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Assessing Hereditary Cancer Awareness among Medical students: Development and Psychometric Evaluation of the Hereditary Cancer Awareness Scale

Tıp Fakültesi Öğrencilerinde Kalıtsal Kanserin Farkındalığının Değerlendirilmesi: Kalıtsal Kanser Farkındalık Ölçeğinin Geliştirilmesi ve Psikometrik Değerlendirilmesi

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Abstract

Aim: Cancer is the first or second leading cause of death in Worldwide. About 5 percent to 10 percent of most all cancers are caused by inherited mutations. This rate is up to 50 per cent in some cancers. Medical faculty graduates are the first group in contact with patients compared to specialized physicians. The level of knowledge or awareness of this group about familial inherited cancers is important in terms of early detection of cancer in the community. The main purpose of the study was to develop a hereditary cancer awareness scale in medical students and to test its validity, reliability and item analysis.

Methods: This study is a descriptive research and it was conducted based on the survey model in order to develop the Hereditary Cancer Awareness Scale (HCAS). In exploratory factor analysis, there are 211 females (55.5%) and 169 males (44.5%) in the sample. The mean age of the group was found to be 21.36 (SD; 1.98). Personal Information Form, and Hereditary Cancer Awareness Scale (HCAS) were used to collect the data in all part of the research. IBM SPSS 22.00, JAMOVI, and LISRELprograms were used in analyzing data. Validity of scales was ensured through Exploratory and Confirmatory Factor Analysis (EFA and CFA), while reliability was measured using Cronbach's Alpha and McDonald's ω. Scales were administered, taking approximately 10-15 minutes per participant. The research involved Pamukkale University Faculty of Medicine students from May 2022 to July 2022, and adherence to the principle of voluntariness was fundamental. Participants received brief information about the research purpose before deciding to participate. Identity information was not solicited, and additional clarifications were provided as needed.

Results: The study used Krippendorff's alpha to establish inter-rater reliability for Content validity, yielding an agreement of 0.84 (Krippendorff's $\alpha = 0.84$). Exploratory factor analysis confirmed a single-factor structure with 14 items, all positively coded (item loadings: .49 to .65), explaining 30.22% of scale variance. Confirmatory factor

Keywords:
Hereditary Cancer Scale, Cancer Awareness, Validity, Reliability, Scale Development

Anahtar Sözcükler:
Kalıtsal Kanser Ölçeği, Kanser Farkındalığı, Geçerlilik, Güvenirlik, Ölçek Geliştirme

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analysis supported the model's compatibility (χ^2/df = 1.83, GFI = .92, AGFI = .92, CFI = .91, NFI = .91, NNFI = .92, RMR = .033, RMSEA = .066). Path coefficients ranged from .36 to .59, all above .30. Reliability was demonstrated with Cronbach's alpha (α = 0.83) and McDonald's ω (ω = 0.84). All items correlated significantly ($r \geq 0.20$) with the scale, and individual item reliabilities exceeded 0.70. Overall, findings support the Hereditary Cancer Awareness Scale (HCAS) as a valid and reliable tool for assessing medical students' awareness of hereditary cancer.

Conclusions: The study introduced the Hereditary Cancer Awareness Scale (HCAS) as a reliable and valid tool to measure hereditary cancer awareness among medical students. The findings highlighted the need to improve this awareness. Using this scale in medical education and cancer awareness programs is crucial for increasing cancer awareness and preventing familial hereditary cancer in the future.

Özet

Amaç: *Kanser, dünya genelinde ölümün başlıca veya ikinci başlıca sebebidir. Tüm kanserlerin yaklaşık %5 ila %10'u kalıtsal mutasyonlardan kaynaklanmaktadır. Bu oran bazı kanser türlerinde %50'ye kadar çıkmaktadır. Tıp fakültesi mezunları, uzman doktorlara kıyasla hastalarla ilk temas kuran ilk grup olmaktadır. Bu grubun ailevi kalıtsal kanserler konusundaki bilgi veya farkındalık düzeyi, toplumda kanserin erken teşhisi açısından önemlidir. Çalışmanın temel amacı, tıp öğrencileri arasında bir kalıtsal kanser farkındalık ölçeği geliştirmek ve bu ölçeğin geçerliliği, güvenirliği ve madde analizini test etmektir.*

