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Original Article

Validation of an instrument to assess knowledge, attitudes, and practices on tuberculosis among health care workers in Colombia

Validación de un instrumento para evaluar conocimientos, actitudes y prácticas sobre tuberculosis, en los trabajadores de la salud en Colombia

Validação de um instrumento para avaliar conhecimentos, atitudes e práticas sobre tuberculose em profissionais da saúde na Colômbia

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Author Contributions

HNUP. *Conceptualization, research, data curation, writing original draft.* ***AIMS.*** *Conceptualization, validation, supervision, writing, reviewing, and editing.* ***MIP.*** *Methodology, software, formal analysis.* ***YLMC.*** *Writing, reviewing, and editing.*

ABSTRACT

Introduction. Tuberculosis persists in the national epidemiologic scenery; 289 cases of tuberculosis in healthcare workers were notified in 2022; this disease in sanitary workers is related to low levels of knowledge, deficient self-care measures, and low health attention quality. This study's objective was to validate an instrument for the evaluation of knowledge, attitudes, and practices about tuberculosis in healthcare workers. **Methodology.** Methodology study. Five experts validated the content, the face validation with 32 healthcare workers (HW), and construct validation with 140 HW. The inclusion and exclusion criteria depend on the validation phase. Data was processed in SPSS. **Results.** The instrument comprises three dimensions: knowledge, attitudes, and practices, and 43 items. The content validation procedure revealed a global content validation index of 0.96. The face validation demonstrated the understandability of the items in 84%. The exploratory factorial analysis ratified the conformation of the three dimensions with a sampling adequacy measure of Kaiser-Meyer-Olkin (0.741). Finally, the instrument reached an Alpha of Cronbach global of 0.72. **Discussion.** In Colombia, no validated and reliable instruments that evaluated this topic were identified. Different investigations in the world have indicated the utility and effectiveness of this type of tool. **Conclusions.** The instrument "evaluated" in workers showed content, construct, and face validity to measure knowledge, attitudes, and practices about tuberculosis in healthcare workers.

Keywords:
Validation Study; Health Knowledge, Attitudes, Practice; Health Personnel; Tuberculosis; Education, Continuing

RESUMEN

Introducción. La tuberculosis persiste en el escenario epidemiológico nacional, en el país se notificaron 289 casos de tuberculosis en trabajadores de la salud en el 2022, esta enfermedad en los trabajadores sanitarios está relacionada con los bajos niveles de conocimiento, las medidas de autocuidado deficientes y baja calidad de atención en salud. El objetivo del estudio fue validar un instrumento de evaluación de conocimientos, actitudes y prácticas sobre tuberculosis en trabajadores de la salud. **Metodología.** Estudio metodológico. Se validó el contenido con 5 expertos, la validación de apariencia con 32 trabajadores de la salud (TS) y la validación de constructo con 140 TS. Los criterios de inclusión y exclusión dependen de la fase de validación. Los datos fueron procesados en SPSS. **Resultados.** El Instrumento se conforma de tres dimensiones: conocimientos, actitudes y prácticas, y 43 ítems. La validación de contenido alcanzó un Índice de Validez de Contenido Global de 0.96. La validación de apariencia demostró la comprensibilidad de los ítems en un 84%. El análisis factorial exploratorio ratificó la conformación de las tres dimensiones con una medida de adecuación muestral de Kaiser-Meyer-Olkin (0.741). Finalmente, el instrumento alcanzó un Alfa de Cronbach global de 0.72. **Discusión.** En Colombia no se identificaron instrumentos validados y confiables que evaluaran esta temática. Diferentes investigaciones en el mundo han señalado la utilidad y efectividad de este tipo de herramienta. **Conclusiones.** El instrumento en trabajadores "evaluado" mostró validez de contenido, constructo y apariencia para medir conocimientos, actitudes y prácticas sobre la tuberculosis en trabajadores de la salud.

Palabras clave:
Estudio de Validación; Conocimientos, Actitudes y Práctica en Salud; Personal de Salud; Tuberculosis; Educación Continua

RESUMO

Introdução. A tuberculose persiste no cenário epidemiológico nacional, no país foram notificados 289 casos de tuberculose em trabalhadores de saúde em 2022, esta doença em trabalhadores de saúde está relacionada a baixos níveis de conhecimento, medidas de autocuidado deficientes e baixa qualidade dos cuidados de saúde. O objetivo do estudo foi validar um instrumento para avaliação de conhecimentos, atitudes e práticas sobre tuberculose em trabalhadores da saúde. **Metodologia.** Estudo metodológico. A validação de conteúdo foi realizada com 5 especialistas, a validação de aparência com 32 trabalhadores de saúde (TS) e a validação de construto com 140 TS. Os critérios de inclusão e exclusão dependem da fase de validação. Os dados foram processados no SPSS. **Resultados.** O Instrumento é composto por três dimensões: conhecimentos, atitudes e práticas, e 43 itens. A validação de conteúdo alcançou Índice de Validade de Conteúdo Global de 0.96. A validação de aparência demonstrou a compreensibilidade dos itens em 84%. A análise fatorial exploratória confirmou a formação das três dimensões com medida de adequação amostral Kaiser-Meyer-Olkin (0.741). Por fim, o instrumento atingiu um Alfa de Cronbach global de 0.72. **Discussão.** Na Colômbia não foram identificados instrumentos validados e confiáveis que avaliassem esta questão. Diferentes pesquisas ao redor do mundo

