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Adolescents diabetes awareness test (ADAT): Tool development and psychometrics evaluation research

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Abstract:

BACKGROUND: During the last two decades, several reports have indicated an increase in the number of type-2 diabetes among adolescents. Therefore, an assessment of adolescents' awareness of this disease deserves serious consideration. This study aims at designing a psychometric tool for assessing adolescents' awareness of type-2 diabetes.

METHODS AND MATERIAL: In this methodological research, 770 students attending 10 middle schools (five girls "schools and five boys" schools) from Tehran participated in the study. The questionnaire was designed by examining the relevant literature and the existing questionnaires, as well as considering the research team's comments, and the initial pool of items with 57 questions was designed. Face validity, content validity, and construct validity were calculated to determine the validity of the instrument. Reliability was measured via internal consistency coefficient (ICC) and internal consistency reliability was measured with Cronbach Alpha. SPSS 16 was used for data analysis.

RESULTS: The questionnaire was initially designed with 57 items. Based on the results of CVR and CVI, five questions were removed. The average CVR and CVI were 0.75 and 0.82, respectively. Following exploratory factor analysis, the 30 questions in the questionnaire were categorized into five dimensions: public awareness, symptoms, behavioral risk factors, long-term effects, and medium-term effects. The internal reliability was calculated for the whole questionnaire—ICC = 0.87 with a Cronbach alpha coefficient of 0.80.

CONCLUSIONS: The resulting questionnaire on adolescents' awareness of type-2 diabetes, with 30 questions in five dimensions, can be employed by researchers for its high factor loading in factor analysis and its standard psychometric properties.

Keywords:

Adolescents, awareness, designing, diabetes mellitus, evaluation, psychometrics

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Introduction

Type-2 diabetes is a chronic disease similar to a pandemic and constitutes 90% of all cases of diabetes.[1] According to a report by the World Health Organization (WHO), about 422 million people in the world suffer from diabetes mellitus (DM), with Eastern Mediterranean countries accounting for the highest prevalence (43 million people). DM is among the 10 highest lethal diseases worldwide and caused 1.6 million deaths in 2016.[2] In addition, this serious disease is witnessed as a new clinical condition among children. There has been a surge in the number of type-2 diabetics among children.[3] Evidence is accumulating that young-onset type-2 diabetes has a more aggressive disease phenotype, leading to premature development of complications, with adverse effects on quality of life and unfavorable effects on long-term outcomes, raising the possibility of a future public health catastrophe.[4] Experts expect more cases of

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this malady to appear among children in the coming decades.[5] The age of type-2 diabetes diagnosis is reported to be between 12 and 14 years, which co-occurs with the age of puberty.[6] The prevalence of type-2 diabetes was almost 1% among Iranian youth in 2011.[7] This disease can cause several complications in different parts of the body.[8] Nearly 5 million diabetics in the 20 to 79 years age range died in 2015. This appalling figure equals one death per 6 s. In 2016, type-2 diabetes was the seventh major cause of death in the world. In Iran, 10.8% of all mortalities (3,7075 cases) were associated with diabetes.[8] Sufferers not only incur enormous expenses but they have to deal with other dire consequences such as pain, anxiety, headache, discomfort, disability, stress, depression, infection, amputation, and digestive disorders.[9] Type-2 diabetes can be caused by a multitude of factors such as sociocultural, geographical, and environmental ones.[10] What WHO has adopted as a strategic measure to combat and curb diabetes is education.[11] Education or awareness raising seems essential[12] to the point that it can transform people's attitudes and lifestyles.[13]

Raising awareness among adolescents of non-infectious diseases and their risk factors is an integral part of preventive strategies. One such strategy is the evaluation, as well as the dissemination of information, regarding reversible risk factors.[14] Adolescents comprise a large portion of the population of countries, especially our country, and play a vital role in the dynamism and continuity of the social life of a nation and its comprehensive development.[15] Assessing adolescents' awareness of type-2 diabetes requires a valid instrument.[16] Most of the existing instruments measure diabetics' quality of life (DQOL),[17] diabetes self-care,[18] diabetes knowledge,[19] diabetics' awareness, attitude, and behavior,[20] and other instruments in the field of type-2 diabetes prevention are not designed to be comprehensive and most of them only deal with factors such as nutrition and physical activity and do not include all the risk factors of type-2 diabetes.[21]

Therefore, this study aimed at designing a comprehensive instrument with acceptable reliability and validity.

