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Development and Validation of a Questionnaire to Assess Awareness and Knowledge of Nonalcoholic Fatty Liver Disease, a Liver Cancer Etiological Factor, among Chinese Young Adults

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RESEARCH ARTICLE

Development and Validation of a Questionnaire to Assess Awareness and Knowledge of Nonalcoholic Fatty Liver Disease, a Liver Cancer Etiological Factor, among Chinese Young Adults

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Abstract

    Purpose: Despite the increasing prevalence of nonalcoholic fatty liver disease (NAFLD), a liver cancer etiological factor, among Chinese young adults (CYA), there is a lack of valid, reliable, ready-to-use survey instruments for assessing awareness and knowledge of NAFLD in this population. The aims of this study were to develop, validate, and assess the reliability of a web-based, self-administered questionnaire evaluating awareness and knowledge of NAFLD among CYA. **Methods:** Based on review of relevant literature, a draft questionnaire was initially developed. Face and content validity of the questionnaire was evaluated by an expert panel of seven gastroenterologists. The construct validity was tested through item analysis based on item response theory. Reliability assessment included test-retest for stability and test for internal consistency. Two pilot tests were conducted among 60 randomly selected students at Lanzhou University, China, through WeChat App. **Results:** The content validity and clarity indexes were both greater than 0.85. Face validity was established by concluding that questions had no issue with feasibility, readability, clarity of wording, clarity of layout, and style. Response rates for two pilot tests were 96.7% (58 out of 60) and 98.3% (59 out of 60), respectively. Results testing the construct validity showed estimated amount of information obtained by the test between -3 and +3 range of ability was 97.57%. The test-retest reliability (Pearson's r) was 0.62. The internal consistency (KR20) was 0.92. **Conclusions:** This newly developed questionnaire is a reliable and valid instrument for assessing awareness and knowledge of NAFLD among this sample from CYA.

Keywords: Questionnaire development- questionnaire validation- awareness and knowledge

Introduction

    Nonalcoholic fatty liver disease (NAFLD) has become the leading cause of chronic liver disease, which cumulatively affects more than 1.7 billion people globally (Younossi et al., 2018). NAFLD has been identified as an etiological factor for liver cancer (Teng et al., 2022). It was estimated that the prevalence of NAFLD in China would be the highest around the world, with more than 300 million cases by 2030 (Estes et al., 2018). Because most patients with NAFLD had no symptoms, testing for NAFLD is not recommended for people who had no risk factors, which means the prevalence of NAFLD is underestimated (Juo and Livingston, 2019). The underestimated prevalence of NAFLD could be particularly prominent among young adults who are considered as having good health in general. In recent years, there has been increased incidence of NAFLD among younger people (Zhou et al., 2020). The increasing incidence of NAFLD in younger individuals will create a substantial disease burden in the coming decades (Estes et al., 2018).

    Lifestyle modification, including increasing physical activity and adopting a healthy diet, is recommended as first-line treatment for NAFLD (Ghaemi et al., 2013). Acknowledgment that reversal of NAFLD is possible by adherence to healthier lifestyle habits does not seem to be sufficient for behavioral changes (Zou et al., 2018). According to the Health Belief Model, perceived susceptibility and severity are prerequisites for positive changes in health behavior (Painter et al., 2008). Awareness and knowledge of NAFLD can enhance the perceived severity and susceptibility of NAFLD and consequently prompt behavioral changes towards a healthier lifestyle (Painter et al., 2008).

    Young adults (age 18-25 years) are considered in good health generally (Zastrow and Kirst-Ashman, 2001). Attending college characterizes the early stage of young adulthood (Kim et al., 2018). It is the first time young adults leave their parental homes, live by themselves, and choose their own lifestyle (Kim et al., 2018). Following China's modernization, several urbanized living habits have been introduced into young people's daily life,

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including limited physical activity, a sedentary lifestyle, and unhealthy dietary habits (Li et al., 2016; Miao and Wu, 2016). These unhealthy lifestyles have been recognized as established risk factors of NAFLD.(Steptoe et al., 1994; Hallsworth and Adams, 2019)

Progression of NALFD is relatively slow and mostly asymptomatic until advanced stages, making it imperative to place more emphasis on prevention. Thus, providing information regarding NAFLD to young adults to increase their perceived severity and susceptibility to NAFLD may lead to adopting a healthy lifestyle and prevention of disease. Currently, there is no research on awareness and knowledge of NAFLD among CYA. Previous studies about awareness and knowledge of NALFD focused on middle-aged and older adults (Chen et al., 2019; Zhang et al., 2019). In addition, to the authors' knowledge, previous studies on awareness and knowledge of NAFLD, did not provide or use a valid, reliable, ready-to-use survey instrument for assessing awareness and knowledge of NAFLD.