têm apontado a utilidade e eficácia deste tipo de ferramenta. **Conclusões.** O instrumento "avaliado" em trabalhadores apresentou validade de conteúdo, construto e aparência para mensurar conhecimentos, atitudes e práticas sobre tuberculose em trabalhadores de saúde.

Palavras-chave:
Estudo de Validação; Conhecimentos, Atitudes e Prática em Saúde; Pessoal de Saúde; Tuberculose; Educação Continuada

Introduction

Tuberculosis (TB) is an infectious-contagious disease caused by *Mycobacterium tuberculosis*. According to the World Health Organization (WHO), in 2022, it was estimated that 10.6 million people got TB in 2021, and 1.6 million people died due to it (1). In labor health terms, all over the world, 9,299 cases of TB in healthcare workers were reported (1).

In Colombia, in 2022, 17,460 cases of TB were reported, with an incidence rate of 31 cases per 100,000 people; 84.9% corresponded to cases of pulmonary TB, and 15.1% cases were extrapulmonary TB. Equally, it was reported 12% of coinfected cases with TB and human immunodeficiency virus (HIV), and in total, 213 cases of drug-resistant TB were presented (2).

This disease is considered a risk factor that can affect the well-being of healthcare workers. Different investigations have demonstrated that the probability of contagion is two or three times higher in this population group than in the general population (3,4). Also, it has been related to low levels of knowledge about TB, with deficient control measures at the administrative level and personal protection that increases the risk of transmission between people and healthcare personnel (5-8). In this sense, evaluating objectively the knowledge, attitudes, and practices (KAP) about TB of the healthcare workers, allows the identification of strengths and weaknesses to develop effective and efficient strategies that increase self-care and care for everyone else (7,8).

The measurement instruments are tools that allow quantifying constructs. To achieve this objective, they must undergo validation processes that guarantee the confirmability and validity of the collected data (9). The WHO has developed a methodology guide to orient the development of valid and reliable instruments that allow the evaluation of KAP based on promotion, communication, and social mobilization activities (10).

Scientific literature evidenced different instruments that measure KAP in continents like Asia and Africa, where the translation and adaptation processes were unviable because epidemiologic, normative, and cultural contexts differed from the Colombian contexts (11,12). Conversely, no valid or reliable instruments have evaluated KAP on TB among healthcare workers in Colombia.

For this reason, the objective of this investigation was to design and validate an evaluating instrument of KAP on TB healthcare workers in Colombia.

Methodology

Study design

Content, face, and construct validation study of the instrument knowledge, attitudes, and practices about TB for healthcare workers (KAP-TB in workers) (13-15) (Figure 1).

Sample

Content validity

Five experts participated for the content validity indices, following the recommendations of Tristan-Lopez (16) to be able to use a modified Lawshe index for each of the items.

Face validation

For the face validity study, 32 healthcare workers were enrolled, the minimum sample number recommended by Perneger et al. (17), which allows to know if there is confusion about any item and if healthcare professionals have suggestions for possible improvements to the items. Likewise, having this validation allows us to have an approximate idea of the distribution of the response to each item, which can be informative to determine if there is enough variation in the response.

Construct validation

Regarding the validation of the construct, because 44 items and three dimensions are expected, that is, there are 15 items per factor, the criteria given by Mundfrom (18) are considered. In this case, it is guaranteed that with at least 100 healthcare workers, we have an excellent level to obtain correlations between items and good performance of the factor analysis. Furthermore, according to the criteria given in Comrey (19), with at least 132 healthcare workers, we will have a ratio of 3 workers to 1 item, guaranteeing a good level of adequacy of the factor analysis. Therefore, with 140 healthcare workers, a good construct validity performance was obtained.