Materials and Methods

Study design and setting

This research is a methodological investigation performed in Tehran.

Inclusion and exclusion criteria

The entry criteria for research were junior high school students, students' willingness to participate, and not suffering from type-1 or type-2 diabetes. Also, the exclusion criteria from the study were reluctance to participate in the study at any stage.

Study participants and sampling

In this research, 770 male and female adolescents (between 13 and 15) participated. Initially, Tehran was divided into five sections. From each section, one area was selected. Then, a girl's school and a boy's school were randomly selected from each area—totally 10 schools. Finally, following the participation criteria, students were randomly selected from each grade to meet the study's criteria.

Data collection tool and technique: The design of the instrument took place in four stages:

1. Systematic review of the literature and the relevant instruments
2. Designing the items of the instrument employing the existing documents, papers, and questionnaires in Iran and other countries
3. Reliability of the instrument
4. Validity of the instrument.

Stage 1. In this stage, the relevant questionnaires and the review of literature were carefully studied.

Stage 2. Relevant questions were extracted from various instruments and some questions were designed by virtue of papers and documents. Then, after negotiation with research team members, the final items were added to the pool of questions. The first draft of the questionnaire with 57 questions was designed.

Stage 3. Face validity, content validity, and construct validity were used to determine the validity of the instrument.

Determination of content validity

Both quantitative and qualitative methods were employed to determine content validity. In quantitative analysis of content validity, content validity ratio (CVR), as well as content validity index (CVI), was calculated. To determine the content validity ratio, 11 experts (7 health education experts and 4 endocrinologists) were purposefully selected and asked to evaluate each question with respect to content as essential, beneficial, or non-essential.

Then, the responses were calculated based on this formula:

$$CVR = \frac{n_E - N/2}{N/2}$$

Finally, the resulting CVR amounts higher than 59% were accepted based on Lawshe Table.

To calculate the content validity index, those 11 experts examined each question based on the three criteria of

relevance, clarity, and simplicity. CVI is the sum of the number of answers 3 and 4 by the total number of answers:

$$CVI = \sum \frac{\text{Number of answers 3 or 4}}{\text{Total Number of answer}}$$

The resulting amounts higher than 79% were accepted. In the qualitative analysis, the experts were asked to express their opinions on each item.

Determination of face validity

Face validity was determined both qualitatively and quantitatively. In the qualitative phase, 20 students of 13 to 15 years of age (10 male and 10 female) were interviewed face-to-face. Their views on the questions were regarded. Finally, the necessary modifications were made by the research team. In the next stage, the quantitative method was used to remove the inappropriate questions and determine the significance of each question. The same 20 students were asked to examine the questions based on a 5-point Likert scale scoring and select one. Then, the impact score of each question was calculated.

Scores higher than 1.5% were considered acceptable.[22] No question was removed at this stage.

Determination of construct validity

Based on at least 10 samples for each question designed for the questionnaire,[23] 770 students were selected to meet the requirements for determining construct validity. To determine this validity, exploratory factor analysis with varimax rotation was employed. To perform exploratory factor analysis, two tests of sampling adequacy Kaiser-Mayer-Olkin (KMO) and Bartlett's test of sphericity were utilized. The amount of 0.8 was determined to be adequate.[23]

Stage 4. To determine the reliability of the instrument, test-retest and internal consistency were utilized.

Determination of reliability

Cronbach's alpha was calculated to determine the internal consistency and Cronbach's alpha of between 70% and 80% was set.[24] Test-retest was employed to investigate the stability of the instrument over time: a 15-day gap between the two tests. A correlation coefficient of higher than 70% was considered adequate for the questions. The questionnaire was completed by 40 adolescents (20 female and 20 male). After 15 days, the same students filled out the questionnaire [Figure 1].

Data analysis

CVR/CVI and impact scores were calculated to determine content validity and face validity, respectively.