We hypothesized that a standard, multi-step validation and test-retest analysis demonstrate the validity and reliability of a newly designed questionnaire to assess awareness and knowledge of NAFLD among CYA. The aims of this study were to develop, validate, and assess the test-retest reliability of a web-based, self-administered questionnaire evaluating awareness and knowledge of NAFLD among CYA aged 18-25 years.

Materials and Methods

Development of the draft questionnaire

Our initial version of questionnaire (Appendix A) adopted several questions from existing studies about awareness and knowledge of NAFLD conducted among different population (Leung et al., 2009; Yan et al., 2013; Chen et al., 2019; Zhang et al., 2019). There are six sections in the questionnaire: 1) awareness of NAFLD; 2) level of knowledge of NAFLD; 3) self-perceived risk of NAFLD; 4) physical activity status; 5) dietary habits; 6) demographic information, medical history, and family history of NAFLD.

Validation of the questionnaire

Validation was focused on Section 2 (Appendix B), which involved developing a new tool to quantify the level of knowledge of NAFLD. The questionnaire development and validation processes included eleven steps (Figure 1) (Tsang et al., 2017).

Step 1: Identifying the purpose of the test and the target population

We determined the purpose was to assess awareness and knowledge of NAFLD. The target population was CYA aged 18-25.

Step 2: Checking whether a validated questionnaire was available

We reviewed literature and were unable to identify an existing valid and reliable questionnaire met the purpose of our study.

Step 3: Establishing an expert panel

The expert panel included seven gastroenterologists, two epidemiologists, one sociologist, and one biostatistician.

Step 4: Determining the dimensionality of the construct

The expert panel determined the presented study included eight subsections in Section 2 addressing knowledge of NAFLD in various disease domains: prevalence, symptoms, causes, risk factors, diagnosis, complications, prevention, and treatment.

Step 5: Determining the format of the questionnaire

The expert panel determined that the best format of the questionnaire, given the target population, was a web-based self-administered questionnaire to be distributed through the WeChat app.

Step 6: Determining the format of the questions

To enable more accurate coding and scoring for downstream data analyses, the question format was chosen to be closed-ended.

Step 7: Developing a draft questionnaire and validating the questionnaire

A draft questionnaire was developed by adapting questions from existing studies about knowledge of NAFLD.(Leung et al., 2009; Goh et al., 2016; Matthias et al., 2018; Chen et al., 2019; Zhang et al., 2019)

Validity assessment included content validity index (CVI), construct validity, and face validity.(Bolarinwa, 2015)

1) CVI: the expert panel members were asked to review relevance of each question on a 4-point Likert scale (1 = "not relevant," 2 = "somewhat relevant," 3 = "relevant," and 4 = "very relevant"). The Expert Panel Evaluation Form was built using Google Forms and distributed to the expert panel composed of seven gastroenterologists. The proportion of experts giving 3 or 4 points for each question was calculated. A question was included when CVI was greater than 0.78 (Polit et al., 2007).

2) The construct validity was tested through item analysis (IA) based on classical test theory (CTT) and item response theory (IRT).(Arifin WN, 2017) The CTT were analyzed based on difficulty and discrimination indices of question items. The IRT allows to evaluate question items and participants' ability (trait) simultaneously.

3) Face validity was established after subject matter experts reviewed the questionnaire and concluded it measures the trait of interest. The questionnaire was checked for common errors like double-barreled, confusing, and leading questions.

Assessment of reliability

A test-retest for stability was conducted by testing the survey instrument twice among same participants at different times. We compared and calculated the scores received from responses in the two tests through correlation coefficient formula (range -1 to 1). For score of stability, "+/- 0.7 to 1.0," "+/-0.3 to 0.69," and "+/- 0.0 to 0.29" indicate strong, moderate, and none or weak

relationships, respectively.

The internal consistency, denoting extent to which questions are inter-correlated, was tested using the Kuder-Richardson method.(Cody, 2014) The Kuder-Richardson Formula 20 (KR_{20}) is shown as the following, $KR_{20} = \frac{K}{K-1}\left[1 - \frac{\sum pq}{s^2}\right]$, where K is number of test item, p is proportion of participants who answered item correctly, q is proportion of participants who answered item incorrectly, S^2 is variance of scores, $\sum pq$ is summation of product of p and q.(Cody, 2014) $KR_{20} = 0$ indicates no internal consistency, whereas $KR_{20} = 1$ reflects perfect internal consistency. In practice, KR_{20} of at least 0.70 is recommended to indicates adequate internal consistency. (Cody, 2014)

Study population

Two pilot test surveys were conducted from May 1st to 15th, 2021 at Lanzhou University, China. The source population were students who enrolled in the Lanzhou University undergraduate program in 2018, 2019 and 2020. In the spring semester (February to July, 2021), there were 20,121 students in the Lanzhou University undergraduate program. The estimated age range of participants was 18-25 years. Both males and females were included in the study.