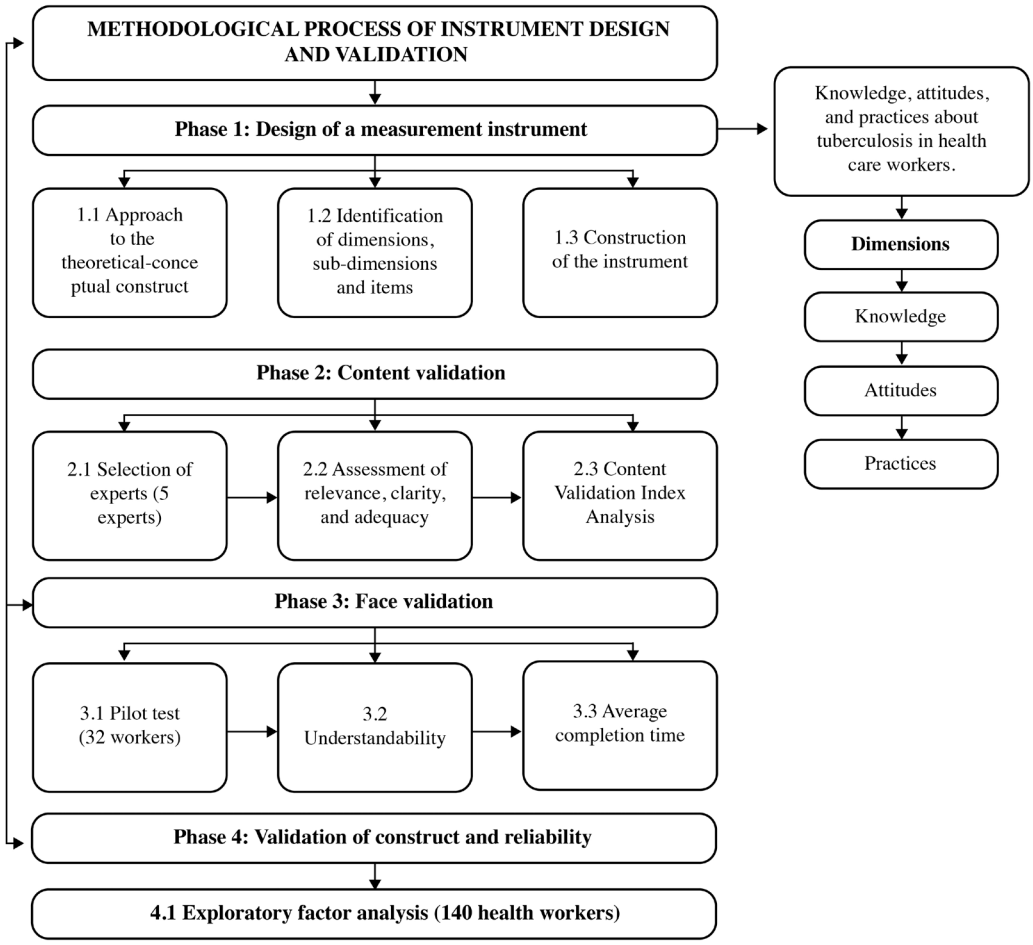

Figure 1. Methodological process of instrument design and validation
Source: Adapted from Cruz OA (15).

Inclusion and exclusion criteria

Content validation

The experts enrolled in the content validation were required to have at least five years of academic or professional experience related to TB in the Colombian context, experience in instrument validation psychometric processes in the healthcare sector and agree to participate. Those experts who sent their evaluation outside the established times were excluded.

Face validation

The inclusion criteria in the face validation phase were workers from a healthcare institution, technicians or professionals in the healthcare industry, a minimum of one year's experience in TB-related issues, having internet access, and a computer or smartphone. Workers with a history of TB and students studying healthcare sciences were excluded.

Construct validation

Finally, the workers included in the construct validation had to be healthcare personnel with employment contract, have access to the internet and a mobile device or computer, and sign the informed consent. Workers with a history of TB and healthcare science students were excluded.

Data collection

Data collection was carried out in phases. Content validity was assessed through a panel of five experts. The judges evaluated the sufficiency, clarity, and relevance (20-22) through a scale from one to four (1. Does not meet the criteria, 2. Low level, 3. Moderate level, and 4. High level) (23).

In the face validation, the understandability of the KAP-TB in healthcare workers was assessed. The instrument was evaluated through the Google Forms platform, where the participants were asked directly whether each item

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was understandable; it was applied to 32 healthcare workers.

Finally, construct validation was carried out using the latest version of the KAP-TB instrument in healthcare workers through a Google form between November and December 2020; it was applied to 140 healthcare workers.

Type of analysis

Content validity

For content validity, the validity agreement between the judges was calculated and measured with the Lawshe Content Validity Index by item (CVR') and Global (CVI). The following formulas were used (16,24):

- Formula for content validity modified for each item:

$$CVR = \frac{n_e - n/2}{n/2}$$

Where:

ne = Number of experts who have agreement on the category per item.

n = Total number of experts

The adjusted validity index was used as an acceptance criterion for item validity:

$$CVR' = \frac{CVR + 1}{2}$$

The criterion "Correction of the minimum value of the CVR" used to accept each item was CVR'> 0.583. Each item must be 58% acceptable, regardless of the number of evaluators (16).