Yöntem: *Bu çalışma, Kalıtsal Kanser Farkındalık Ölçeği (KKFO) geliştirmek amacıyla ilişkisel tarama modeline dayalı olarak yapılan tanımlayıcı bir araştırmadır. Örneklemde 211 kadın (%55.5) ve 169 erkek (%44.5) bulunmaktadır. Grubun yaş ortalaması 21.36 (SD; 1.98) olarak bulunmuştur. Araştırmanın tüm aşamalarında Kişisel Bilgi Formu ve Kalıtsal Kanser Farkındalık Ölçeği (KKFO) kullanılmıştır. Verilerin analizinde IBM SPSS 22.00, JAMOVI ve LISREL programları kullanılmıştır. Ölçeklerin geçerliliği Açımlayıcı ve Doğrulayıcı Faktör Analizi ile sağlanmış, güvenirlik ise Cronbach's Alpha ve McDonald's ω kullanılarak ölçülmüştür. Katılımcılara ortalama 10-15 dakika süren testler uygulanmıştır. Araştırma, Mayıs 2022 ile Temmuz 2022 tarihleri arasında Pamukkale Üniversitesi Tıp Fakültesi öğrencileri üzerinde gerçekleştirilmiş olup, katılımcıların gönüllülük ilkesine dayalı olarak katıldığı belirtilmiştir. Katılımcılara araştırmanın amacı hakkında kısa bilgi verilmiş, kimlik bilgisi istenmemiş ve ihtiyaç duyulması halinde ek açıklamalar yapılmıştır.*

Bulgular*: Çalışmada, kapsam geçerliğinin belirlenmesi için Krippendorff's alfa kullanmış ve alfa değeri 0.84 (Krippendorff's α = 0.84) olarak bulunmuştur. Açımlayıcı faktör analizi, 14 maddeden oluşan tek faktörlü bir yapıyı doğrulamış (madde yükleri: .49 ile .65 arasında), 14 maddelik formun ölçeğin varyansının %30.22'sini açıkladığı görülmüştür. Doğrulayıcı faktör analizi, modelin uyumunu desteklemiştir (χ^2/df = 1.83, GFI = .92, AGFI = .92, CFI = .91, NFI = .91, NNFI = .92, RMR = .033, RMSEA = .066). Yol katsayıları .36 ile .59 arasında değişmiş olup, tümü .30'un üzerindedir. Güvenilirlik çalışması, Cronbach's alpha (α = 0.83) ve McDonald's ω (ω = 0.84) değerlerini vermiş ve ölçeğin güvenilir olduğunu gstermiştir. Tüm maddeler ölçekle anlamlı şekilde korele olup ($r \geq 0.20$), bireysel madde güvenilirlikleri 0.70'in üzerindedir. Genel olarak bulgular, Kalıtsal Kanser Farkındalık Ölçeği'nin (KKFO) tıp öğrencilerinin kalıtsal kanser farkındalığını ölçmek için geçerli ve güvenilir bir araç olduğunu desteklemektedir.*

Sonuç: *Çalışmada, tıp öğrencileri arasında kalıtsal kanser farkındalığını ölçmek için güvenilir ve geçerli bir araç olarak Kalıtsal Kanser Farkındalık Ölçeği'ni (KKFO) geliştirilmiştir. Bulgular, bu farkındalığın artırılması gerekliliğini vurgulamaktadır. Bu ölçeğin tıp eğitiminde ve kanser farkındalığı programlarında kullanılması, gelecekte ailevi kalıtsal kanserin önlenmesi ve kanser farkındalığının artırılması açısından önemlidir.*

INTRODUCTION

Cancer is the second leading cause of death in the world and in Turkey. When the 2022 US data is analyzed, it is seen that the total number of data is 1,958,310 cases which means 5370 new cases per day. These cases are followed by

prostate, lung and colon cancers in men and breast, lung and colon cancers in women (1).