Pilot tests

Sixty randomly selected participants were invited to complete an anonymous, web-based, self-administered questionnaire distributed by the Student Affairs Department at Lanzhou University through the WeChat app. They were randomly selected from four colleges (College of Civil Engineering and Mechanics, College of Life Science, College of Public Health, and College of Foreign Languages and Literatures) at Lanzhou university, which were randomly selected from four classification fields (engineering, science, medicine, and humanities and social science). The random selection was stratified by enrollment year. All participants provided written informed consent through WJX.cn. The questionnaire was built on a web-based survey tool (WJX.cn).

Statistical analysis

CVI and IA analyses were conducted in Microsoft Excel. IRT analyses were performed in R software using RStudio with three packages (psych, ltm, and irtoys). The rest of data analyses were performed with SAS 9.4 (SAS, Inc., Cary, NC). Significance was set at a two-sided 5% level.

Results

Content validity

The content validity of each question in draft questionnaire was evaluated by the gastroenterologists. The results of CVIs are shown in Table 1. Because seven
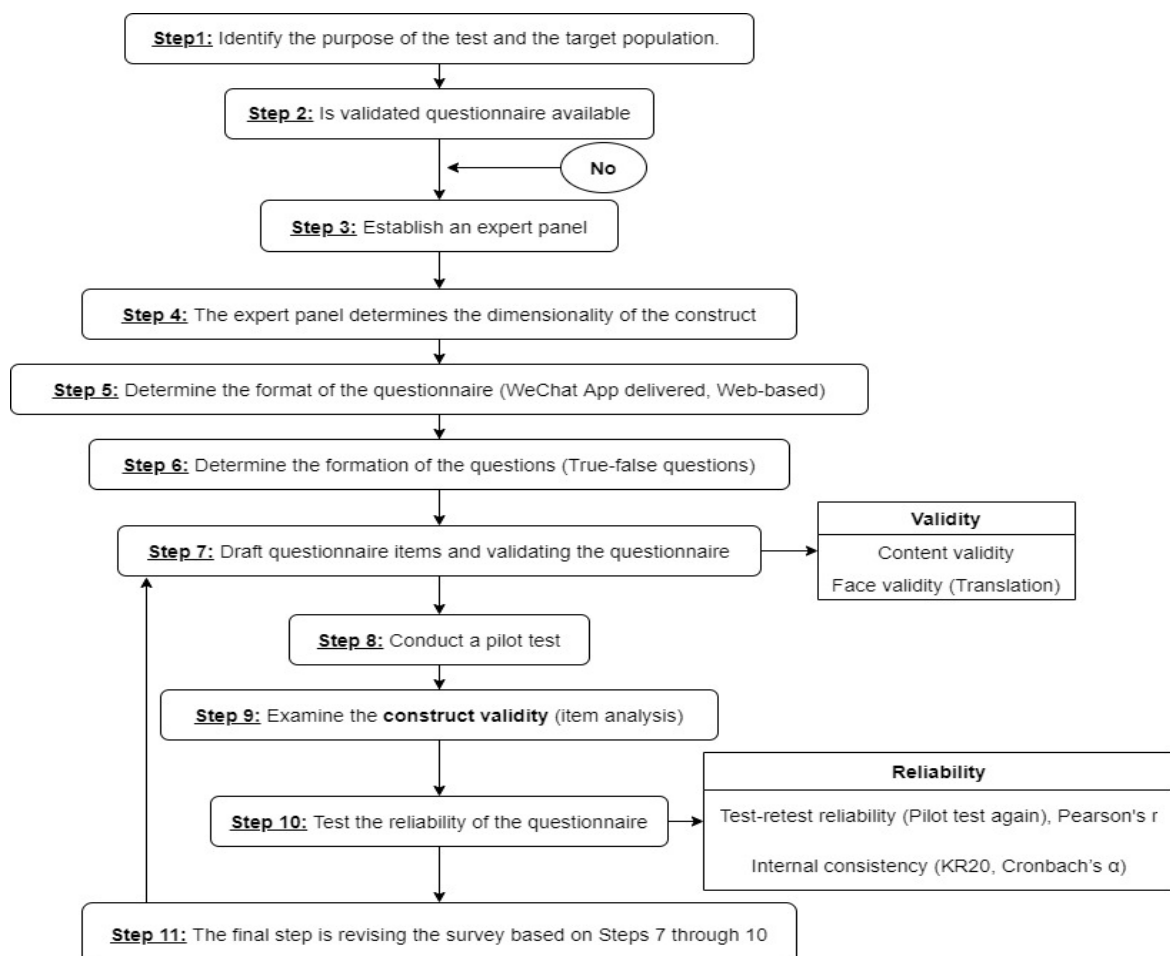