Face validation

On the other hand, in face validation, a descriptive and qualitative analysis of the questions was carried out to identify percentages of clarity. In those items where the user expressed concerns, adjustments were made to the writing and grammar of the question.

Construct validation

Finally, construct validation was carried out with 140 healthcare workers. An exploratory factor analysis was carried out for this validation using the Kaiser-Meyer-Olkin measure of sampling adequacy (>0.60). Additionally, Bartlett's test of sphericity was applied to identify that the correlation between the items of the instrument is significant ($p<0.001$) (25,26). In the same way, Cronbach's Alpha was calculated to quantify the instrument's reliability level. The information was entered and refined in Excel version 2019 and processed in SPSS version 25.0.

Ethical considerations

Regarding ethical considerations, in this research, the national and international provisions related to research ethics, outlined in Resolution 8430 of 1993 of the Ministry of Health (27), were respected. In addition, this research had ethics approval 013-19 from the Faculty of Nursing of the Universidad Nacional de Colombia. The participants in each phase voluntarily signed the informed consent in which they agreed to participate.

Results

• *Literature review*

A total of 14 articles were selected. The instrument's development was identified to measure validated and reliable KAP in most countries with a high incidence of TB in Asia and Africa (23.10%) (6,8,28–32) (Table 1).

Three evaluating dimensions of the instrument were recognized: knowledge, attitudes, practices, and the items that conformed to each dimension. The following components were identified in the knowledge dimension: the etiology, transmission, control measures, treatment, and diagnosis of TB in the transversal studies revised (6,8,32,33). The attitudes were more heterogenic; not all the instruments evaluated them (5,33–35); however, the perceptions against TB as a labor disease, control measures, feelings, and stigma were the most frequent aspects. The practice dimension was also not considered in all the revised articles (8,29,32). Still, the items related to the development of controlled activities and prevention, the use of personal protection, and the contact investigation of people affected with TB were highlighted.

• *Instrument design*

Three principal dimensions (knowledge, attitudes, and practices) and an initial version of 44 items were established. Subsequently, the knowledge scale was defined as correct and incorrect. For attitude and practice, a Likert scale was used: never, rarely, frequently, almost always, and always.

Table 1. Literature review on KAP measurement instruments, 2020.

N°	Author	Country	Instrument	Validation	Components	Measurement Results
1	Van Rensburg AJ et al. (5)	South Africa	52-items questionnaire.	Validated and reliable with a previous pilot study.	Sociodemographic characteristics, knowledge, attitudes, and practices.	Nurses do not have adequate knowledge, attitudes, and practices to enable self-care and care for others from TB.
2	Cruz-Martínez ÓA (6)	Colombia	25-items questionnaire.	Validation of content in a previous pilot test.	Sociodemographic characteristics and knowledge.	It was found that 34% of workers had medium knowledge, 27% had low knowledge, and only 7% had high knowledge.
3	Noé A et al. (7)	Mozambique	79-items questionnaire.	Validity by experts (a physician, a scientist, and an epidemiologist).	Sociodemographic characteristics, knowledge, attitudes, and practices.	Deficient knowledge was identified in health workers, which meant adverse outcomes in care.
4	Carvajal-Barona R et al. (8)	Colombia	16-items questionnaire (knowledge and attitudes).	Cognitive interview with pilot study.	Sociodemographic characteristics, attitudes, perceptions and practices.	According to the assessment, the workers have knowledge about TB and good management. However, there are risky infection control practices and attitudes that report stigma towards TB.
5	Trajman A et al. (28)	Brazil	23-items adapted questionnaire.	Validation by experts (3 researchers) and a pilot study with ten students and 30 people (content validity).	Sociodemographic characteristics, knowledge, and practices.	Seventy-six percent of participants knew how to prevent TB; however, there was a gap in differentiating latent infection from active TB (64%), among other things.
6	Gaspar LM da S et al. (29)	Brazil	28-items Structured questionnaire (13 of knowledge, 5 attitudes and 10 of practices).	Validation with experts (specialists) and pilot study with 20 participants (content validity).	Sociodemographic characteristics. Knowledge, attitudes, and practices.	A significant study population showed satisfactory knowledge about TB related to appropriate practices.
7	Romani FR et al. (30)	Peru	14-items questionnaire.	Validation by experts and content in a previous pilot test.	Sociodemographic characteristics, knowledge, attitudes, and practices.	The study identified a knowledge gap among health personnel.