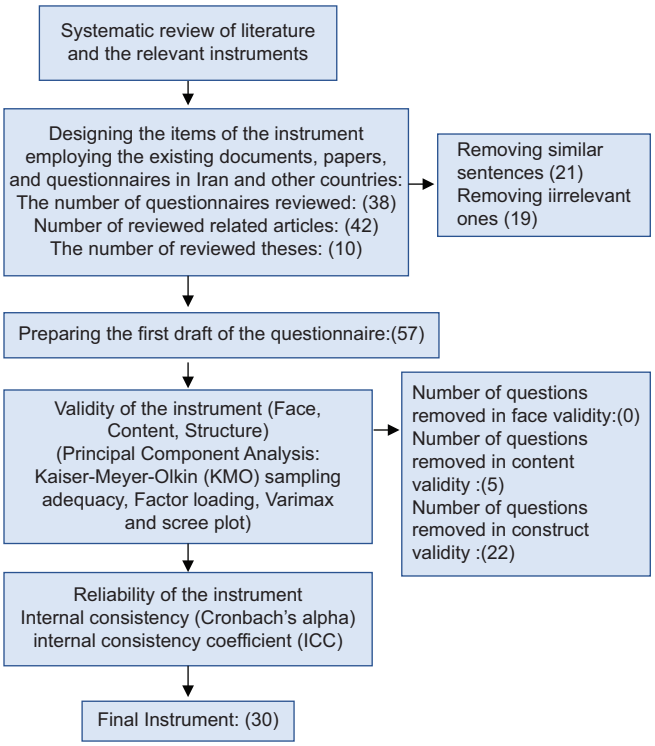

Figure 1: Flowchart of the design and psychometric stages of the questionnaire

Construct validity was calculated through exploratory factor analysis (EFA) with varimax rotation.

Cronbach's alpha coefficient was calculated to determine the internal consistency. To check the stability of the instrument, the internal correlation coefficient (ICC) was used. SPSS16 was consulted for data analysis.

Ethical consideration

The researchers observed all the ethical codes including informed consent, confidentiality, plagiarism, double publication, data manipulation, and fake data generation. The ethical research code for this study is IR.SBMU.PHNS.REC.1398.146 from Shahid Beheshti Medical Sciences University.

Results

Participants

In this study, 770 people participated. The participants' descriptive characteristics are listed in Table 1.

Question design

Having explored various instruments and studied relevant papers and documents, the research team came up with an initial list of 77 items. Then, similar sentences (12 items) and irrelevant ones (8 items) were removed and the first draft of the questionnaire with 57 questions was designed.

Content validity

In the qualitative phase of content validity, much attention was paid to experts' suggestions.

CVI and CVR were used to quantitatively measure the content validity. Five items were removed and 52 questions remained. The average CVR and CVI were 0.75 and 0.82, respectively, for the whole questionnaire.

Qualitative face validity

In the qualitative phase of face validity, based on participants' feedback, some questions were modified to minimize ambiguity.

Quantitative face validity

In the quantitative phase, the student's responses were analyzed. Since the impact scores of all the questions were higher than 1.5, no question was removed at this stage. Next, the questionnaire with 52 items was analyzed for construct validity.

Structural validity

KMO index and Bartlett's test of sphericity showed the adequacy of the data for performing factor analysis. The KMO test result demonstrated the adequacy of the data (KMO = 0/91), and so did Bartlett's test (P </001).

According to Table 2, five factors with particular amounts higher than one were extracted.

Based on the results, five factors were extracted from factor analysis with varimax rotation [Table 3]. Twenty-two expressions/questions that had a loading lower than 0.4 were removed from the questionnaire. The number of questions was reduced to 30 items.

Reliability

Internal instrument compatibility was 82% and the stability of the instrument was 87% [Table 4].

Final tool

The designed questionnaire included 30 questions in five dimensions. The scoring procedure was as follows: "correct answers" 2 points, "wrong answers" zero, and "I don't know" 1 point. The maximum obtainable score was 58 and the lowest score was zero.

Table 1: Demographic information of the Participants

Variables	Group Sub	Number	Percent
Age	13	267	35
	14	247	32
	15	256	33
Gender	Girl	453	59
	Boy	317	41
Grade education	Seventh	270	36
	Eighth	242	31
	Ninth	258	33
Fathers' occupation	Employee	223	29
	Self-employed	407	54
	Unemployed	48	6
	Retired	92	11
Mothers' occupation	Employed	247	32
	House keeping	523	68
Fathers' education	Illiterate	25	3
	Primary	58	7
	Intermediate	155	20
	Secondary	296	39
	Institutes/College	236	31
Mothers' education	Illiterate	17	2
	Primary	72	9
	Intermediate	116	15
	Secondary	324	43
	Institutes/College	241	31
Economic situation	Poor	67	8
	Middle	268	35
	Good	304	39
	Excellent	131	17

Table 2: Rotated component matrix, eigenvalue, and cumulative variance contribution rate