Figure 1. Flowchart of the Process of Questionnaire Development and Validation

Table 1. Content Validity and Clarity of the Draft Questionnaire Assessed by the Expert

Question item	Domain	CVI	Clarity
Awareness section			
1. Have you ever heard of NAFLD before taking this survey?	Awareness	1.00	1.00
2. What was the source of NAFLD information?	Awareness	0.57	0.57
Knowledge section			
1. What percentage of adults (age ≥ 18 years old) in China has NAFLD?	Prevalence	0.71	0.86
2. Abdominal pain is a common symptom of NAFLD.	Symptoms	1.00	1.00
3. Yellow pigmentation of skin and eyes (jaundice) is a common symptom of NAFLD.	Symptoms	0.86	0.86
4. Most people with NAFLD are asymptomatic.	Symptoms	1.00	1.00
5. Drinking too much alcohol can cause NAFLD.	Cause	0.86	0.86
6. Eating too much added sugar can cause NAFLD.	Cause	1.00	1.00
7. Eating too much fat can cause NAFLD.	Cause	1.00	1.00
8. Sedentary lifestyle can cause NAFLD.	Cause	1.00	1.00
9. Being obese or overweight is a risk factor for NAFLD.	Risk Factors	1.00	1.00
10. Diabetes is a risk factor for NAFLD.	Risk Factors	0.86	0.86
11. High triglyceride is a risk factor for NAFLD.	Risk Factors	0.86	0.86
12. High blood pressure is a risk factor for NAFLD.	Risk Factors	1.00	0.86
13. Smoking is the risk factor for NAFLD.	Risk Factors	0.86	1.00
14. Genetics is the risk factor for NAFLD.	Risk Factors	1.00	0.86
15. Blood tests can be used for the diagnosis of NAFLD.	Diagnosis	1.00	0.86
16. Liver imaging (ultrasound, CT, MRI) can be used to diagnose NAFLD.	Diagnosis	1.00	1.00
17. Liver biopsy is the gold standard of diagnosis of NAFLD.	Diagnosis	1.00	1.00
18. Can NAFLD lead to cirrhosis (severe scarring of the liver)?	Complications	1.00	1.00
19. Can NAFLD lead to liver cancer?	Complications	1.00	1.00
20. Can NAFLD spread to other people?	Complications	0.71	1.00
21. There are no complications associated with NAFLD.	Complications	0.57	0.71
22. NAFLD is reversible.	Prevention	1.00	1.00
23. Diet with fewer calories or less fat can be used as methods to reduce liver damage in those with NAFLD.	Prevention	0.86	1.00
24. Decreased outdoor eating can be used as a method to reduce liver damage in those with NAFLD.	Prevention	0.14	0.57
25. Increased physical activity can be used as a method to reduce liver damage in those with NAFLD.	Prevention	0.86	0.86
26. Quick weight loss is a useful prevention strategy for NAFLD.	Prevention	0.43	0.57
27. Weight loss through changes in diet and activity can be used as a method to reduce liver damage in those with NAFLD.	Treatment	1.00	1.00
28. Natural supplements for liver protection can be used as a method to reduce liver damage in those with NAFLD.	Treatment	0.86	1.00
29. Medications for weight reduction can be used as a method to reduce liver damage in those with NAFLD.	Treatment	0.86	1.00
30. There are specific medications that could be used to cure NAFLD.	Treatment	0.86	0.86

gastroenterologists completed the evaluation, question's CVI needs to be greater than 0.78 to be included. Question 2 in the awareness section and questions 1, 20, 21, 24, and 26 in the knowledge section yielded CVIs less than 0.78, therefore needed to be revised or removed.

Question 2 in the awareness section and questions 1, 20 and 21 in the knowledge section were included because one expert had misunderstood the intentions of the questions.

Question 24 was removed because only one expert rated "relevant." Five gastroenterologists indicated "outdoor eating" was not specific. Moreover, we cannot assume "outdoor eating" is unhealthy.

Question 26 was revised because only three gastroenterologists rated 3 or 4 points. The other four gastroenterologists questioned the term "quick weight loss." After reviewing with the epidemiologists, we decided to revise this question as "Losing a large amount of weight in a very short period of time (in one to two weeks) is a useful prevention strategy for NAFLD."