8	Bhebhe LT et al. (31)	Lesotho	57-items questionnaire.	Validated content with a previous pilot study with six people.	Sociodemographic characteristics, knowledge.	Harmful practices and critical knowledge gaps were found.
9	Irani A et al. (32)	Iran	44-items questionnaire.	Validity with experts in epidemiology, microbiology, and the TB program. A pilot study of 30 persons. Cronbach's α coefficients for knowledge (0.76) and attitudes (0.75)	Sociodemographic characteristics, knowledge, attitudes, and practices.	Good knowledge and attitudes were obtained from health workers in the TB area.
10	Alotaibi B et al. (33)	Saudi Arabia	47-items questionnaire.	Validity and reliability: Cronbach's α coefficients for knowledge 0.78, attitude 0.72, and practices 0.86 (study with 20 participants).	Sociodemographic characteristics, knowledge, attitudes, and practices.	There were positive results but significant gaps in knowledge and some attitudes and practices.
11	Ramathebane MM et al. (34)	Lesotho	8-items questionnaire.	Pre-pilot study - content validity.	Sociodemographic characteristics and knowledge.	In general terms, knowledge of TB was inadequate.
12	Alene KA et al. (35)	Ethiopia	18-items questionnaire.	It is validated by experts and a pilot study with 20 healthcare workers.	Sociodemographic characteristics, knowledge, and practices.	The study found low knowledge and inadequate practices.
13	Ou Y et al. (36)	China	32-items adapted questionnaire.	--	Sociodemographic characteristics, knowledge, and attitudes.	Deficient knowledge is reported among medical students.
14	Montagna MT et al. (37)	Italy	20-items questionnaire.	Pilot study with 30 students: Cronbach's α coefficients of 0.83.	Sociodemographic characteristics and knowledge.	Sufficient knowledge of TB was reported.

Source: prepared by authors.

● *Content validation*

The content validation was realized through a panel of five experts in TB disease who have experience in psychometric processes of instrument validation for health measurement. The 44 items obtained a CVR', sufficiency greater than 0.58. The global index of sufficiency was 0.97. The consensus was reached in two rounds.

The clarity evaluation process indicated that 43 items obtained a CVR superior of 0.58. The only item underneath the limit was question 17, "Is extrapulmonary tuberculosis diagnosed with tissue samples?" (CVR' 0.40). The global index in terms of clarity was 0.95.

In the case of relevance, all the items reached the index of Lawshe's Adjusted Validity, achieving a Global Content Validation Index, which was 0.96 (Table 2).

Table 2. Evaluation of the adequacy, clarity, and relevance of the Tuberculosis Knowledge, Attitudes, and Practices Instrument for health care workers.

	Sufficiency			Clarity			Relevance		
Ítem	Consensus	CVR	CVR'	Consensus	CVR	CVR'	Consensus	CVR	CVR'
KNOWLEDGE									
1. Is pulmonary tuberculosis an infectious disease?	5	1	1	5	1	1	5	1	1
2. Is tuberculosis a curable disease?	5	1	1	5	1	1	4	0.6	0.8
3. Is the causative agent of tuberculosis a bacterium?	5	1	1	5	1	1	4	0.6	0.8
4. Is Mycobacterium tuberculosis sensitive to heat and light?	5	1	1	4	0.6	0.8	5	1	1
5. Can tuberculosis affect any part of the body?	5	1	1	5	1	1	5	1	1
6. Are healthcare workers considered a population at risk of developing tuberculosis?	4	0.6	0.8	4	0.6	0.8	4	0.6	0.8
7. Is pulmonary tuberculosis transmitted through the respiratory route in the form of aerosols?	5	1	1	5	1	1	5	1	1
8. Does a person with latent tuberculosis infection transmit the disease?	5	1	1	4	0.6	0.8	5	1	1
9. Does a person with untreated pulmonary tuberculosis transmit the disease?	5	1	1	4	0.6	0.8	5	1	1
10. Does a person with pulmonary tuberculosis usually transmit the disease after 15 days of treatment?	5	1	1	5	1	1	5	1	1
11. Is Sputum Smear Microscopy the best-known diagnostic technique for pulmonary tuberculosis?	5	1	1	5	1	1	5	1	1
12. Are molecular tests the most effective way to diagnose pulmonary tuberculosis?	5	1	1	5	1	1	5	1	1
13. Is chest radiography an aid in the diagnosis of pulmonary tuberculosis?	5	1	1	5	1	1	5	1	1
14. Does the tuberculin test diagnose latent tuberculosis infection?	5	1	1	5	1	1	5	1	1
15. Should three sputum specimens be collected to diagnose pulmonary tuberculosis?	5	1	1	5	1	1	5	1	1