According to 2020 data, there are a total of 233834 new cases in Turkey. While lung, prostate and colorectal cancers are more common in men, breast, thyroid and colorectal cancers are more common in women (web1). In the light of current data, tumor suppressor and oncogenes are responsible for 5-10% of familial inherited cancer cases (FICC) (2). Although there are more than 200 of these genes, only pathogenic variants of these genes cause FICC (2). These pathogenic variants are not only autosomal recessive and some of them, such as familial breast and ovarian cancer syndrome (FBOCS), Lynch syndrome, Li-Fraumeni syndrome and others, are inherited as autosomal dominant (3). Individuals who are carriers of inherited cancers are considered as potential early cancer cases. Initially, BRCA1-2 genes associated with breast and ovarian cancers were thought to account for 12-15% of cases (4). In addition, recent studies have found that these genes are also associated with prostate and pancreatic cancer (4). However, with the development of new generation sequencing technology, ATM, CHEK2, BRIP1, BARD1, RAD51C, RAD51D, NF1, NBN, PALB2, MLH1, MSH2, PMS1, PMS2, MSH6, TP53, CDH1, SKT11 and PTEN genes have been found to be associated with other cancer types (4-7).

Early diagnosis of cancer cases significantly reduces cancer-related mortality (1). It is not expected that individuals with a family history of cancer will understand the importance of their own genetic knowledge in countries like ours with low sociocultural level. In this context, due to the reasons listed above, measuring the level of awareness of familial hereditary cancer in medical students can contribute to both the field and life. In the review, it was thought that there is no measurement tool measuring familial hereditary cancer awareness in both international and Turkish literature and this situation is a deficiency for the literature. In this regard, in order to solve the related problem, this study aimed to develop a tool to measure familial hereditary cancer awareness in medical students. This situation reveals the importance of genetic counselling. General practitioners graduated from medical faculties undertake many tasks in the field in Turkey. Therefore, graduates of medical faculties are the first group in contact with patients compared to specialized physicians. The level of knowledge or awareness of this group about familial inherited cancers is important in terms of early detection of cancer in the community. In the curricula of medical faculties, the structure and function of DNA is explained in the first or second year, but genetics in the clinic is not explained in 4-5-6 years. In this respect, this scale was developed to reveal the presence or absence of this deficiency. The main purpose of the study was to develop a cancer awareness scale in medical students and to test its validity, reliability and item analysis.

The lack of a measurement tool to measure the level of awareness of medical students about hereditary cancer is prominent in the relevant literature. In this study, it was aimed to develop a tool to measure hereditary cancer awareness in medical students and to test its psychometric properties. In order to construct the HCAS, item pool, content validity and then exploratory factor analysis were performed.

METHODS

Research Model

This study is a descriptive research and it was conducted based on the survey model in order to develop the Hereditary Cancer Awareness Scale (HCAS). Survey models are research approaches that aim to describe a past or current situation as it exists (8). The data were obtained from individuals of different ages and cross-sectional research design was used.

Participants

The study focused on medical students,

employing purposive sampling with specific criteria, including enrollment in the Medical Biology and Genetics course. The maximum diversity method was adopted within purposive sampling (9-11). Initially, 406 participants were included, but after reviewing data tool responses, 26 outliers were excluded. The final analysis comprised 380 observations, emphasizing the importance of the chosen sampling method in gaining insights into universe values. The gender distribution shows that there are 211 females (55.5%) and 169 males (44.5%) in the sample. This indicates that females are more represented in the sample. Regarding the grade distribution, 2nd grade students have the highest proportion with 102 individuals (26.8%). They are followed by 1st grade students with 81 individuals (21.3%). The other grades are distributed as follows: 3rd grade with 54 individuals (14.2%), 4th grade with 64 individuals (16.8%), 5th grade with 39 individuals (10.3%), and 6th grade with 40 individuals (10.5%). In terms of perceived socioeconomic status, the majority of participants perceive themselves to be at a medium level (68.7%). Those who identify as having a low socioeconomic status account for 73 individuals (19.2%), while those who perceive themselves as having a high socioeconomic status number 46 individuals (12.1%). The mean age of the group was found to be 21.36 (SD; 1.98).

Data Collection Tools

In the study, data were collected through personal information form and scales described below in the form of individual application.