There were suggestions about adding questions on "lean NAFLD," "prevalence of NAFLD among CYA

Table 2. Comparison of Results by Item Analysis and 2-PL IRT

#	Question[3]	Key	C²/Y² %	O²/N² %	U² %	Diff[4]	Corr[4]	1 PC4(%)	2 PC(%)	3 PC(%)	4 PC(%)	Disc[4]	2-PL Diff	2-PL Disc
1	PNAFLD	C	9	14	77	9	0.14	7	0	7	21	14	6.91	0.35
2	PYNAFLD	C	5	9	86	5	-0.03	0	12	7	0	0	-14.24	-0.21
3	SymAPain	N	31	7	62	7	0.25	0	0	7	21	21	2.63	1.21
4	SymYellowEye	N	38	7	55	7	0.19	0	6	7	14	14	3.5	0.83
5	SymAsym	Y	22	16	62	22	0.43	0	13	29	50	50	1.16	1.64
6	CauseDrink	N	14	46	40	46	0.66	0	31	79	79	79	0.27	2.22
7	CauseSugar	Y	53	9	38	53	0.58	14	50	64	86	72	-0.04	1.25
8	CauseFat	Y	57	10	33	57	0.62	14	44	79	93	79	-0.12	1.6
9	CauseSeden	Y	59	5	36	59	0.56	14	63	79	79	65	-0.26	1.26
10	RiskObs	Y	74	3	22	74	0.78	14	88	93	100	86	-0.59	3.29
11	RiskDiab	Y	64	5	31	64	0.71	14	63	79	100	86	-0.28	2.25
12	RiskTri	Y	50	0	50	50	0.52	7	56	50	86	79	0.11	1.36
13	RiskHP	Y	57	12	31	57	0.58	7	69	71	79	72	-0.14	1.51
14	RiskSmk	N	45	16	40	16	0.19	7	13	21	21	14	3.98	0.45
15	RiskGene	Y	55	10	35	55	0.52	7	63	71	79	72	-0.06	1.56
16	RiskHealthW	N	10	62	28	62	0.73	0	69	86	93	93	-0.09	4.33
17	DiagBlood	N	45	9	46	9	0.1	0	13	14	7	7	19.45	0.12
18	DiagImag	Y	47	6	47	47	0.66	0	25	86	79	79	0.26	1.99
19	DiagBiopsy	Y	45	5	50	45	0.6	7	31	57	86	79	0.31	1.72
20	ResCir	Y	53	4	43	53	0.81	0	25	93	100	100	0.03	40.54
21	ResCancer	Y	47	5	48	47	0.66	0	38	64	86	86	0.27	2.36
22	ResInfect	N	7	52	41	52	0.56	14	44	64	86	72	0.09	1.8
23	ResNoCom	N	9	52	39	52	0.51	14	44	79	71	57	0.04	1.26
24	ResRever	Y	26	19	55	26	0.57	0	6	14	86	86	0.69	30.8
25	PreLowCal	Y	66	9	25	66	0.74	7	69	86	100	93	-0.27	2.91

[1] 2-PL IRT indicates 2-parameter logistic model of item response theory; [2] C indicates the correct answer; O indicates the other answers; U indicates "do not know or not sure"; Y indicates "Yes"; N indicates "N"; [3] The details of these questions are shown in the supplemental material (Appendix A); [4] Diff indicates difficulty parameter; Corr indicates point-biserial correlations; PC indicates proportion correct; Disc indicates discrimination parameter.

Table 2. Continued

#	Question³	Key	Y²%	N²%	U²%	Diff⁴	Corr.⁴	PC4(%)	Q1 PC(%)	Q2 PC(%)	Q3 PC(%)	Q4 PC(%)	Disc⁴	Diff	Disc
26	PreOEat	Y	64	5	31	64	0.72	0	69	86	100	100	100	-0.14	4.12
27	PrePhysical	Y	67	3	30	67	0.72	0	88	86	93	93	93	-0.34	2.81
28	PreAgLose	N	10	50	40	50	0.69	0	44	64	93	93	93	0.19	2.83
29	PreDietPhy	Y	67	7	26	67	0.58	21	75	79	93	72	72	-0.54	1.63
30	TxNatural	N	29	17	54	17	0.35	0	13	21	35	35	35	2.4	0.74
31	TxWLDrug	Y	9	55	36	9	0.23	0	6	14	14	14	14	2.5	1.14
32	TxDrug	N	60	3	37	3	0.23	0	0	7	7	7	7	2.19	2.32

(Choices; Item analysis Quartile; 2-PL IRT1)

¹ 2-PL IRT indicates 2-parameter logistic model of item response theory; ² C indicates the correct answer; O indicates the other answers; U indicates "do not know or not sure"; Y indicates "Yes"; N indicates "N"; ³ The details of these questions are shown in the supplemental material (Appendix A); ⁴ Diff indicates difficulty parameter; Corr indicates point-biserial correlations; PC indicates proportion correct; Disc indicates discrimination parameter.