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16. Can extrapulmonary tuberculosis be diagnosed with the culture of the affected organ, blood, histopathological, or molecular tests?	5	1	1	5	1	1	5	1	1
17. Can any health professional request a serial Sputum Smear Microscopy?	5	1	1	3	-0.2	0.4	5	1	1
18. Are there standardized schemes in Colombia to manage pulmonary tuberculosis?	5	1	1	5	1	1	5	1	1
19. Does the standardized treatment scheme for drug-susceptible pulmonary tuberculosis last for one year?	4	0.6	0.8	4	0.6	0.8	4	0.6	0.8
20. Do patients hospitalized with pulmonary tuberculosis during the first weeks of treatment require airborne isolation?	4	0.6	0.8	4	0.6	08	4	0.6	0.8
21. Should the N95 respirator be used by the patient with pulmonary tuberculosis during the first days of treatment?	5	1	1	5	1	1	5	1	1
22. Should the surgical mask be used by patients with pulmonary tuberculosis in the first days of their treatment?	5	1	1	5	1	1	5	1	1
23. Does the surgical mask protect a healthcare worker from pulmonary tuberculosis droplets?	5	1	1	5	1	1	5	1	1
24. In the general population, what symptoms are present in pulmonary tuberculosis?	5	1	1	5	1	1	5	1	1
25. Which of the following risk factors make you more susceptible to developing pulmonary tuberculosis?	5	1	1	5	1	1	5	1	1
ATTITUDES									
26. Do you consider yourself at risk for tuberculosis?	5	1	1	5	1	1	4	0.6	0.8
27. Have you ever been afraid of getting sick with tuberculosis?	5	1	1	5	1	1	5	1	1
28. If you became ill with tuberculosis, would you inform your co-workers of your illness?	4	0.6	0.8	4	0.6	0.8	4	0.6	0.8
29. If you became ill with tuberculosis, would you inform your family members of your illness?	5	1	1	5	1	1	5	1	1
30. If you got sick with tuberculosis, would you inform your friends about your illness?	5	1	1	5	1	1	5	1	1
31. how often would you avoid enclosed public places if you became ill with tuberculosis?	5	1	1	5	1	1	5	1	1
32. If a co-worker was diagnosed with tuberculosis, how often would you support him/her?	5	1	1	5	1	1	5	1	1

33. If a co-worker was diagnosed with latent tuberculosis infection, how often would you avoid contact with him/her?	4	0.6	0.8	4	0.6	0.8	4	0.6	0.8
PRACTICES									
34. Do you actively look for respiratory symptoms in your patients?	5	1	1	5	1	1	5	1	1
35. Do you request serial Sputum Smear Microscopy for a patient with respiratory symptoms?	5	1	1	5	1	1	5	1	1
36. Do you separate a patient with a permanent cough from other users in the health institution?	5	1	1	5	1	1	5	1	1
37. Do you use the N95 respirator when in contact with a newly diagnosed pulmonary tuberculosis patient?	5	1	1	5	1	1	5	1	1
38. Do you use a surgical mask when in contact with a patient with pulmonary tuberculosis?	5	1	1	5	1	1	5	1	1
39. Do you offer a surgical mask to a patient with pulmonary tuberculosis during the initiation of treatment at the health care facility?	5	1	1	5	1	1	5	1	1
40. Do you offer an N95 respirator to a patient with pulmonary tuberculosis during the initiation of treatment at the health care facility?	5	1	1	5	1	1	5	1	1
41. Do you wash your hands before caring for a patient with pulmonary tuberculosis?	5	1	1	5	1	1	5	1	1
42. Do you wash your hands after caring for a patient with pulmonary tuberculosis?	5	1	1	5	1	1	5	1	1
43. Do you airborne isolate a hospitalized patient with pulmonary tuberculosis during the first weeks of treatment?	5	1	1	5	1	1	5	1	1
44. Do you educate the patient with tuberculosis and/or respiratory symptomatology? a. Tuberculosis disease b. Hand hygiene c. Hand washing d. Tuberculosis control measures in the home. e. Adherence to anti-tuberculosis treatment.	5	1	1	5	1	1	5	1	1
	Global Sufficiency Index	**0.97**		**Global Clarity Index**	**0.95**		**Global Relevance Index**	**0.96**	

Source: prepared by authors.

- ***Face validity***

A pilot test was conducted with 32 healthcare workers to evaluate how understandable the instrument items were (Table 3). The understandability of the instrument items reached 84%. Seven questions received observations and were subjected to a revision of clarity, content, and grammar by the investigators. Six questions were adjusted, and question 31 was deleted from the attitudes dimension, achieving a second version of 43 items.

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Table 3. Sociodemographic characteristics of healthcare workers pilot test, 2020.