1. Personal Information Form. Information about the demographic characteristics of the participants was obtained through the personal information form.

2. Hereditary Cancer Awareness Scale (HCAS) In order to prepare a measurement tool for hereditary cancer awareness, medical students were asked to write essays about hereditary cancer. These essays and both theoretical and empirical studies in the literature were analyzed and the sentences that could be scale items were underlined. At the end of this process, a 42-item draft form was prepared, which was thought to be an indicator of peer relations. As a result of the review by experts working in the field of cancer and in the field of measurement and evaluation, it was agreed that all 42 items were suitable for the purpose, and thus the trial form of the scale was created. Each item in the trial form was rated using a three-point Likert-type scale labelled as "wrong", "don't know" and "correct".

Data Analysis

The research utilized IBM SPSS 22.00, JAMOVI, and LISREL for statistical analysis (web 2-4). Demographic characteristics were assessed through frequency and percentage distribution. Validity of scales was ensured through Exploratory and Confirmatory Factor Analysis (EFA and CFA), while reliability was measured using Cronbach's Alpha and McDonald's ω. Exploratory Factor Analysis aims to condense variables into meaningful ones, and Confirmatory Factor Analysis tests the known factor structure of a scale. The inclusion of items in a factor during EFA depends on a high loading value, signifying a strong relationship. While a loading value of 0.45 or higher is typical, items with a 0.30 value can also be retained (12.13). A 95% confidence interval was applied in data analysis.

Process

The study received approval from the Pamukkale University Non-interventional Clinical Research Ethics Committee (Ethics Committee number: E-601167887-020-362798), and data collection occurred through individual applications. Scales were administered, taking approximately 10-15 minutes per participant. The research involved Pamukkale University Faculty of Medicine students from May 2022 to July 2022, and adherence to the principle of voluntariness was

fundamental. Participants received brief information about the research purpose before deciding to participate. Identity information was not solicited, and additional clarifications were provided as needed.

RESULTS

Item Pool and Content Validity

The determination of the theoretical framework of HCAS was accomplished in two stages. In the initial stage, a literature review was conducted. The literature review encompassed studies related to familial hereditary cancer (14-18). As the second stage for determining the theoretical framework of HCAS, compositions related to hereditary cancer were obtained from 24 medical students. A trial form was then created using sentences that could potentially become item candidates from the literature review and compositions.

The item pool for the study comprised 42 statements, and expert opinions were sought for the trial form. Content validity, assessing the alignment of the scale and each item with the intended purpose (19), utilized the Davis technique (1992), categorizing opinions into "Appropriate," "Item needs minor revision," "Item needs significant revision," and "Item is inappropriate." A content validity index of 0.80 was set as the threshold (20). After initial item evaluations, expert opinions were gathered for scale structuring, involving 6 experts in this study (21). Experts indicated their agreement level with each statement's ability to measure the intended attribute clearly. Opinions of "Agree" or "Undecided" were considered valid, while "Disagree" was deemed invalid. Based on expert recommendations, all items were reevaluated, leading to adjustments.

Inter-rater reliability was calculated using Krippendorff's alpha, a technique applicable to all measurement levels. The analysis revealed an inter-rater agreement of 0.84 (Krippendorff's $\alpha = 0.84$). Krippendorff's alpha values range from 0 to +1, with 1 indicating perfect agreement. In this study, an alpha value of 0.80 or higher suggested high inter-rater agreement (22). Following expert recommendations and adjustments, the Health Care Attitudes Scale (HCAS) achieved scope validity, consisting of 33 items.

Exploratory Factor Analysis

For the factor analysis study, a 33-item scale was administered to 380 participants, and exploratory factor analysis was performed on the collected data. Results (KMO=0.86; χ^2=2857.46; df=561; p=0.00) demonstrated the data set's suitability. Principal Component Analysis revealed a single-factor structure explaining 19.96% total variance. The analysis was iteratively repeated, recommending removal of items with high loadings on multiple factors and those below 0.30, until no redundant or low-loading items remained. This refining process ensured a robust and meaningful factor structure for the scale. Deciding the number of factors in factor analysis involves using methods like Kaiser's criterion and the eigenvalue (Scree plot) graph. Kaiser's criterion suggests retaining factors with an eigenvalue of 1.00 or greater for analysis (23).