(aged 18-25 years)," and "BMI." Thus, we added the following three questions:

1) Have you ever heard of lean NAFLD before taking this survey? (Awareness section)

2) What percentage of adults (aged 18-25 years) in China has NAFLD? (Knowledge section)

3) People with a healthy weight will not develop NAFLD. (Knowledge section)

Face validity

Face validity was established after seven gastroenterologists evaluated clarity of the questions and concluded the questions measure the trait of interest. The epidemiologists and the sociologist checked the questionnaire for common errors including double-barreled, confusing, and leading questions. There was no issue with the feasibility, readability, clarity of wording, clarity of layout, and style.

Question 14 was revised to "Genetic makeup is a risk factor for NAFLD." according to suggestion from one expert.

Moreover, we decided to revise all the questions to be assertive sentences instead of interrogative sentences.

The questionnaire was developed in English. Because the questionnaire would be used among CYA, the questionnaire was translated into Chinese by one epidemiologist (native Chinese speaker) and was back-translated by the sociologist, who is fluent in written Chinese and English with more than ten years of survey research experience.

Step 8: conducting a pilot test

Two pilot tests were conducted among 60 randomly selected participants. The response rates for two pilot tests were 96.7% (58 out of 60) and 98.3% (59 out of 60), respectively. The characteristics of participants are shown in Appendix C. The score received for each question among pilot test 1 and 2 participants are shown in Appendix D.

Step 9: examining the construct validity

The comparison of results by CTT item analysis, and 2-parameter logistic (2-PL) model of IRT are displayed in Table 2.

The estimated amount of information can be obtained by the test between -3 and +3 ability range is 97.57% (Appendix E). The P-value is greater than 0.05, which indicates the unidimensionality assumption is met. Thus, unidimensional 2-PL IRT can be applied.

Step 10: testing the reliability of the questionnaire

The KR_{20} of the questionnaire was 0.9186.

The test-retest reliability was calculated through Pearson correlation coefficient. Result was 0.62, indicating a strong relationship. Thus, the questionnaire is qualified for the test-retest reliability.

Step 11: finalizing the questionnaire

Step 9 showed questions 1, 2, 3, 4, 14, 17, 30, 31, 32 were too difficult for the participants. However, questions 1, 2, 3, 4, 30, 31, 32 represented three subsections of

NAFLD knowledge, which are prevalence, symptom, and treatment. Moreover, question 14 and question 17 were important. Because question 14 was an interference choice about NAFLD risk factor, which could be considered as a screening test of whether participants could identify true risk factor of NAFLD. Question 17 was also an interference choice about NAFLD diagnosis. Although these questions were in difficult range, the goal was to determine whether participants understood certain knowledge objectives. Thus, we concluded it was appropriate to keep those items in the final version of the questionnaire.

Discussion

Our questionnaire is designed to assess the awareness and knowledge of NAFLD among CYA. The content validity index reflected the content validity of each question included. The invalidated items were revised or removed. Besides face validity reviewed on feasibility, readability, clarity wording, clarity of layout, and style, clarity index was calculated for each question. Low clarity index questions were revised or removed. Construct validity of the questionnaire was evaluated through IA based on CTT and 2-PL IRT. Both methods generated difficulty index and discrimination index for each question. Furthermore, 2PL-IRT analysis provided more information including the total information given by the test is 97.6% in -3 to +3 ability range and the results met the unidimensionality assumption.

The reliability of the questionnaire was tested through KR_{20} and Pearson correlation coefficient (Pearson's r). "$KR_{20} = 0.9$" and "Pearson's r = 0.6," indicated acceptance of the assumption of the questionnaire was reliable. Although $KR_{20} > 0.90$ indicated a homogeneous test, our decision was to keep all the questions because they were valuable to test certain knowledge subsections of NAFLD.

The parameter estimates of difficulty and discrimination of each question were obtained from CTT and IRT. The essence of the debate between these two camps of scholars supported each approach focuses on whether the measures should meet certain requirements (CTT) versus the measures should capture the test results as they are (IRT). A further explanation is that the two statistics (difficulty and discrimination indices) received through CTT depend on participants' scores; whereas, IRT allows for evaluation of the question items and the test takers' latent trait simultaneously. In addition, measures through CTT are considered more reliable than their counterparts when including more items (longer questionnaire); however, measures through IRT were the opposite. It is worth noting the item properties depend on a representative sample through CTT, and which does not apply in IRT. Thus, the position on the latent trait continuum is derived from comparing the scores with the reference group in CTT. But the positions on the latent trait continuum through IRT are derived by comparing the distance between items on the ability scale.

