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Construction and validation of an instrument to assess knowledge about hepatitis B among nurses

Construção e validação de um instrumento para avaliação do conhecimento sobre hepatite B entre enfermeiros

Construcción y validación de un instrumento para evaluar conocimientos sobre hepatitis B entre enfermeros

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ABSTRACT

Objective: To construct and validate an instrument to assess knowledge about hepatitis B among nurses.

Method: Methodological study developed in three stages: theoretical (integrative review, construction of the instrument, content validation by an expert in the subject and semantic validation with the target population), empirical (pilot study with the target population) and analytical (content validity index, Cronbach's alpha and exploratory factor analysis). The target population of the instrument was primary health care nurses in the capital of Piauí, Brazil. Data collection was carried out online from August 2021 to May 2022.

Results: Semantic validation was performed by 20 nurses and the agreement score obtained through the Content Validity Index (CVI) was adequate, above 0.8. In the exploratory factor

analysis, all indicators were within adequate and satisfactory limits, without any cross-loading or Heywood Case issues. Reliability indices also reached adequate levels (α = 0.89; ω = 0.89; and ORION ranging from 0.855 to 0.886 between domains). The final version of the instrument consists of 18 items that are categorized into three dimensions, accounting for an explained variance of 66.76%.
Conclusion: The instrument shows evidence of satisfactory content, appearance and internal structure validity to assess nurses' knowledge about hepatitis B, thus it can be used to support the planning and evaluation of continuing education programs for nurses and undergraduate students.
Descriptors: Knowledge; Hepatitis B; Nurses; Validation studies.

RESUMO
Objetivo: Construir e validar um instrumento para avaliação do conhecimento sobre hepatite B entre enfermeiros.
Método: Estudo metodológico desenvolvido em três etapas: teórica (revisão integrativa, construção do instrumento, validação de conteúdo por especialista na temática e validação semântica com a população-alvo), empírica (estudo piloto com a população-alvo) e analítica (índice de validade de conteúdo, alfa de cronbach e da análise fatorial exploratória). A população-alvo do instrumento foi composta por enfermeiros da atenção primária à saúde da capital do Piauí, Brasil. A coleta de dados foi realizada de forma *online* e compreendeu o período de agosto de 2021 a maio de 2022.
Resultados: A validação semântica foi realizada por 20 enfermeiros e o escore de concordância obtidos por meio do Índice de Validade de Conteúdo (IVC) foi adequado, acima de 0,8. Na análise fatorial exploratória, todos os indicadores estavam dentro de limites adequados e satisfatórios, sem quaisquer problemas de carregamento cruzado ou do Caso Heywood. Os índices de confiabilidade também atingiram níveis adequados (α = 0,89; ω = 0,89; e ORION variando de 0,855 a 0,886 entre domínios). A versão final do instrumento consiste em 18 itens que são categorizados em três dimensões, respondendo por uma variância explicada de 66,76%.
Conclusão: O instrumento exibe evidências de validade de conteúdo, de aparência e estrutura interna satisfatórias para avaliar o conhecimento de enfermeiros sobre a hepatite B, dessa forma poderá ser utilizado para subsidiar o planejamento e a avaliação de programas de educação permanente de enfermeiros e estudantes da graduação.
Descritores: Conhecimento; Hepatite b; Enfermeiras e enfermeiros; Estudos de validação.

RESUMEN
Objetivo: Construir y validar un instrumento para evaluar el conocimiento sobre la hepatitis B entre enfermeros.
Método: Estudio metodológico desarrollado en tres etapas: teórica (revisión integrativa, construcción del instrumento, validación de contenido por un experto en el tema y validación semántica con la población objetivo), empírica (estudio piloto con la población objetivo) y analítica (índice de validez de contenido, alfa de Cronbach y análisis factorial exploratorio). La población objetivo del instrumento fueron enfermeros de atención primaria de salud de la capital de Piauí, Brasil. La recolección de datos se realizó en línea y abarcó el período de agosto de 2021 a mayo de 2022.
Resultados: La validación semántica fue realizada por 20 enfermeras y el puntaje de concordancia obtenido a través del Índice de Validez de Contenido (IVC) fue adecuado, superior a 0,8. En el análisis factorial exploratorio, todos los indicadores estuvieron dentro de límites adecuados y satisfactorios, sin problemas de carga cruzada ni de Caso Heywood. Los índices de confiabilidad también alcanzaron niveles adecuados (α = 0,89; ω = 0,89; y ORION oscilando entre 0,855 y 0,886 entre dominios). La versión final del instrumento consta de 18

ítems que se categorizan en tres dimensiones, lo que representa una varianza explicada del 66,76%.
Conclusión: El instrumento muestra evidencia de validez de contenido, apariencia y estructura interna satisfactoria para evaluar el conocimiento de las enfermeras sobre la hepatitis B, por lo que puede ser utilizado para apoyar la planificación y evaluación de programas de educación continua para enfermeras y estudiantes de pregrado.
Descriptores: Conocimiento; Hepatitis B; Enfermeras y ordenanzas; Estudios de validación.

INTRODUCTION

The infection caused by the Hepatitis B Virus (HBV) has an epidemiological and healthcare impact, as well as affecting the different dimensions that consists the health and Quality of Life (QoL), with the stage of the disease being a factor associated with the greatest impact[1]. HBV is the cause of one of the main public health problems worldwide. Therefore, the infection can equally affect the entire population, however healthcare professionals are part of the most vulnerable group, as they are exposed to occupational and daily risks[2].

Hepatitis B (HB) is responsible for a high annual mortality rate worldwide, comparable to other diseases such as the Human Immunodeficiency Virus (HIV), tuberculosis and malaria. It is estimated that by the year 2040 the number of people diagnosed with hepatitis B may exceed the impact of these three diseases combined[3]. In Brazil, 264,640 confirmed cases of hepatitis B were reported between 2000 and 2021, with different distributions across regions. During this period, it was the second leading cause of death among viral hepatitis, with 17,540 recorded deaths related to this condition[4]. Thus, its priority as a public health issue is justified by its high prevalence, along with its potential for chronicity and the development of cirrhosis, as well as hepatocellular carcinoma[5]. Early diagnosis becomes an essential tool for attenuating its impacts.