Special amount of extraction agents by rotation (Rotation Sums of Loadings)			
Fact	**Eigenvalues%**	**Variance%**	**Cumulative%**
General knowledge	3.78	12.62	12.62
Symptoms of disease	2.49	8.30	29.99
Behavioral risk factors	2.11	7.03	37.02
Long-term consequences	2.71	9.06	21.68
Medium-term consequences	2.05	6.85	43.88

Discussion

This study aims at designing a psychometric tool for assessing adolescents' awareness of type-2 diabetes. This study gave rise to a questionnaire with 30 items and five factors were extracted: public awareness, symptoms, behavioral risk factors, medium-term effects, and long-term effects. The findings of this study provide clear evidence concerning the validity and reliability of the psychometric tool or the questionnaire. In any measure, a researcher is interested in representing the characteristics of the subject accurately and consistently. The desirable characteristics of a measure are reliability and validity. Both are important for the conclusions about the credibility of good research.[25] To check the validity of the questionnaire, content validity, face validity, and construct validity were used in this project. Content validity is defined as the degree to which elements of an assessment instrument are relevant to a representative of the targeted construct for a particular assessment purpose.[26] Evaluation of the content of the questionnaire by experts constitutes

Table 3: Factor load of knowledge questionnaire items based on factor analysis with varimax rotation

Questions	Component				
	1	2	3	4	5
A decline in cholesterol level can prevent type-2 diabetes.	0.721				
Adequate sleep (between 7 and 8 hours) can prevent type-2 diabetes.	0.655				
Controlling blood pressure (ideally 120/80 mm Hg) can play a role in preventing type-2 diabetes.	0.638				
Combatting stress and depression can curb type-2 diabetes.	0.621				
Regular physical activity can prevent type-2 diabetes.	0.612				
Vitamins D and K can reduce type-2 diabetes risks.	0.586				
Maintaining a healthy weight can minimize the risk of type-2 diabetes.	0.568				
Controlling blood sugar (less than 100 mg/dL) can reduce type-2 diabetes risks.	0.512				
A healthy diet (less sugar, salt, and fat; more fruit and vegetables) can prevent type-2 diabetes.	0.491				
Type-2 diabetes is one major cause of death.		0.641			
Diabetic foot ulcers and amputations are some of the complications of type-2 diabetes.		0.636			
Type-2 diabetes can increase household expenses.		0.622			
Type-2 diabetes reduces the quality of life.		0.609			
Type-2 diabetes can cause blurred vision or blindness.		0.566			
Extreme hunger is one of the symptoms of type-2 diabetes.			0.579		
Constant feeling of exhaustion can be one of the symptoms of type-2 diabetes.			0.573		
Frequent urination is one of the symptoms of type-2 diabetes.			0.558		
Excessive and persistent thirst (polydipsia) is one of the symptoms of type-2 diabetes.			0.531		
Chronic skin wounds can be one of the symptoms of type-2 diabetes.			0.483		
Blurred vision is one symptom of type-2 diabetes.			0.467		
Tingling fingers and toes can be a symptom of type-2 diabetes.			0.458		
Vitamin and nutrient deficiency (D, K) is one cause of type-2 diabetes.				0.623	
High TV viewing (more than 3 h a day) can contribute to type-2 diabetes.				0.603	
Smoking can increase type-2 diabetes risk.				0.545	
Sleep deprivation (less than 7 h) or insomnia can result in type-2 diabetes.				0.541	
Type-2 diabetes can lead to strokes.					0.636
Nonalcoholic fatty liver disease (NAFLD) is one of the complications of type-2 diabetes.					0.537
Type-2 diabetes can contribute to depression.					0.526
Type-2 diabetes can increase the risk of cardiovascular diseases.					0.523
Type-2 diabetes can lead to hypertension.	.				0.429

Table 4: The ICC and the Cronbach's α coefficient of each factor and the whole questionnaire

Factor	Number of Items	Cronbach's alpha coefficient	Intra-class Correlation Coefficient ICC (*n*=40)
General knowledge	9	0.78	0.86
Symptoms of disease	7	0.70	0.74
Behavioral risk factors	4	0.73	0.93
Long-term consequences	5	0.70	0.70
Medium-term consequences	5	0.70	0.70
Total	30	0.80	0.87

a great way to gather evidence in support of the validity of a measurement tool.[27] Eleven eminent professors conducted the process of content validation of the present questionnaire. They were asked to give their verdict on the questions. According to Lawshe Table, the amounts higher than 0.59 and 0.79 for CVR and CVI, respectively, were accepted.