Sociodemographic variables	N	%
Sex		
Female	30	93.8
Male	2	6.3
Age		
< 30	4	12.6
30-39	14	43.7
40-49	9	28.1
>= 50	5	15.5
Educational level		
Technician or technologist	12	37.5
Professional degree	8	25.0
Postgraduate degree	12	37.5
Occupation		
Nursing Assistant	9	28.1
Nurse	11	34.4
Bacteriologist		18.8
Public health technician	3	9.4
Psychologist	2	6.2
Social Worker	1	3.1
Time of work experience		
< 2 years	1	3.1
2-5 years	1	3.1
6-10 years	14	43.8
>10 years	16	50.0

Source: prepared by authors.

• *Construct validity*

Exploratory factorial analysis

An exploratory factorial analysis was conducted with 140 healthcare workers to validate the construct. The knowledge items were grouped into three factors, the attitudes, and practices in one factor each. The pertinence of the factorial analysis was evaluated with Kaiser-Meyer-Olkin sampling adequacy, which was 0.741, and Bartlett's sphericity test demonstrated that the matrix items are significantly correlated ($p < 0.001$). Finally, the intern consistency was evaluated, and a Cronbach's Alpha of 0.72 was obtained.

The factors selection with the criteria of the eigenvalues greater than two, was fulfilled three factors with an explained variance of 44.70%. Each of the factors was presented as follows: F1 – knowledge (23.50%), F2 – attitudes (11.50%), and F3 – practices (9.70%).

In the evaluation of factorial weights or loadings of each instrument item, the second factor of knowledge is the one that contributes more weight to the construct (two with high positive correlations and one with high negative correlation). In the third factor of practices, the highest weights were observed in items 28, 29, 30 y 3 (high positive correlations) (Table 4).

Table 4. Exploratory factor analysis. Matrix of factor loadings of the rotated factors.

Question	Factor		
	1	2	3
knowledge			
F1	0.025	**0.375**	-0.250
F2	-0.100	**-0.447**	0.084
F3	-0.004	**0.500**	0.123
Attitudes			
p26	0.211	0.177	-0.224
p27	0.199	-0.205	-0.169
p28	0.054	-0.002	0.755
p29	0.093	0.011	**0.767**
p30	-0.019	-0.189	**0.487**
p31	0.145	0.111	**0.558**
p32	-0.030	-0.651	0.072
Practices			
p33	**0.432**	0.424	0.121
p34	**0.423**	0.107	-0.036
p35	**0.433**	-0.161	0.010
p36	**0.246**	0.044	0.125
p37	**0.300**	-0.117	-0.185
p38	**0.381**	0.165	-0.119
p39	**0.216**	-0.485	0.014
p40	**0.824**	-0.178	0.136
p41	**0.830**	-0.147	0.064
p42	**0.463**	-0.175	-0.019
p43a	**0.640**	0.568	0.007
p43b	**0.692**	0.414	0.039
p43c	**0.717**	0.120	0.135
p43d	**0.670**	0.448	0.062
p43e	**0.649**	0.495	0.080

Source: prepared by authors.

Items 26, 27, and 32 were not part of the attitudes factor. However, they are not excluded from the final version of the instrument cause of the consensus and expertise of the authors; they are considered relevant to this dimension evaluation.

Finally, the KAPTB-HW instrument, which has 3 dimensions and 43 questions, is validated.

Discussion

The KAP-TB instrument for healthcare workers has undergone successful validation of its content, comprehensibility, and construct through a systematic, statistical, and reliable process. The validation of questionnaires within the healthcare field is a crucial process, ensuring the reliability and validity of data collection; our study provides a robust instrument for assessing the knowledge, attitudes, and practices related to TB among healthcare workers.

It is important to note that studies on the three dimensions among healthcare workers in Latin America are very scarce or even unexisting, despite the region being home to countries with a high and medium burden of disease. Most relevant research in these areas is conducted in African and Asian countries: this disparity underscores a gap in Latin American research and reveals the region's scarcity and low quality of research processes.

Additionally, some studies measure the KAP regarding TB in healthcare workers using instruments lacking demonstrated validation or reliability (38,39), or with validation limited to face (40). This scenario introduces information bias, as data collected through unvalidated instruments risks producing unreliable yet statistically significant information. Hence, the validation of measurement instruments becomes highly relevant, supporting methodological rigor and the generation of reliable results (41).

Next, the validation processes in this research will be compared to those of similar investigations. Irani et al. (32) developed a KAP questionnaire on TB for healthcare workers in Iran, primarily relying on available scientific literature. Unlike this study, content validity was solely assessed qualitatively with a panel of experts. Similarly, Noe et al. (7) employed a KAP instrument on TB for healthcare workers in Mozambique. This instrument was evaluated through a pilot test involving 32 healthcare workers. Conversely, Van Rensburg et al. (5) noted that their pilot study in South Africa enhanced reliability and achieved both face and content validity, as it facilitated clarification of certain dimensions and adjustments to the measurement.