Measures favorable to screening, monitoring, complete immunization and investigation of seroconversion are necessary alternatives to promote the adequate assessment of post-exposure prophylactic measures[6]. Also there is evidence of advancements in treatment options, which have proven promising and efficient in reducing complications related to chronic infection, with advances in comprehensive action within the context of Primary Health Care (PHC)[7].

However, healthcare professionals' management of HB cases revealed flaws and contradictions, especially on the identification of these conditions as preventable pathologies, in the approach to reducing occupational exposure, as well as in strategies to interrupt the transmission cycle and epidemiological control, which can difficult prevention, case management and treatment[8].

Along with the expansion of nurses' practice in PHC[9], in which this professional category has assumed the management of healthcare units, it is important to improve their training since undergraduate level, with a view to developing professional skills for comprehensive and decentralized hepatitis care[10]. Moreover, it is important to expand clinical training with the supervision of experts[11], in addition to the participation of Nursing in consolidating advanced practice guidelines[12].

It is observed that, in this population, knowledge about HB is limited, which can lead these professionals to become involved in situations of exposure to the virus, mainly due to the lack of risk perception, reinforced by the lack of knowledge of the forms of transmission, prevention and care after exposure[13]. Therefore, it is important to investigate the knowledge of healthcare professionals about HB as a way of identifying gaps and strengthening adherence to prevention practices.

By assuming technical responsibility in different hepatitis care services, nursing works to achieve the goals agreed upon the 2030 Agenda, in which objective three stands out, which deals with coping with hepatitis. For this goal, resources must be adjusted to strengthen, within the healthcare network, the capacity to connect services and expand testing, integrating monitoring and evaluation as essential tools in health care management[10].

The construction and validation of instruments capable of identifying the level of professional knowledge and limitations that may interfere with the quality of care and occupational safety are fundamental, representing resources that improve health outcomes, such as expanding vaccination coverage and reducing morbidity and mortality rates related to HB.

Given the importance of assessing nurses' knowledge about HB, the following research question emerged: does an instrument to assess nurses' knowledge about HB present evidence of validity and reliability for its applicability in this population? Thus, the objective of this study was to construct and validate an instrument for assessing nurses' knowledge about hepatitis B.

METHOD

The methodology of this study is based on the psychometric framework proposed by Pasquali[14], and structured in three stages – theoretical, empirical and analytical – aimed at the construction and validation of the instrument "Assessment of knowledge about hepatitis B among nurses". The target population of the instrument consisted of nursing professionals working in PHC in the city of Teresina, capital of Piauí. Due to the COVID-19 pandemic, all data collection was conducted virtually.

In the theoretical stage, the instrument's construction and the definition of the domains and evaluation items were carried out after searching, analyzing and synthesizing scientific evidence in national and international databases, based on an integrative review that identified limitations in knowledge, inconsistent attitudes and neglected care practices[13]. Additionally, the Clinical Protocol and Therapeutic Guidelines for Hepatitis B and Coinfections (*Protocolo Clínico e Diretrizes Terapêuticas para Hepatite B e Coinfecções*) of the Ministry of Health (Brazil) was also included as reference material[15].

The themes that emerged from the integrative review and analysis of the Clinical Protocol comprised the domains and items of the instrument. Thus, it was possible to develop the first version of the instrument, which contained 46 items, distributed on a Likert-type scale, with a five-point response options: 1. Strongly disagree; 2. Disagree; 3. Neither agree nor disagree; 4. Agree; 5. Strongly agree.

The content and semantic evaluation of the instrument items was conducted by expert judges in the theme of hepatitis B and the target population (nurses). The selection of content judges was based on criteria adapted from Fehring[16], which consider academic background, professional practice (teaching, research, extension), update course and scientific production in the area of interest. Thus, the search for eligible participants for content validation was conducted based on the scientific production declared on the Lattes Platform of the National Council for Scientific and Technological Development (*Conselho Nacional de Desenvolvimento Científico e Tecnológico* - CNPq), totaling 16 eligible judges.

The number of judges was defined according to the recommendations of Pasquali[14], who suggests prioritizing an odd number, with a minimum of three and an ideal of between six and twenty judges. Of the 16 eligible judges, only eight experts responded to the email containing the invitation letter with guidance for face and content validation, the Informed Consent Form (ICF), the first version of the instrument and the questionnaire on sociodemographic aspects, indicating their acceptance to participate in the research. However, of the eight, one judge did not send their corrections and suggestions, thus the sample consisted of seven expert judges.

Data collection for this evaluation took place from August to December 2021. The Delphi technique was adopted, which seeks consensus from a group of experts, through validations carried out in different phases, cycles, rounds[17]. This procedure consisted of a careful analysis of the dimensions and items of the instrument. The judges evaluated each item of the domain, assigning values from 1 to 3, as follows: 1, keep the item; 2, keep the item after

corrections; and 3, exclude the item. The instrument also had additional space so that the judges could include their considerations and suggestions when they considered necessary.

After the evaluation by the committee of expert judges that recommended changes to the items, modifications were made to those considered inadequate and ambiguous, others were readjusted to better align with the designated situation, with items added according to the experts' opinion, maintaining the instrument's proposal. Thus, version 2 of the instrument was developed, with 42 items. This version was forwarded to the same judges for a new evaluation, based on the suggested proposals, resulting in version 3, with 40 items.

After making the modifications suggested by the expert judges, the instrument was sent to the target population for semantic validation. This stage was conducted in March and April 2022. Nursing professionals who had been working in PHC for at least six months and who scored at least three out of ten points, according to the established criteria, were considered eligible: a minimum of one year of general patient care experience (3 points); specialization in Infectiology or Public Health (3 points); scientific production in the field of interest (2 points); and experience in instrument validation (2 points). Those absent on vacation or any type of leave were excluded.