Face validity was determined through qualitative and quantitative methods. In fact, face validity is an evaluation of the layman's perception of an instrument, and demonstrates that the designed instrument measures exactly what it has been designed to measure.[28] In the quantitative analysis, since the impact scores of all the questions were above 1.5, all the questions were considered appropriate for further analysis. Considering the feedback from the research population, this result indicates that the resulting questionnaire has been simple to understand and respond to. It also highlights the fact that the expressions used have been relevant and significant.

In the qualitative analysis of the face validity, students' comments on some items resulted in slight modifications of some of the questions.

Exploratory factor analysis was conducted to determine construct validity. Factor analysis is a multivariate

statistical method to determine whether there are recognizable dimensions to describe and categorize a multitude of the variable. The primary aim of exploratory factor analysis is to reduce the number of dimensions so as to describe and use them with ease.[29] In this study, KMO and Bartlett's tests were used to determine the construct validity through exploratory factor analysis. KMO amount fluctuates between zero and one. If the amount is lower than 0.5, the data are not acceptable for factor analysis. If it is between 0.5 and 0.69, factor analysis is performed with caution. If the amount is above 0.7, the correlations between and among the data are strong enough for factor analysis. To ensure that the resulting correlation matrix is significantly different from zero in this study, Bartlett's test of sphericity was employed to justify the use of factor analysis.[30] In this project, the index was found to be 0.91 for all the constructs and the significant level was set to be 0.001 in Bartlett's test of sphericity, which confirms the adequacy of sampling and factor analysis.

By obtaining these five factors through exploratory factor analysis, the validity of the construct was verified to measure adolescents' awareness of type-2 diabetes.

Adolescents' awareness of this disease can contribute to its timely diagnosis and reduce its irreversible complications. This goal can be attained by education and training in the early stages of life. In addition, adolescents' awareness of type-2 diabetes can significantly reduce the risk of this disease in adulthood.[13] Symptoms and behavioral risk factors were other variables extracted by exploratory factor analysis. Most of these risk factors are reversible; therefore, the identification of these contributing factors plays a crucial role in preventing or at least postponing type-2 diabetes among adolescents. The other extracted factors in this study are the complications of the disease and its latent, long-term effects. It seems that type-2 diabetes among children and adolescents is more invasive than latent type-2 diabetes. The development of glucose intolerance or impaired glucose fasting (IGF) to type-2 diabetes is not necessarily linear over time and is faster among children or adolescents compared to adults.[31] Diabetes management is quite complicated among children as it involves managing diseases concomitant with diabetes and obesity.[32] It is estimated that adolescents suffering from type-2 diabetes will live 15 years less than their peers without diabetes.[33]

In this study, Cronbach's Alpha Coefficient was used to measure internal consistency reliability. This is the most common method of determining the internal consistency coefficient employed in research studies[34] and representing the degree of consistency among a group of items measuring a construct. The alpha value should be at least 0.7 or beyond so that a question can be retained in an instrument.[35]

In addition, test-retest—the most valid measure of intraclass correlation coefficient—was used to determine the consistency of the instrument. In the present study, the result obtained from the reliability of the instrument showed that the Cronbach's alpha coefficient stood at 0.80, and the consistency coefficient of 0.87 for each factor represents the internal consistency of the awareness questionnaire concerning type-2 diabetes among adolescents. According to the results, the stability, replicability, and reliability of this instrument were seen to be acceptable. Considering the prevalence of type-2 diabetes and its myriad complications among adolescents, it is imperative to adopt preventive measures to stop the growth of this disease among adolescents.

Limitations and recommendation

In addition to being reliable, valid, and replicable, one of the strong points of the instrument is the fact that it completely covers all the behavioral risk factors contributing to type-2 diabetes. One limitation of the study is self-report in data gathering.

Conclusion

In this study, an instrument was designed to measure adolescents' awareness of type-2 diabetes in Tehran. Data analysis approved the content validity, face validity, construct validity, internal consistency, and stability of the instrument. This instrument is an objective, simple yet comprehensive tool to assess adolescents' awareness of type-2 diabetes, which can be used in future research projects.

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Declaration of patient consent

The authors certify that they have obtained all appropriate patient consent forms. In the form the patient(s) has/have given his/her/their consent for his/her/their images and other clinical information to be reported in the journal. The patients understand that their names and initials will not be published and due efforts will be made to conceal their identity, but anonymity cannot be guaranteed.

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Conflicts of interest
There are no conflicts of interest.

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