After discarding low-loading items and items with low communalities, in the final step, based on the results of the promax rotated principal component analysis, the KMO value was found to be 0.87 (χ^2=1048.20; df=91; p=0.00). A single factor with an eigenvalue above 1 was identified, explaining 30.22% of the variance in scores. Acknowledging the strengths and weaknesses of rules like Kaiser's criterion, it's recommended to use multiple criteria in factor analysis studies (12,24-26). The eigenvalue graph and Kaiser criterion results support the idea that the items measure a one-dimensional structure. The outcomes of the single-factor structure and the variance table for the factor are presented below.

Table 1. EFA Results for FTCAS

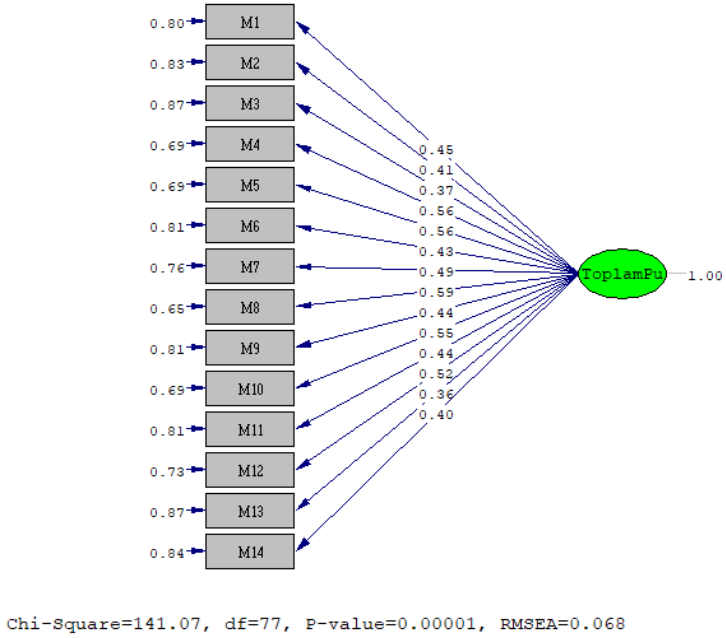
Item	Item Loading
1.Cancer is divided into three groups: sporadic, hereditary, and familial cancers, with a genetic basis.	,492
2.If a pathogenic variant is not identified but there is a strong family history of the disease, it is considered familial.	,501
3.Hereditary cancers cannot be identified through genetic testing since they are not caused by mutations.	,456
4.Hereditary cancers appear at younger ages than normal.	,643
5.In hereditary cancers, multiple types of cancer occur in a single individual.	,584
6.Hereditary cancers are seen in multiple generations.	,534
7.In Hereditary cancers, cancer is observed in at least two organs.	,584
8.Familial hereditary cancers, such as breast, prostate, and colon cancers, affect multiple members of the same family.	,648
9.Hereditary cancers arise from multiple effects.	,482
10.In familial hereditary cancers, the absence of influence from a single gene creates uncertainty about who will develop the disease.	,611
11.Hereditary cancer is typically seen between the ages of 30 and 40.	,569
12.Hereditary cancer is less common than sporadic cancer.	,560
13.If there is a recurring cancer transmitted across generations within a family, it is considered familial hereditary cancer.	,477
14.Predicting cancer risk in individuals with a family history is only possible through genetic testing.	,509

As a result, it has been observed that the scale consists of a single factor and 14 items; no negatively coded items are present in the scale. Item loadings vary between .49 and .65. The 14-item form explains 30.22% of the variance of the scale. Therefore, the result of the exploratory factor analysis indicates that the scale can be used to measure familial cancer awareness among medical school students. The results of the confirmatory factor analysis (CFA), a commonly preferred method for determining construct validity in scale adaptation studies, are explained in the following section.

