 5)	4.13 ± 0.89 4 (2, 5)	3.98 ± 0.78 4 (1, 5)	3.98 ± 0.73 4 (2, 5)	3.98 ± 0.73 4 (1, 5)	4.03 ± 0.78 4 (1, 5)	<0.0001*
Ranking	**GS = JMS= SMS=ES =HS < SC**							
4. I would not feel uncomfortable being with TB patients	3.41 ± 1.10 3 (1, 5)	3.18 ± 1.19 3 (1, 5)	3.48 ± 1.21 3 (1, 5)	3.21 ± 1.07 3 (1, 5)	3.09 ± 0.93 3 (1, 5)	2.90 ± 0.99 3 (1, 5)	3.14 ± 1.05 3 (1, 5)	0.0002*
Ranking	**SMS< JMS= HS = GS =SC = ES**							
5. I would not deliberately conceal if I or my family member(s) contract(s) TB	3.90 ± 1.09 4 (1, 5)	3.72 ± 1.02 4 (1, 5)	4.06 ± 1.32 5 (1, 5)	3.80 ± 0.85 4 (1, 5)	3.63 ± 0.84 4 (1, 5)	3.57 ± 0.95 4 (1, 5)	3.71 ± 0.94 4 (1, 5)	0.0011*
Ranking	**SMS= JMS= HS = GS =SC = ES**							
Total Score of Attitude Assessment Mean ± SD Median (Minimum, Maximum)	20.82 ± 2.79 20 (15, 25)	18.99 ± 2.81 19 (12, 25)	20.04 ± 3.69 21 (10, 25)	18.77 ± 2.77 19 (11, 25)	18.00 ± 2.46 18 (11, 25)	17.98 ± 2.98 18 (5, 25)	18.62 ± 2.88 18 (5, 25)	<0.0001*
Ranking of Total Score	**SMS = JMS < GS = HS <ES= SC**							

[o] **SC:** senior citizens**; HS:** high school students**; ES**: elementary school students**; CS:** college non-medical school students**; JMS:** junior medical students, year 1 and 2**; SMS:** senior medical students, year 4 and 5**.**

[a] Each attitude item was based on a Likert scale ranging from 1 to 5 , higher score indicate better attitude with a maximum total score of 25.

[b] P-value was based on one-way analysis of variance including group as the only factor in the model adjusted by Bonferroni test for all possible pair-wise comparisons

* Significant: p-value < 0.05.

Table 4. TB Knowledge Assessment (a Total of 6 Items): Pre- vs. Post-Test Score

Group	Number of Subjects:	Knowledge: Pre-Test Score		Knowledge: Post-Test Score		Difference: Post-Test Score - Pre-Test Score			
		Mean (SD)	Median (Range)	Mean (SD)	Median (Range)	Mean (SD)	Median (Range)	LS Means (95% CI)[b]	P-value[b]
1) Senior Citizens (SC)	78	3.026 (0.939)	3 (1 to 5)	4.474 (1.028)	5 (2 to 6)	1.449 (0.989)	2 (-1 to 4)	1.291 (1.097, 1.484)	P <0.0001*
2) High School Students (HS)	158	3.886 (1.432)	4 (0 , 6)	5.728 (0.560)	6 (3 , 6)	1.842 (1.412)	2 (-2, 6)	2.369 (2.225, 2.513)	P < 0.0001*
3) Elementary School Students (ES)	54	1.574 (1.722)	1 (0 , 5)	4.185 (1.415)	5 (0 , 6)	2.611 (1.806)	2.5 (0, 6)	1.297 (1.036, 1.558)	P < 0.0001*
All Groups Combined	290	3.224 (1.629)	4 (0 , 6)	5.103 (1.139)	5 (0 , 6)	1.879 (1.447)	2 (-2, 6)	1.879 (1.765, 1.994)	P < 0.0001*
Overall difference among groups[c]:		P < 0.0001* **(Group 2 > 1 > 3)**		P < 0.0001* **(Group 2 > 1 = 3)**				P < 0.0001* **(Group 2 > 3 = 1)**	
Pair-wise Comparison among Groups[c]:									
a) Group 1 vs. 2		P < 0.0001*		P < 0.0001*				P < 0.0001*	
b) Group 1 vs. 3		P < 0.0001*		P = 0.0732				P = 0.9685	
c) Group 2 vs. 3		P < 0.0001*		P < 0.0001				P < 0.0001*	

Abbreviation: CI stands for confidence interval.

* Significant: p-value < 0.05.

[a] There were 5 items for TB attitude assessment. Higher score indicates better attitude. The maximum total score was 25.

[b] LSMeans, 95% CI, and p-value for assessing the difference between post -vs. pre—test score were based on analysis of covariance including groups of subjects as the major factor adjusting for
pre-test score as the covariate in the model.

[c] P-values for overall and pair-wise comparison among the 3 groups were based on:
- one-way analysis of variance for pre- and post-test score including groups of subjects as the major factor in the model; and
- analysis of covariance for difference in post- vs. pre-test score including groups of subjects as the major factor adjusting for pre-test score as the covariate in the model.