Initially, the coordination of the Municipal Health Foundation was contacted to obtain telephone contacts of the nurses. Messages were sent individually via Whatsapp® to avoid repeated collections, with information about the research objectives and an invitation to participate with the link to the electronic form via Google Forms®. At the end, the contact information of new nurses was requested, a characteristic of the Snowball sampling method[18]. The semantic validation stage included the participation of 20 PHC nurses, who evaluated version 3 of the instrument.

In the empirical stage, a field study was conducted with 205 participants from the target population, during April and May 2022. The same sampling method was used in the semantic validation stage, which aimed to analyze the psychometric properties of the instrument. The Pasquali[14], framework was adopted, which recommends using five to ten participants for each item of the instrument analyzed, and indicates that factorial analysis should be performed with a sample of at least 200 individuals to be considered adequate. The professionals who participated in the previous stage were not interviewed again to exclude assessment biases.

In the analytical stage, descriptive analyses were performed, such as absolute frequency, percentage, mean, median, standard deviation, minimum and maximum. The data were obtained through validated instruments and grouped into a database, using the Microsoft Office

Excel 2016® and analyzed using the statistical software Statistical Package for Social Sciences version 26.0®.

The values assigned by the judges in each assessment of the instrument were described and obtained using the Content Validity Index (CVI). The recommended cutoff point for this analysis is at least 0.78 for each item (I-CVI) and 0.80 for the overall scale (S-CVI) and preferably greater than 0.90[19]. The internal structure was tested using Exploratory Factor Analysis (EFA), using the Factor program (version 12.05)® for the analyses.

At first, it was verified whether the data matrix could be factored using the sample adequacy measures, the Kaiser-Meyer-Olkin (KMO) criterion; and Bartlett's Sphericity Test, to test the correlation between the component items[20]. KMO values range from 0 to 1 (the higher, the better), with values between 0.5 and 0.7 are considered "mediocre"; values between 0.7 and 0.8 are "good"; between 0.8 and 0.9, "excellent"; and, above 0.9, "magnificent". A significant result of Bartlett's test of sphericity ($p<0.05$) shows that there are some relationships between the variables that are expected to be included in the analysis[20].

The dimensionality test was performed with Robust Parallel Analysis (RPA), using the Optimal implementation of Parallel Analysis (PA)[21]. The polychoric correlation matrix was created using Bayes Modal Estimation[22]. This matrix is recommended for ordinal data. The robustness of the test was determined by associating a bootstrap with sample extrapolation to 500 cases.

The factors were extracted using the Robust Unweighted Least Squares (RULS) technique, which reduces the residuals of the matrix[23]. The Oblique Promax rotation was considered in case of identification of multiple factors, indicating multidimensionality[24]. Therefore, the rotation and extraction method of the matrix used was the unweighted least squares extraction with Promax rotation of the data. Subsequently, the correction for the robust Chi-square was performed with LOSEFER empirical correction[25].

The replicability of the construct was assessed by the Generalized G-H Index, requiring an index greater than 0.80. For the quality of factor score estimates, the factor determination index (FDI) was used to identify adequacy with estimated values greater than 0.90, marginal reliability of the EAP (> 0.80), sensitivity ratio (SR > 2), and expected percentage of true differences (EPTD > 90%)[26].

Reliability was assessed by 3 indicators: ordinal Cronbach's alpha[27] McDonald's Omega[28] and ORION (Overall Reliability of Fully-Informative Prior Oblique N-EAP scores N)[29]. The following were adopted for the model adjustment indices: $\chi 2/df$; Non-Normed Fit Index (NNFI) > 0.95; Comparative Fit Index (CFI) > 0.95; Goodness Fit Index (GFI) > 0.95);

Root Mean Square Error of Approximation (RMSEA) < 0.08; and Root Mean Square of Residuals (RMSR) < 0.06), as recommended[20].

The study was approved by the Research Ethics Committee (REC) of UFPI, with CAAE No. 45569321,9,0000,5214, registered on the *Plataforma Brasil*, and opinion number 4,856,711, in compliance with the Resolution 466/2012 of the National Health Council. All nurses and experts agreed to participate in the research and signed the ICF. Additionally, the anonymity of the participants was guaranteed by creating numeric codes based on the sequence of the instrument feedback.

RESULTS

In the content and appearance validation process of the first version of the instrument, seven judges participated, all female, aged between 36 and 62 years old. All participants had doctoral degrees and up to 30 years of experience in teaching, healthcare, and research.

The professional experience of the expert judges was described in several areas, including higher education and postgraduate teaching; coordination of primary health care; health surveillance, organ donation and transplantation processes; neonatal intensive care unit (NICU); pediatrics; kidney transplant; wound care and dressings; hospital infection control commission (CIC) management; nursing coordination; participation in hospital committees; and clinic management.

As for experience with the theme, most judges had more than 15 years of experience in teaching (57.1%), less than 20 years of experience in healthcare (57.1%), and more than ten years of experience in research (57.1%). Regarding the length of experience with the theme of hepatitis B, four of them had more than 10 years of experience (57.1%).

The agreement indicators regarding the evaluation of the first version of the instrument are shown in Table 1. Most items and domains presented adequate scores, indicating validity of the content. It is evident that, despite the high frequency of CVI equal to or greater than 0.80, as well as the satisfactory overall score (0.83), some items in the domains general aspects (2 and 5), symptomatology (13), phases (19 to 23), treatment (25, 26; 28 to 34) and diagnosis of the disease (44) presented considerable disagreements, resulting in the removal or modification of the content.

In the second evaluation of the instrument, the judges recommended modifications to the content in all dimensions and the removal of items 41 (anti-HIV is a common complementary test to all patients with chronic hepatitis B) and 42 (the diagnosis of chronic hepatitis B is defined as the persistence of the virus or the presence of HBsAg for more than

one year), which consist the diagnostic domain. It is worth noting that the overall score was 0.952, as shown in Table 1.