Pradipta et al. (42) developed a KAP instrument tailored for healthcare workers in Indonesia. Their questionnaire was based on recommendations from the WHO KAP survey guide, the national tuberculosis guidelines of Indonesia, and expert consensus. Their methodology is similar to ours, as we also reviewed and incorporated the WHO guide during the instrument development. Additionally, Resolution 227 of 2020 from the Ministry of Health and Social Protection was a foundational reference, and input from field professionals was sought to ensure thoroughness and relevance.

However, there are points of agreement and discrepancies regarding the design of KAP instruments on tuberculosis for healthcare workers. In terms of knowledge, the most relevant aspects to assess are the cause of tuberculosis, modes of transmission, symptoms, signs, diagnosis, and treatment; these elements are included in the instrument used in this study (42,43).

Conversely, various authors have approached the dimension of attitudes differently. An Y. et al. (43) assessed perceptions about the disease within this construct, whereas Pradipta et al. (42) interpreted attitudes in terms of the workers' risks, beliefs, and capacities. In contrast, we defined attitudes as encompassing beliefs, feelings, thoughts, and values towards the disease. Finally, the definition of practices did not present difficulties because, in all the studies, it is related to the activity carried out by the healthcare worker or their duties.

In terms of construct validation, research has been conducted in African countries with a high incidence of tuberculosis to identify KAP regarding childhood TB among different healthcare workers. For example, in Cambodia, the KAP of 330 healthcare workers were evaluated using an instrument that covered three dimensions: knowledge, attitudes, and practices. The evaluation of each dimension achieved a Cronbach's Alpha of 0.856, 0.653, and 0.676, respectively (43).

In Indonesia, a KAP instrument tailored for healthcare workers, particularly pharmacy personnel, was developed and validated. The questionnaire comprised 40 items distributed across three dimensions. Face, content, and construct validity were achieved through a pilot test involving 200 healthcare workers. The instrument demonstrated moderate reliability with Cronbach's Alpha coefficients of 0.63 for knowledge, 0.69 for attitudes, and 0.79 for practices (42).

The Cronbach's Alpha achieved by our instrument was 0.72, which is considered acceptable. This result indicates a moderate correlation between the items. However, it is important to highlight that acceptability criterion can vary depending on the context of its application, the type of scale used, and the population studied.

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Additionally, it is important to mention that instruments have also been designed and validated for patients with TB. Muñoz-Sánchez et al. (12) developed a KAP instrument for people with TB in Colombia. After evaluation by experts and the target population, the instrument proved to be sensitive, reliable, and valid, underscoring its usefulness in measuring health education and its impact on this population. This study is particularly relevant because it represents the first attempt to validate an instrument with this purpose in the country. Scatena et al. (44) validated an instrument in Brazil to evaluate the structure of primary healthcare units in the treatment of TB. They concluded that such tools are useful for determining the feasibility of their application and their potential use in primary care units for tuberculosis treatment.

Given the points mentioned previously, it is recognized how important it is to conduct studies to develop and validate KAP instruments for TB among healthcare workers. These studies are crucial in both public and occupational health domains.

Limitations

We recognize some limitations in the development of the instrument. The attitudes dimension had fewer questions and received a lower rating than the other dimensions. Moreover, it underwent substantial modifications based on feedback from experts and healthcare workers regarding its comprehensibility. These limitations stem from both inherent and external factors related to the instrument, including the selected sample and the wording of the questions.

Furthermore, the COVID-19 pandemic contributed to delays in the data collection process, which is acknowledged as an additional limitation in this study.

Conclusion

It is important to mention that a group of highly skilled thematic and methodological experts validated the results of this study. Additionally, a pilot group of healthcare workers, specialists in TB, adjusted the comprehensibility and grammar. Finally, construct evaluation demonstrated the presence of three robust dimensions with strongly related items.

This process evidences an organized, systematic, and statistically rigorous approach, yielding a validated, reliable, and updated instrument tailored to the Colombian context.

Assessing the KAP of healthcare workers identifies the need for continuous health education within this population, thus strengthening the processes of constant improvement in tuberculosis programs.

It is recommended that the validation processes of this instrument continue to enhance the attitude dimension, ensuring a valid, reliable, and helpful tool for the Colombian context and its target population.

Conflicts of interest

The authors declare that they have no conflicts of interest.

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Ethical responsibilities

Protection of people: This study is considered risk-free due to its nature. It was approved by the Institutional Ethics Committee.

Confidentiality of data: The authors declare they have followed their work center's protocols on the publication of patient data.

Right to privacy and informed consent: The authors have obtained the informed consent of patients and/or subjects mentioned in the article. This document is in the possession of the corresponding author referred to in the article.

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