Confirmatory Factor Analysis

In addition to conducting exploratory factor analysis, in the second part of the study, confirmatory factor analysis (CFA) was conducted to determine the extent to which the observed data fit a one-dimensional model. Confirmatory factor analysis aims to evaluate how well a factorial model composed of observable factors (latent variables) aligns with actual data (24). The primary aim was to test the CFA structure of the cancer awareness scale among medical students. Data has been recollected for the CFA study. Participants were purposively sampled based on criteria like being a faculty of medicine student and taking the medical biology and genetics course. Data collection tools were administered to 210 participants. Exclusions for blank responses (5% or more), outliers, and centroid shift errors resulted in analyses on 182 observations. Female participants (103, % 56.6), second grade students (51, % 28.0) and participants from middle socioeconomic level (128, % 69.2) were more in the research group. The mean age of the group was found to be 21.32 (SD; 1.9).

The correlation matrix obtained from 182 participants and 14 items was used as data. Results showed that the (χ^2/sd) ratio calculated by confirmatory factor analysis is 1.83 and this value shows that the proposed factor model is compatible with the data (25.26). The GFI value of .92, AGFI value of .92, CFI value of .91, NFI value of .91, NNFI value of .92, RMR value of .033 and RMSEA value of .066 indicate that the one-factor structure of the scale gives acceptable and valid results as a result of confirmatory factor analysis. In addition to these findings, the coefficients of item-factor relationships calculated by confirmatory factor analysis are shown in Figure 1 and Table 2.



M: Item, ToplamPu= Total Point

Figure 1. CFA Results of Factor-Item Relationship of the Scale

As seen in Figure 2, the observed data fit the one-dimensional model well. Path coefficients vary between .36 and .59. All of these values are above .30 and values of .30 and above are acceptable (web 2). The item standardized loadings are shown in Table 2 below.

Table 2. CFA Results and Item Loadings

							95% reliability	
Factor	**Item**	**Symbol**	**Standardized Value**	**Standard Error**	**Z**	**p**	**lowest**	**highest**
Factor 1	Item1	Sλ11	0.528	0.065	8.091	< .001	0.400	0.655
	Item2	λ12	0.496	0.067	7.429	< .001	0.365	0.626
	Item3	λ13	0.452	0.070	6.414	< .001	0.314	0.590
	Item4	λ14	0.672	0.051	13.101	< .001	0.572	0.773

Factor	Item	Symbol	Standardized Value	Standard Error	Z	p	95% reliability lowest	95% reliability highest
	Item5	λ15	0.669	0.059	11.339	< .001	0.553	0.784
	Item6	λ16	0.540	0.072	7.528	< .001	0.399	0.680
	Item7	λ17	0.599	0.071	8.474	< .001	0.461	0.738
	Item8	λ18	0.659	0.052	12.698	< .001	0.557	0.761
	Item9	λ19	0.532	0.070	7.621	< .001	0.395	0.669
	Item10	λ110	0.650	0.053	12.265	< .001	0.546	0.754
	Item11	λ111	0.549	0.064	8.614	< .001	0.424	0.673
	Item12	λ112	0.642	0.062	10.308	< .001	0.520	0.764
	Item13	λ113	0.454	0.071	6.421	< .001	0.316	0.593
	Item14	λ114	0.456	0.076	6.035	< .001	0.308	0.604

As a result of confirmatory factor analysis, it is seen that the one-dimensional structure fits the proposed model well. Path coefficients ranged between. 45 and. 67. Loadings of all items were found to be significant at 0.001 level.

Reliability and Item Analysis

In the third section, the main aim was to test the reliability and item analysis of the cancer awareness scale in medical students. A new data was collected using a personal information form and the Hereditary Cancer Awareness Scale (HCAS). The tools were administered to 160 participants, and after reviewing responses, exclusions were made for blank items (5% or more), outliers, and centroid shift errors. Analyses were conducted on 146 observations. In terms of gender distribution, 53.4% are female, and 46.6% are male. Among the grades, the majority are from the second grade (30.8%), followed by the first grade (17.8%). Regarding perceived SES, the majority perceive their SES as medium (71.9%), followed by low (18.5%) and high (9.6%). The mean age of the group was found to be 21.32 (SD; 1.9). Cronbach's alpha value was 0.83 and McDonald's ω value was 0.84. In addition, when the heatmap of the items (Figure 2) is analyzed, it is seen that every item in which all of them are green (0,05 and above) is reliable.