Table 1. Content Validity Index for each item in the evaluation of the second version of the instrument "Assessment of knowledge about hepatitis B among nurses" by expert judges. Teresina, Piauí, n=7, 2024

Domain/Item	Do not keep item	Keep after corrections	Keep item	
	N(%)	N(%)	N(%)	CVI
General aspects of hepatitis B				
Item 1	-	-	7 (100.0)	1.000
Item 2	-	-	7 (100.0)	1.000
Item 3	-	-	7 (100.0)	1.000
Item 4	-	3 (42.9)	4 (57.1)	1.000
Item 5	-	3 (42.9)	4 (57.1)	1.000
Item 6	-	1 (14.3)	6 (85.7)	1.000
Transmission of hepatitis B				
Item 7	-	-	7 (100.0)	1.000
Item 8	-	2 (28.6)	5 (71.4)	1.000
Item 9	-	1 (14.3)	6 (85.7)	1.000
Item 10	-	-	7 (100.0)	1.000
Item 11	-	-	7 (100.0)	1.000
Item 12	-	1 (14.3)	6 (85.7)	1.000
Symptoms of hepatitis B				
Item 13	-	1 (14.3)	6 (85.7)	1.000
Item 14	-	-	7 (100.0)	1.000
Item 15	-	-	7 (100.0)	1.000
Item 16	-	-	7 (100.0)	1.000
Item 17	1 (14.3)	1 (14.3)	5 (71.4)	0.857
Serological markers				
Item 18	-	3 (42.9)	4 (57.1)	1.000
Item 19	-	1 (14.3)	6 (85.7)	1.000
Item 20	-	1 (14.3)	6 (85.7)	1.000
Item 21	-	1 (14.3)	6 (85.7)	1.000
Item 22	-	4 (57.1)	3 (42.9)	1.000
Item 23	-	2 (28.6)	5 (71.4)	1.000
Item 24	-	-	7 (100.0)	1.000
Follow-up and treatment of hepatitis B				
Item 25	-	1 (14.3)	6 (85.7)	1.000
Item 26	-	-	7 (100.0)	1.000
Item 27	-	2 (28.6)	5 (71.4)	1.000
Item 28	-	1 (14.3)	6 (85.7)	1.000
Item 29	-	1 (14.3)	6 (85.7)	1.000
Item 30	-	-	7 (100.0)	1.000
Immunization against hepatitis B				
Item 31	-	-	7 (100.0)	1.000
Item 32	-	-	7 (100.0)	1.000
Item 33	-	-	7 (100.0)	1.000
Item 34	-	1 (14.3)	6 (85.7)	1.000
Item 35	-	1 (14.3)	6 (85.7)	1.000
Item 36	-	0 (0.0)	7 (100.0)	1.000
Item 37	-	1 (14.3)	6 (85.7)	1.000
Diagnosis of hepatitis B				
Item 38	-	1 (14.3)	6 (85.7)	1.000
Item 39	-	1 (14.3)	6 (85.7)	1.000
Item 40	1 (14.3)	1 (14.3)	5 (71.4)	0.857
Item 41	6 (85.7)	-	1 (14.3)	0.143
Item 42	6 (85.7)	1 (14.3)	-	0.143

Total	14 (4.76)	34 (11.6)	246 (83.67)	0.952

Source: Research data, 2024.
Legend: *CVI: Content validity index.

The semantic validation was performed by 20 nurses working in PHC, mostly were female professionals, 17 (85%); with an average age of 34.10 (SD=8.28) years; and income equal to or greater than four minimum wages, 10 (50%). The majority declared themselves to be brown, 13 (65%); single, 12 (60%); Catholic, 13 (65%); without children, 12 (60%); and from Teresina, 14 (70%).

The professional profile showed that the majority of participants had worked for more than ten years, 9 (45%); as well as other professional bonds, 10 (50%). Participation in training activities was significant, 11 (55%); and the level of professional satisfaction was considered good, 14 (70%). Regarding the workplace, it was found that the nurses worked in different sectors, including the hospital network, followed by the basic health unit and the health surveillance and epidemiology networks.

The semantic analysis indicated that the nurses considered it necessary to maintain the items in the instrument but requested changes in the wording of five of them. The agreement score was considered satisfactory (1.00), indicating adequate semantic validity. The requested changes involved modifying the wording of items in the domains general aspects, serological markers and immunization against hepatitis B.

In the internal structure phase, 205 nurses participated. Regarding the sociodemographic characterization, 171 (83.4%) were female; mostly aged 20 to 59 years (98%); 120 (58.5%) declared having brown or dark skin color; without postgraduate degree, 146 (71.2%); and monthly income of more than four minimum wages, 128 (62.4%). Regarding professional data, the time since professional training of 134 (65.4%) participants was over ten years; 83 (76.9%) had not participated in professional training on hepatitis B; the level of professional satisfaction was considered good by 127 (62%) nurses; and 127 (62%) had more than one employment bond.

Regarding the workplace, they worked in different sectors, such as 115 (56%) in the hospital network, followed by 81 (39.5%) in the basic health unit, 5 (2.4%) in specialized care, 3 (1.5%) in management services and 1 (0.5%) in health surveillance.

O The cutoff point for knowledge analysis was 75% correct answers, in line with previous studies that assessed knowledge[22-24]. Thus, knowledge was classified as good or poor

based on the percentage of correct answers given by nurses to the instrument items, as shown in Table 2.

The dimensions “General aspects of hepatitis B” and “Follow-up and treatment of hepatitis B” were the only ones that presented percentages of correct answers greater than 75% in most items, with knowledge about hepatitis B classified as good. Regarding “Transmission of hepatitis B”, participants obtained percentages of correct answers lower than 75% for items 9, 10 and 12.

The dimension “Symptoms of hepatitis B” had a percentage of correct answers below the recommended level in all items, and only item 23 of the dimension “Serological markers of hepatitis B” had knowledge classified as good. Items 34, 36 and 37, on immunization against hepatitis B, and item 38, on diagnosis of hepatitis B, presented percentages below the recommended level, with knowledge classified as poor.