Table 5. TB Attitude Assessment (a Total of 5 Items): Pre- vs. Post-Test Score

Group	Number of Subjects:	Attitude Pre-Test Score		Attitude Post-Test Score		Difference: Post-Test Score - Pre-Test Score			
		Mean (SD)	Median (Range)	Mean (SD)	Median (Range)	Mean (SD)	Median (Range)	LS Means (95% CI)[b]	P-value[b]
1) Senior Citizens (SC)	78	20.82 (2.79)	20 (15 to 25)	21.81 (2.50)	22 (15 to 25)	0.987 (2.515)	1 (-6 to 7)	1.508 (0.980, 2.036)	P <0.0001*
2) High School Students (HS)	158	18.99 (2.81)	19 (12 to 25)	20.71 (2.85)	21 (14 to 25)	1.715 (2.853)	1 (-5 to 12)	1.402 (1.033, 1.772)	P < 0.0001*
3) Elementary School Students (ES)	54	20.04 (3.69)	21 (10 to 25)	20.93 (3.21)	21.5 (15 to 25)	0.889 (2.424)	0 (-2 to 10)	1.052 (0.429, 1.676)	P = 0.0010*

All Groups Combined	290	19.68 (3.08)	20 (10 to 25)	21.04 (2.86)	21 (14 to 25)	1.366 (2.708)	1 (-6 to 12)	1.366 (1.097, 1.634)	P < 0.0001*
Overall difference among groups [c]: Pair-wise Comparison among Groups [c]: a) Group 1 vs. 2 b) Group 1 vs. 3 c) Group 2 vs. 3		P < 0.0001* **(Group 1 = 3 > 2)** P < 0.0001* P = 0.1390 P = 0.0273*		P = 0.0195* **(Group 1 > 2, 1= 3, 2=3**) P = 0.0054* P = 0.0796 P = 0.6271				P = 0.5193 (Group 1 = 2 = 3) P = 0.7516 P = 0.2708 P = 0.3438	

Abbreviation: CI stands for confidence interval.

* Significant: p-value < 0.05.

[a] There were 5 items for TB attitude assessment. Higher score indicates better attitude. The maximum total score was 25.

[b] LSMeans, 95% CI, and p-value for assessing the difference between post -vs. pre—test score were based on analysis of covariance including groups of subjects as the major factor

adjusting for pre-test score as the covariate in the model.

[c] P-values for overall and pair-wise comparison among the 3 groups were based on:

- one-way analysis of variance for pre- and post-test score including groups of subjects as the major factor in the model; and
- analysis of covariance for difference in post- vs. pre-test score including groups of subjects as the major factor adjusting for pre-test score as the covariate in the model

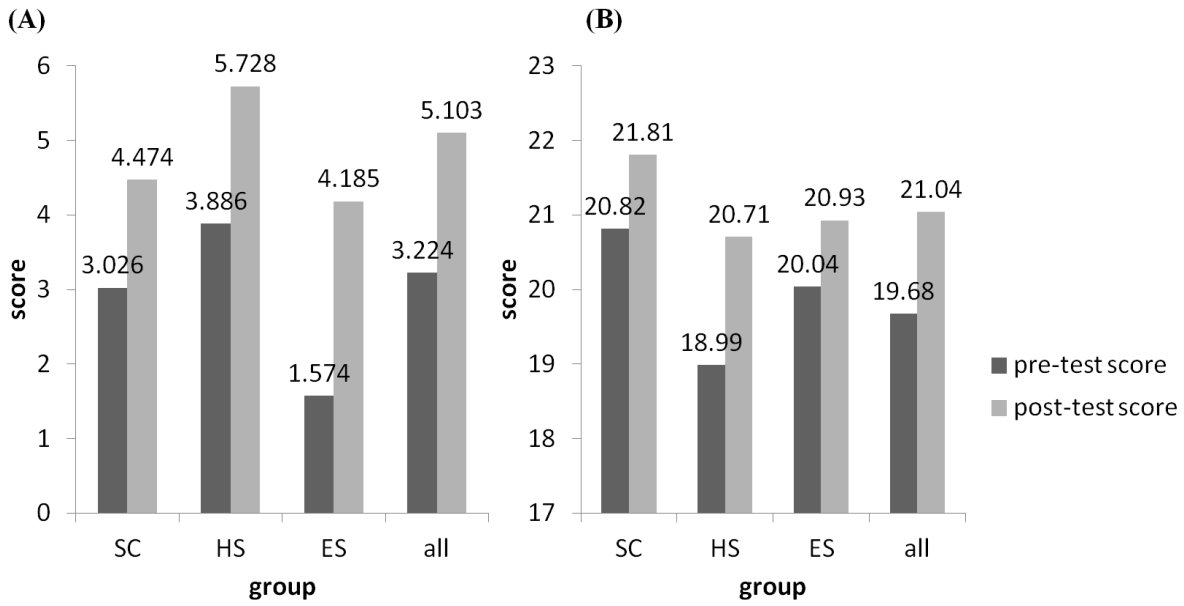

Figure 1. Comparison of Pre-Test and Post-Test Scores. (A) assessment of knowledge (B) assessment of attitude.