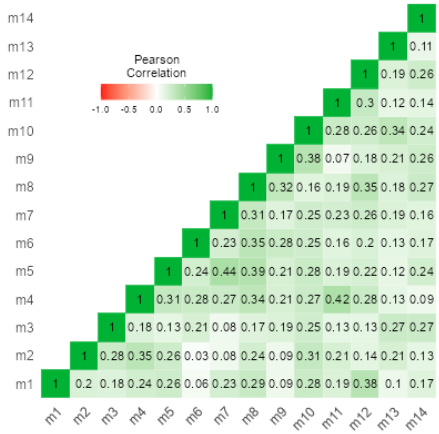


Figure 2. Correlation Heatmap

One of the aim of item analysis is to determine how well scales or tests work. The item analysis results of the scale are presented below.

Table 3. Item Analysis

	When Item Deleted				
Item	**McDonald ω**	**Cronbach α**	Item **Scale Correlation**	$\overline{X}$	**Ss**
Item1	0.781	0.777	0.402	0.648	0.602
Item2	0.785	0.779	0.366	0.720	0.684
Item3	0.792	0.785	0.336	1.033	0.885
Item4	0.775	0.770	0.487	0.566	0.651
Item5	0.772	0.769	0.488	0.885	0.912
Item6	0.785	0.780	0.372	0.857	0.448
Item7	0.780	0.776	0.421	0.885	0.924
Item8	0.773	0.768	0.523	0.714	0.591
Item9	0.784	0.780	0.374	0.797	0.512
Item10	0.774	0.769	0.510	0.665	0.606
Item11	0.783	0.778	0.381	0.527	0.679
Item12	0.777	0.772	0.455	0.643	0.779
Item13	0.787	0.782	0.330	0.852	0.487
Item14	0.787	0.781	0.367	1.055	0.846

As can be seen in the table, all items showed significant correlations of 0.20 and above with the scale scores. In addition, Cronbach's alpha and McDonald's ω values of each item were higher than 0.70. Therefore, it can be stated that all items are reliable and Hereditary Cancer Awareness Scale (Appendix A) can be used to measure the awareness in medical students.

DISCUSSION

In this study, the Hereditary Cancer Awareness Scale (HCAS), a tool to measure the level of awareness of hereditary cancer in medical students, was developed. The study introduced the HCAS as a reliable and valid tool developed to measure the awareness of hereditary cancer among medical students. The findings highlighted a need to improve the awareness of medical students about hereditary cancer (27-28). Given the global and local significance of cancer, particularly the impact of early diagnosis on reducing cancer-related deaths (29), addressing this awareness gap becomes crucial. Medical students, as future physicians, play a vital role in raising cancer awareness, especially in communities with lower sociocultural levels (30). The HCAS, validated through exploratory factor analysis, proves to be an effective instrument for assessing and enhancing medical students' awareness of hereditary cancer and contributing to early cancer diagnosis (31).

The exploratory factor analysis revealed that the initial 33-item scale was refined to 14 items,

demonstrating a single-factor structure with loading values ranging between 0.49 and 0.65. This factor, labeled "Awareness," accounted for 30.22% of the total variance (32). The comprehensive nature of the scale in measuring cancer awareness in a singular dimension is evident. While the study emphasizes the scale's validity, testing it across diverse populations and cultural groups is recommended to ensure general validity and cultural appropriateness (33). Additionally, a long-term follow-up study could provide valuable insights into how cancer awareness evolves over time (34).

In this study, confirmatory factor analysis was employed to assess the cancer awareness scale among medical students, revealing compatibility with a one-dimensional structure. The fit indices, including GFI, AGFI, CFI, NFI, NNFI, RMR, and RMSEA, all exceeded acceptable thresholds, indicating a good fit and valid results (35-36). Path coefficients demonstrated that loading values for all items were above 0.30, affirming the one-dimensional structure's acceptable fit. While the study underscores the scale's validity, it is crucial to test it in diverse populations, sample groups, and cultural contexts for broader applicability (37). Using sample groups from various regions and socioeconomic levels in future studies could enhance general validity and usability. Notably, the study focused on medical students, and expanding the scale's use to other professional groups or the general population would increase its generalizability (38). Recommending validity and reliability studies adapting the scale to different educational levels and occupational groups is pertinent. Additionally, the study delved into participants' demographic characteristics, emphasizing the need to explore other factors influencing cancer awareness in future research (39). Factors such as family history of cancer, year of medical education, and cancer-related education could further contribute to a comprehensive understanding of cancer awareness.