Table 2. Distribution of responses to items by nurses who participated in the empirical stage. Teresina, Piauí, n=205, 2024

ITEMS	Strongly agree	Agree	Neither agree nor disagree	Disagree	Strongly disagree
	N (%)	N (%)	N (%)	N (%)	N (%)
GENERAL ASPECTS ABOUT HEPATITIS B					
1. Hepatitis B is caused by a DNA virus.	84 (41.0)	85 (41.5)	18 (8.8)	9 (4.4)	9 (4.4)
2. Brazil is a country with low endemicity for hepatitis B.	5 (2.4)	25 (12.2)	30 (14.6)	101 (49.3)	44 (21.5)
3. Hepatitis B is a compulsory notification disease.	95 (46.3)	91 (44.4)	8 (3.9)	7 (3.4)	4 (2.0)
4. Liver cancer can be caused by the hepatitis B virus (HBV).	75 (36.6)	95 (46.3)	17 (8.3)	14 (6.8)	4 (2.0)
5. Newborns infected with the hepatitis B virus (HBV) have an increased risk of developing chronic hepatitis B.	68 (33.2)	101 (49.3)	21 (10.2)	14 (6.8)	1 (0.5)
6. Acute infection with the hepatitis B virus (HBV) can be asymptomatic or present mild to very severe symptoms (called fulminant hepatitis).	71 (34.6)	100 (48.8)	16 (7.8)	13 (6.3)	5 (2.4)
TRANSMISSION OF HEPATITIS B					
7. The hepatitis B virus (HBV) can be transmitted through the ingestion of contaminated food and water.	2 (1.0)	3 (1.5)	2 (1.0)	43 (21.0)	155 (75.6)
8. The hepatitis B virus (HBV) can be sexually transmitted.	128 (62.4)	64 (31.2)	4 (2.0)	5 (2.4)	4 (2.0)
9. The hepatitis B virus (HBV) can be transmitted through contact with non-intact skin and mucous membranes.	68 (33.2)	83 (40.5)	12 (5.9)	23 (11.2)	19 (9.3)
10. The transmission of the hepatitis B virus (HBV) does not occur through sharing contaminated sharp objects.	28 (13.7)	26 (12.7)	5 (2.4)	42 (20.5)	104 (50.7)
11. The transmission of the hepatitis B virus (HBV) can occur vertically.	110 (53.7)	66 (32.2)	14 (6.8)	12 (5.9)	3 (1.5)
12. The hepatitis B virus (HBV) can be transmitted through breastfeeding.	38 (18.5)	59 (28.8)	17 (8.3)	47 (22.9)	44 (21.5)

SYMPTOMS OF HEPATITIS B					
13. The symptoms of acute hepatitis B are more severe in children compared to the elderly.	11 (5.4)	54 (26.3)	69 (33.7)	59 (28.8)	12 (5.9)
14. Jaundice is always present in confirmed cases of acute hepatitis B.	7 (3.4)	64 (31.2)	34 (16.6)	78 (38.0)	22 (10.7)
15. Hepatitis B may be present silently in the acute phase.	39 (19.0)	83 (40.5)	35 (17.1)	36 (17.6)	12 (5.9)
16. Hepatitis B may be present silently in the chronic phase.	39 (19.0)	82 (40.0)	24 (11.7)	41 (20.0)	19 (9.3)
17. About 5% to 10% of individuals infected with hepatitis B virus (HBV) may develop the chronic form of the disease.	44 (21.5)	105 (51.2)	44 (21.5)	11 (5.4)	1 (0.5)
SEROLOGICAL MARKERS OF HEPATITIS B					
18. The HBsAg serological marker is not always detected in the acute phase.	10 (4.9)	61 (29.8)	45 (22.0)	67 (32.7)	22 (10.7)
19. The detection of the HBsAg serological marker can be detected in both the acute and chronic phases of hepatitis B.	35 (17.1)	110 (53.7)	30 (14.6)	25 (12.2)	5 (2.4)
20. The detection of the HBsAg serological marker for more than six months after its appearance indicates progression to chronic hepatitis B.	34 (16.6)	95 (46.3)	50 (24.4)	21 (10.2)	5 (2.4)
21. The detection of the anti-HBc total serological marker indicates that the individual is infected with the hepatitis B virus.	16 (7.8)	54 (26.3)	49 (23.9)	59 (28.8)	27 (13.2)
22. The presence of the HBeAg serological marker indicates that the individual is infected with the hepatitis B virus (HBV) and has a high viral load.	34 (16.6)	83 (40.5)	47 (22.9)	30 (14.6)	11 (5.4)
23. The isolated detection of the anti-HBs serological marker indicates previous vaccination against hepatitis B.	63 (30.7)	100 (48.8)	24 (11.7)	16 (7.8)	2 (1.0)
24Glutamic Oxaloacetic Transaminase (GOT) is a sensitive marker for detecting hepatic parenchymal injury.	44 (21.5)	104 (50.7)	37 (18.0)	16 (7.8)	4 (2.0)
FOLLOW-UP AND TREATMENT OF HEPATITIS B					
25. Hepatitis B has no cure.	39 (19.0)	63 (30.7)	14 (6.8)	58 (28.3)	31 (15.1)
26. The treatment of hepatitis B aims to reduce the risk of progression of liver disease.	69 (33.7)	120 (58.5)	9 (4.4)	4 (2.0)	3 (1.5)
27. For the treatment of hepatitis B, it is important to check for coinfections with hepatitis C, hepatitis D, and human immunodeficiency virus.	72 (35.1)	114 (55.6)	14 (6.8)	4 (2.0)	1 (0.5)
28. For an unvaccinated individual with a contaminated sharp object injury, the ideal is to start the vaccination schedule and administer immunoglobulin within 48 hours.	45 (22.0)	98 (47.8)	32 (15.6)	24 (11.7)	6 (2.9)
29. Human anti-hepatitis B immunoglobulin (HBIg) should be administered preferably within the first 12 to 24 hours of life for newborns of any weight or gestational age born to HBsAg-positive mothers.	38 (18.5)	104 (50.7)	37 (18.0)	22 (10.7)	4 (2.0)
30. The indication for preventive therapy will be guided by the serological profile (type of immunosuppressive treatment) and the risk of viral reactivation.	38 (18.5)	110 (53.7)	43 (21.0)	12 (5.9)	2 (1.0)
IMMUNIZATION AGAINST HEPATITIS B					