In addition to 2PL-IRT model, 3PL-IRT model could estimate influence of guessing right answers. However, guessing would be a main consideration when questionnaire involves multiple-choice items. The 3PL-IRT should be performed to evaluate guessing behavior. To avoid guessing behaviors, in our True-False questions, we provided "I do not know, or I am not sure" option. Also, in the introduction of knowledge section of the questionnaire, we had the following statement: "Please answer the following questions truthfully according to your understanding. If you are not sure or do not know the answer, please select "I do not know, or I am not sure" option."

The reliability indicated the degree of a test consistently measures what it intends to measure. Test-retest reliability estimated the degree to which scores are consistent between two tests. We randomized the order of the question items in the second pilot made the test-retest even more robust. We evaluated the internal consistency through the KR_{20} which is a special case of Cronbach's α. Under the no missing data, unidimensionality of items circumstances, and with binary items, KR_{20} and Cronbach's α should be roughly equal. In our study, the Cronbach's α was also calculated, which was 0.92.

Several question items proved to be too difficult for the participants in Step 11. However, although these questions were in difficult range, they are still needed for assessing differential understanding of NAFLD among participants. In addition, the difficult questions reflected the general lack of knowledge by the participants. Those questions highlighted the needs for education in those domains. We decided it was appropriate to keep those in the final version.

Strengths and limitations

In light of the recent increase in NAFLD prevalence in China, this study represents a rare and urgently needed step in developing and validating a survey instrument on NAFLD awareness and knowledge. Through utilizing this survey instrument, researchers, health education specialists, and community health workers would be able to assess the awareness and knowledge of NAFLD among CYA. If the survey results showed limited awareness and knowledge of NAFLD among them, educational campaigns and interventions would be urgently needed to reduce the substantial disease burden of NAFLD. The study took several steps to ensure the rigor of its findings including content validity assessment and face validity through evaluations by an expert panel, ascertaining construct validity through two commonly used IA, and confirming internal consistency and test-retest reliability through analyzing the results received in two pilot tests among the same group of target population. The response rates in both pilot tests were high. The questionnaire was developed as a web-based, self-administered questionnaire, which will facilitate its use and uptake in the future. Typically, knowledge indicates information acquired from authoritative external sources. In the context of public health, the knowledge about a specific disease includes prevalence, etiology, risk factors, prevention, pathophysiology, symptomatology, progression, treatment, and existing health care services. The current questionnaire covered the main domains of knowledge of NAFLD.

There are some potential limitations. First, the sample size for the pilot test was relatively small. Second, the pilot tests were conducted among university students, thus potentially limiting external validity. Future research can assess suitability of the questionnaire applied to examine NAFLD awareness and knowledge in general adult population. Third, after revising the questions did not meet the criteria of content validity, we did not conduct a second-round panel evaluation.

In conclusion, this newly developed questionnaire is a reliable and valid instrument for assessing knowledge of NAFLD among CYA. This questionnaire will provide a reliable and validated easy-to-use instrument to educational intervention designers to assess baseline and post-intervention awareness and knowledge of NAFLD among CYA. Future studies can evaluate its validity and reliability when the questionnaire is used to assess awareness and knowledge of NAFLD among other age groups.

Author Contribution Statement

Yi Du: Conceptualization, methodology, software, validation, formal analysis, investigation, resources, data curation, writing – original draft, writing – review & editing, visualization, project administration; Fedja A Rochling: Conceptualization, methodology, writing – review & editing; Dejun Su: Conceptualization, methodology, validation, writing – review & editing, visualization, project administration; Kendra L Ratnapradipa: Conceptualization, methodology, validation, writing – review & editing, visualization; Jianghu Dong: Methodology, software, validation, visualization; Paraskevi A Farazi: Conceptualization, methodology, validation, formal analysis, investigation, resources, writing – review & editing, visualization, supervision, project administration.

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Ethics review and approval
The study was approved by the University of Nebraska Medical Center Institutional Review Board (protocol 216-21-EX).

Conflict of interest statement
Yi Du, Fedja A Rochling, Dejun Su, Kendra L Ratnapradipa, Jianghu Dong, Paraskevi A Farazi declare that they have no conflict of interest.

References

Arifin WN YM (2017). Item response theory for medical educationists. *Edu Med*, **9**, 69–81.