31. Vaccination against hepatitis B is recommended for all individuals.	91 (44.4)	93 (45.4)	7 (3.4)	10 (4.9)	4 (2.0)
32. The first dose of the hepatitis B vaccine should be administered at birth.	113 (55.1)	74 (36.1)	6 (2.9)	7 (3.4)	5 (2.4)
33. The hepatitis B vaccine is contraindicated for pregnant women.	3 (1.5)	18 (8.8)	11 (5.4)	61 (29.8)	112 (54.6)
34. Anti-HBs titers greater than or equal to 10 IU/mL indicate immunity against hepatitis B.	41 (20.0)	77 (37.6)	68 (33.2)	16 (7.8)	3 (1.5)
35. In healthy individuals, after three doses of the vaccine using the zero, one, and six-month schedule, more than 90% of individuals develop immunity against hepatitis B.	56 (27.3)	113 (55.1)	16 (7.8)	14 (6.8)	6 (2.9)
36. Immunosuppression, advanced age, obesity, smoking, and diabetes are some causes of a reduced response to the hepatitis B vaccine.	38 (18.5)	88 (42.9)	43 (21.0)	28 (13.7)	8 (3.9)
37. Individuals vaccinated against hepatitis B who do not have protective anti-HBs titers should repeat the vaccination schedule 45 to 60 days after the third dose of the hepatitis B vaccine.	30 (14.6)	101 (49.3)	39 (19.0)	26 (12.7)	9 (4.4)
DIAGNOSIS OF HEPATITIS B					
38. The rapid test for hepatitis B is considered a diagnostic test.	29 (14.1)	78 (38.0)	32 (15.6)	54 (26.3)	12 (5.9)
39. After the confirmation of the hepatitis B diagnosis, it is important to evaluate liver function to measure the levels of liver enzymes and other substances produced by the liver.	73 (35.6)	120 (58.5)	8 (3.9)	2 (1.0)	2 (1.0)
40. Accurate and early diagnosis of hepatitis B virus infection allows for appropriate treatment and has a direct impact on the prevention of complications.	89 (43.4)	104 (50.7)	9 (4.4)	1 (0.5)	2 (1.0)

Source: Research data, 2024.

The Kaiser-Meyer-Olkin (KMO) sampling adequacy measure test was 0.72, considered satisfactory, and Bartlett's sphericity value (<0.001) indicated correlation between the variables. However, items 02, 09, 18, 21, and 25 of the instrument presented levels of adequacy measurement that were insufficient to be factored. Thus, they were removed.

When applying parallel analysis to assess dimensionality, two possibilities emerged: one dimension, based on a more rigorous reading (95% percentile), and two dimensions, considering the means of the eigenvalues.

The postulated theoretical model, with seven domains, did not show convergence of the items in the domains. Thus, in addition to the exclusion of the five items that did not meet the sample adequacy measures, the adjustment process included the gradual removal of items, one by one, until the instrument was adjusted. The items removed were: 2, 7, 8, 9, 10, 12, 13, 14, 15, 16, 18, 19, 20, 21, 25, 29, 31, 33, 36, 37, 38, 40.

The parallel analysis indicated a unidimensional model, with low explained variance (24.28%). However, it is recommended that, in exploratory studies, more than one

configuration of the instrument be considered in addition to that designated by the dimensionality techniques, as long as it is interpretable[30]. Therefore, it was possible to identify two configurations for the instrument: two and three factors. For the model with two factors, the explained variance was 58.85% and with three factors, 66.76%. The three-factor model was chosen to assess knowledge about hepatitis B because, in addition to improving the explained variance, there is a development in the opening of a third domain that is interpretable. There are no double saturations, Heywood Cases or non-substantial loadings in the models. The matrix of factor loadings and commonalities of the instrument with two and three domains are presented in Table 3.

Table 3. Factor loadings and commonality of the models with two and three domains of the instrument "Assessment of knowledge about hepatitis B among nurses". Teresina, Piauí, n=7, 2024

	2 domains			3 domains			
Item	**F 1**	**F 2**	h^2	**F 4**	**F 5**	**F 6**	h^2
1. It is caused by a DNA virus.	**0.37**	0.22	0.29	**0.37**	0.13	0.12	0.29
3. It is a disease that must be reported.	**0.64**	-0.02	0.39	**0.64**	0.00	-0.02	0.39
4. Liver cancer can be caused by the virus (HBV).	**0.82**	-0.17	0.52	**0.83**	-0.14	-0.09	0.53
5. Newborns infected with the HBV virus have a high risk of developing chronic hepatitis.	**0.78**	0.01	0.61	**0.78**	-0.05	0.04	0.61
6. Acute HBV infection may be asymptomatic or present with mild to very severe symptoms (called fulminant hepatitis).	**0.69**	0.11	0.58	**0.69**	0.11	0.02	0.58
11. HBV transmission may occur vertically.	**0.34**	0.24	0.27	**0.34**	0.04	0.21	0.27
17. Approximately 5% to 10% of individuals infected with the HBV virus may develop the chronic form of the disease.	**0.59**	0.14	0.47	**0.59**	0.09	0.07	0.47
22. The presence of the serological marker HBeAg indicates that the individual is infected with the HBV virus and has a high viral load.	0.02	**0.43**	0.20	-0.01	**0.41**	0.14	0.25
23. The isolated detection of the serological marker anti-HBs indicates previous vaccination against Hepatitis B.	0.07	**0.51**	0.32	-0.03	**0.96**	-0.11	0.79
24. Glutamic-Oxaloacetic Transaminase (TGO) is a sensitive marker for detecting liver parenchyma injury.	0.06	**0.49**	0.28	0.02	**0.53**	0.12	0.39
26. Treatment aims to reduce the risk of liver disease progression.	-0.08	**0.85**	0.64	-0.08	0.08	**0.81**	0.65
27. For hepatitis B treatment, it is important to check for coinfections by hepatitis C virus, hepatitis D virus, and human immunodeficiency virus.	-0.01	**0.74**	0.54	-0.02	-0.15	**0.90**	0.65
28. In an individual not vaccinated against hepatitis B, in the event of an accident with a contaminated sharp object, the ideal is to start the vaccination schedule and administer immunoglobulin within 48 hours.	0.05	**0.52**	0.31	0.06	-0.07	**0.59**	0.35
30. The indication for preventive therapy will be guided by the serological profile (type of immunosuppressive treatment) and the risk of viral reactivation.	0.04	**0.45**	0.23	0.04	0.04	**0.43**	0.23

32. The first dose of the vaccine should be administered at birth.	0.11	**0.50**	0.33	0.11	0.08	**0.44**	0.33
34. Anti-HBs titers greater than or equal to 10 UI/mL indicate immunity against Hepatitis B.	0.06	**0.44**	0.24	0.06	0.13	**0.35**	0.23
35. In healthy individuals, after three doses of the vaccine using the zero, one and six month schedule, more than 90% of individuals develop immunity to hepatitis B.	0.03	**0.54**	0.32	0.03	0.01	**0.54**	0.33
39. After confirming the diagnosis, it is important to assess the liver function to measure the levels of liver enzymes and other substances produced by the liver	-0.02	**0.74**	0.53	-0.02	0.12	**0.66**	0.53

Source: Research data, 2024.

Chart 1 presents the values of the model fit indexes, reliability, stability and quality of the score. All model fit indicators for the EFA are at adequate levels.

Chart 1 – Reliability, stability and quality of the score of the instrument "Assessment of knowledge about hepatitis B among nurses". Teresina, Piauí, 2024

Techniques	**Applied indices**	**Three domains**
Sample adequacy measures	Determinant of Matrix	0.000781108133704
	KMO	0.87997
	Bartlett's Sphericity	1410.7 (df = 153; P = 0.000010)
Model adjustment indices	Normed fit index	0.993
	Comparative Fit Index	0.995
	Goodness of Fit Index	0.980
	Adjusted Goodness of Fit Index	0.969
	Root Mean Square Error of Approximation (RMSEA)	0.028
	Root Mean Square of Residuals (RMSR)	0.047
Reliability	ORION*	0.867; 0.855; 0.886
	Standardized Cronbach's Alpha	0.89
	McDonald's Omega	0.89
	Construct Reliability - Index G H H-Latent (observed H)*	0.867 (0.912); 0.855(0.821); 0.886 (0.887);
Quality and Effectiveness	Factor Determinacy Index	0.931; 0.925; 0.941
	Sensitivity Ratio	2.55; 2.43; 2.79
	Expected percentage of true differences	91.0%; 90.6%; 91.8%

Source: Research data, 2024. *For the respective dimensions

The analyses resulted in the instrument presented in Chart 2.

Chart 2. Instrument for assessing knowledge about hepatitis B among nurses. Teresina, Piauí, 2024.

N	ITEMS	Strongly agree	Agree	Neither agree nor disagree	Disagree	Strongly disagree
	EPIDEMIOLOGY OF HEPATITIS B					
01	Hepatitis B is caused by a DNA virus.					
02	Hepatitis B is a compulsory notification disease.					
03	Liver cancer can be caused by the Hepatitis B virus (HBV).					
04	Newborns infected with the hepatitis B virus (HBV) have an increased risk of developing chronic hepatitis B.					
05	Acute infection with the hepatitis B virus (HBV) can be asymptomatic or present mild to very severe symptoms (called fulminant hepatitis).					
06	The transmission of the hepatitis B virus (HBV) can occur vertically.					
07	About 5% to 10% of individuals infected with the hepatitis B virus (HBV) may develop the chronic form of the disease.					
	ITEMS	Strongly agree	Agree	Neither agree nor disagree	Disagree	Strongly disagree
	DIAGNOSIS OF HEPATITIS B					
08	The presence of the HBeAg serological marker indicates that the individual is infected with the hepatitis B virus (HBV) and has a high viral load.					
09	The isolated detection of the anti-HBs serological marker indicates previous vaccination against hepatitis B.					
10	Glutamic-Oxaloacetic Transaminase (TGO) is a sensitive marker for detecting liver parenchymal injury.					
	ITEMS	Strongly agree	Agree	Neither agree nor disagree	Disagree	Strongly disagree
	TREATMENT AND PREVENTION OF HEPATITIS B					
11	The treatment of hepatitis B aims to reduce the risk of progression of liver disease.					

12	For the treatment of hepatitis B, it is important to check for coinfections with hepatitis C, hepatitis D, and human immunodeficiency virus.					
13	For an unvaccinated individual with a contaminated sharp object injury, the ideal is to start the vaccination schedule and administer immunoglobulin within 48 hours.					
14	The indication for preventive therapy will be guided by the serological profile (type of immunosuppressive treatment) and the risk of viral reactivation.					
15	The first dose of the hepatitis B vaccine should be administered at birth.					
16	Anti-HBs titers greater than or equal to 10 IU/mL indicate immunity against hepatitis B.					
17	In healthy individuals, after three doses of the vaccine using the zero, one, and six-month schedule, more than 90% of individuals develop immunity against hepatitis B.					
18	After the confirmation of the hepatitis B diagnosis, it is important to evaluate liver function to measure the levels of liver enzymes and other substances produced by the liver					

Source: Research data, 2024.

DISCUSSION

The study allowed the construction and obtaining of validity evidence for an instrument aimed at assessing professional knowledge about hepatitis B among nurses and followed all the recommended steps to maintain scientific and methodological rigor. The results of the present study confirm a consistent and reliable model through the combination of different psychometric techniques for instrument development.

The first version of the instrument presented an overall agreement indicator of 0.832 and was structured in 46 items, which covered the following domains: general aspects, transmission, symptoms, serological markers, phases, treatment, immunization and diagnosis. The evaluation dimensions were defined after an integrative review and analysis of therapeutic guidelines, which highlighted the main limitations and inconsistencies in knowledge, healthcare practices, and biosafety indicators adopted by nurses during exposure to infection, as well as identifying the main clinical recommendations for managing hepatitis B and coinfections[13, 15].