Bolarinwa OA (2015). Principles and methods of validity and reliability testing of questionnaires used in social and health science researches. *Niger Postgrad Med J*, **22**, 195-201.

Chen S, Chao S, Konerman M, et al (2019). Survey of Nonalcoholic Fatty Liver Disease Knowledge, Nutrition,

and Physical Activity Patterns Among the General Public in Beijing, China. *Dig Dis Sci*, **2019**.

Cody R, Jeffrey K, Smith (2014). Test Scoring and Analysis Using SAS®. Cary, NC: SAS Institute Inc.

Estes C, Anstee QM, Arias-Loste MT, et al (2018). Modeling NAFLD disease burden in China, France, Germany, Italy, Japan, Spain, United Kingdom, and United States for the period 2016-2030. J *Hepatol*, **69**, 896-904.

Ghaemi A, Taleban FA, Hekmatdoost A, et al (2013). How Much Weight Loss is Effective on Nonalcoholic Fatty Liver Disease?. *Hepat Mon*, **13**, e15227.

Goh GB, Kwan C, Lim SY, et al (2016). Perceptions of non-alcoholic fatty liver disease - an Asian community-based study. *Gastroenterol Rep (Oxf)*, **4**, 131-5.

Hallsworth K, Adams LA (2019). Lifestyle modification in NAFLD/NASH: Facts and figures. JHEP Rep, 1, 468-79.

Juo YY, Livingston EH (2019). Testing for Nonalcoholic Fatty Liver Disease. *JAMA*, **322**, 1836.

Kim S, Sinn D, Syn SY (2018). Analysis of College Students' Personal Health Information Activities: Online Survey. *J Med Internet Res*, **20**, e132.

Leung CM, Lai LS, Wong WH, et al (2009). Non-alcoholic fatty liver disease: an expanding problem with low levels of awareness in Hong Kong. *J Gastroenterol Hepatol*, **24**, 1786-90.

Li F, Liu Y, Harmer PA (2016). Physical activity, aging, and health in China: Addressing public health needs in the presence of continued economic growth and urbanization. *J Sport Health Sci*, **5**, 253-4.

Matthias AT, Fernandopulle ANR, Seneviratne SL (2018). Survey on knowledge of non-alcoholic fatty liver disease (NAFLD) among doctors in Sri Lanka: a multicenter study. *BMC Res Notes*, **11**, 556.

Miao J, Wu X (2016). Urbanization, socioeconomic status and health disparity in China. *Health Place*, **42**, 87-95.

Painter JE, Borba CP, Hynes M, et al (2008). The use of theory in health behavior research from 2000 to 2005: a systematic review. *Ann Behav Med*, **35**, 358-62.

Polit DF, Beck CT, Owen SV (2007). Is the CVI an acceptable indicator of content validity? Appraisal and recommendations. *Res Nurs Health*, **30**, 459-67.

Steptoe A, Wardle J, Vinck J, et al (1994). Personality and attitudinal correlates of healthy and unhealthy lifestyles in young adults. *Psychol Health*, **9**, 331-43.

Teng Y-X, Xie S, Guo P-P, et al (2022). Hepatocellular Carcinoma in Non-alcoholic Fatty Liver Disease: Current Progresses and Challenges. 0-.

Tsang S, Royse CF, Terkawi AS (2017). Guidelines for developing, translating, and validating a questionnaire in perioperative and pain medicine. *Saudi J Anaesth*, **11**, 80-9.

Yan J, Xie W, Ou WN, et al (2013). Epidemiological survey and risk factor analysis of fatty liver disease of adult residents, Beijing, China. *J Gastroenterol Hepatol*, **28**, 1654-9.

Younossi Z, Anstee QM, Marietti M, et al (2018). Global burden of NAFLD and NASH: trends, predictions, risk factors and prevention. *Nat Rev Gastroenterol Hepatol*, **15**, 11-20.

Zastrow C, Kirst-Ashman KK (2001). Understanding human behavior and the social environment, Belmont, CA, Brooks/Cole, Thomson Learning.

Zhang W, Chao S, Chen S, et al (2019). Awareness and Knowledge of Nonalcoholic Fatty Liver Disease Among Office Employees in Beijing, China. *Dig Dis Sci*, **64**, 708-17.

Zhou J, Zhou F, Wang W, et al (2020). Epidemiological Features of NAFLD From 1999 to 2018 in China. *Hepatology*, **71**, 1851-64.

Zou TT, Zhang C, Zhou YF, et al (2018). Lifestyle interventions for patients with nonalcoholic fatty liver disease: a network

meta-analysis. *Eur J Gastroenterol Hepatol*, **30**, 747-55.