The CVI is considered to be an effective parameter to assess agreement among experts, acting as a modulating agent for the need for changes, additions, and exclusion of items, resulting in the second version of the measurement instrument, which, despite presenting an overall score of 0.952, still presented inconsistencies to be addressed.

Given the impacts of the disease, as well as the need to propose a resource with evidence of validity, safety, and reliability to support health education practices, this study developed, evaluated, and validated an instrument that is favorable for measuring nurses' knowledge about hepatitis B. Researchers have emphasized the need for in-depth evaluation of the measurement properties of instruments before their use, to ensure a detailed understanding of the underlying theoretical model and the quality of the results obtained[31-34].

In the validation process, it is important to consider the theoretical aspects to justify the correlation between the items that were unified in the component and justified the findings of the factors[35]. Thus, the final version of the instrument "Assessment of knowledge about hepatitis B among nurses" consisted of 18 items allocated into three factors.

A fundamental aspect in the process of validity evidence of internal structure is the interaction between the statistical model proposed from the exploratory factor analysis and the perspective of this statistical model being interpretable, to avoid using a spurious statistical model, considering that Messick defines validity as the assessment of the degree to which empirical evidence and theoretical justifications support the adequacy and accuracy of inferences and actions based on test results or other assessment methods[36].

Messick's concept aligns with the definition of validation proposed by the Standards for educational and psychological testing[37], when it points out that validity concerns the intensity with which evidence and theory support the interpretations of test scores, according to the proposed use. It is about accumulating evidence that provides the scientific basis for interpreting the proposed scores[37], which is the most important guide for instrument development.

By obtaining evidence of content validity and internal structure, which demonstrates the ability of the items to measure the desired phenomenon, it is possible to state that the two central elements for a theoretical model that allows the interpretation of the instrument based on the items that measure the phenomenon are present.

The process, mainly of evidence of internal structure with a contemporary set of techniques, resulted in the final version of the instrument with 18 items that were categorized into three dimensions (Epidemiology, Diagnosis and the third domain Prevention and Treatment), reaching 66.76% of the explained variance, above the recommended 60%[20]. Additionally, all reliability and stability indicators of the model are within adequate and

satisfactory limits, without any issues related to non-substantial factor loadings and/or cross-loadings and/or Heywood cases.

Validation of an instrument to assess nurses' level of knowledge about hepatitis B can assist in the practice of nursing care and expand the profession as a science, providing autonomy to nursing professionals. Thus, it allows guiding actions and operationalizing nursing consultations according to the demands of each patient, and leads to effective outcomes in the health conditions of each individual[38].

Regarding general knowledge about hepatitis B, this study considered it good. In contrast, studies conducted with students and healthcare professionals observed insufficient knowledge and attitudes regarding HBV[39-40]. It is necessary to strengthen the scientific knowledge of healthcare professionals, especially those working in health care assistance, so that they adopt the best practices, based on clinical reasoning with high scientific-methodological rigor. In PHC, early recognition and treatment of hepatitis B are possible, which ensures better long-term results and the reduction of the incidence of liver cancer and the cost of healthcare services[41].

In this study, knowledge about immunization against hepatitis B was considered poor, while knowledge about serological markers of hepatitis B was good. A study conducted in the state of Minas Gerais, Brazil, with primary health care professionals revealed that, although most participants had complete immunization, the total number of individuals who did not obtain seroconversion was evident. Therefore, highlighting the importance of promoting the hepatitis B surface antibody test in the public health context[2]. There is an urgent need to invest in continuing health education that values the local characteristics of health services and meets the real demands of the different healthcare settings, aiming at impacting the health of workers and, consequently, the population.

From this perspective, the development of instruments capable of measuring and improving indicators of knowledge, skills and abilities of healthcare professionals, especially nursing professionals, is necessary to guide decision-making and reduce direct and indirect impacts related to occupational risks and patient safety.

Factor analyses require large samples for their effectiveness and consistency due to their complexity, with samples of more than 500 participants recommended[42]. Therefore, the sample size of this study could be considered a limitation. However, the adoption of analyses with permutation intrinsic to parallel analysis, combined with a bootstrap of 500 iterations[43], minimizes this potential limitation, in addition to the results presenting factor loadings, commonalities, model fit indicators, stability and reliability at satisfactory levels.

It is important to highlight that the content of the item already aligns with the correct practice or "correct" knowledge about hepatitis B that is being assessed in the item. Thus, indicating "strongly agree" and "agree" would indicate an approximation to the desired knowledge, varying towards uncertainty ("neither agree nor disagree") and the elements on the opposite pole "disagree" and "strongly disagree" would indicate a lack of knowledge about the relevance of this element for nurses' knowledge about hepatitis B.

However, setting the cutoff points, that is, which scores will be relevant for classifying the level of knowledge about Hepatitis B among nurses is a future challenge. The number of levels and the scores that will define these levels are not the objective of this stage of the study. The establishment of the cutoff values of a scale cannot be done arbitrarily, but rather through the standardization of scores. Arbitrary decisions can generate bias and inaccuracy in classifying individuals[33].

Thus, the future challenge lies in developing the standardization of the instrument's score and evidence of its relationship with other variables, to verify and guide future users of the instrument regarding the interpretation based on the participant scores.

CONCLUSION

The results obtained showed that the instrument is valid and can be used to measure nurses' knowledge about hepatitis B. The content validation stage conducted by experts contributed to the instrument's development, allowing greater relevance and evidence in the writing of the items. Similarly, the semantic analysis conducted by the nurses confirmed the relevance of the items for assessing knowledge about hepatitis B.

It can be inferred that the instrument can be used to support the planning and assessment of continuing education programs related to knowledge about hepatitis B among nurses, representing an important tool for care management. It is believed that studies of this nature could improve healthcare and management indicators, since identifying the level of knowledge directly impacts the development of strategies for professional training, reducing hospital costs, as well as the physical, mental and social impacts imposed by the disease.

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Data and material availability
Access to the dataset can be obtained upon request to the corresponding author.

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Conflict of interest
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