This study also aimed to evaluate the reliability and item analysis of the cancer awareness scale in medical students. The scale used was considered a reliable measurement tool in terms of Cronbach's alpha reliability coefficient and McDonald's ω value (40). Cronbach's alpha value was 0.83 and McDonald's ω value was 0.84, indicating that the internal consistency of the scale was high. When the heat map of the items was analyzed, it was seen that all items were reliable. As a result of the item analysis, it was seen that all items gave a significant correlation of 0.20 and above with the scale scores. This shows that the items of the scale reflect the awareness subject to be measured well (41). Cronbach's alpha and McDonald's ω values of each item were found to be higher than 0.70, indicating that all items were reliable (42). The findings of the study reveal that the HCAS is an effective tool for measuring the level of awareness of medical students about hereditary cancer. The item pool of the scale was created using expert opinions and factor analysis methods, and content validity was ensured (43-44). It was observed that the majority of the students participating in the study did not give low scores to the scale items and that the HCAS was valid in participants with different demographic characteristics. The main limitations of the study are that there are more women in the research group, the majority of second-year students, and the high number of participants from middle socioeconomic levels. These results support the validity of the HCAS in students with these demographic characteristics. However, it is important to investigate the validity of the scale in other demographic groups (45).

Considering that cancer is one of the leading causes of death in the world, the importance of cancer education in medical faculties should be emphasized (46). The inadequacy of cancer knowledge in medical education should be emphasized, and the current curriculum should be revised (47). Especially genetic cancer

knowledge should be emphasized, and students' awareness of familial inherited cancer should be increased (48). Genetic counseling is of great importance for the follow-up of familial cancer cases and the detection of risky individuals (49). Genetic counseling services should be made more widespread and accessible (50). Genetic counseling courses and internship opportunities should be increased in medical faculties (51). Early diagnosis can significantly reduce cancer-related deaths (52). By increasing the level of awareness of medical students about hereditary cancer, the importance of early diagnosis to society and the establishment of screening programs can be considered (53).

The implications of the HCAS for medical education are significant. Integrating this scale into medical curricula can enhance the training of future physicians by ensuring they possess a thorough understanding of hereditary cancers. Enhanced awareness and knowledge among medical students can lead to better patient outcomes, particularly through early detection and prevention strategies (29, 54). Incorporating the HCAS into educational programs can also address gaps in genetic literacy, which is crucial for the effective management of hereditary cancer syndromes (55). Additionally, the scale can serve as a benchmark for evaluating the effectiveness of educational interventions aimed at improving hereditary cancer awareness.

Furthermore, the scale's application in diverse educational settings can provide insights into the variations in hereditary cancer awareness across different cultural and socioeconomic backgrounds (55). This information is valuable for tailoring educational programs to meet the specific needs of various student populations. The development of the HCAS aligns with the broader goal of precision education, which seeks to customize learning experiences to enhance educational outcomes (34).

In conclusion, the Hereditary Cancer Awareness Scale (HCAS) offers a robust tool for assessing and improving the awareness of hereditary cancer among medical students. Its integration into medical education can significantly contribute to better patient care through enhanced early detection and prevention efforts. Future research should focus on validating the scale across diverse populations and exploring its utility in various educational and clinical settings. This study was conducted on medical students, and the validity and reliability of the scale should be evaluated among different populations and professional groups. It is important to apply the scale in different universities and medical faculties and compare the results to understand how the scale changes according to cultural and educational differences. The findings obtained from item analyses can be used to improve the scale at the item level. Revising the weak items should be considered to make the scale more reliable and valid. The scale used in the study provides a general assessment of cancer awareness. In the future, it is important to develop and test more specific scales to measure awareness of cancer types or specific cancers.

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Declaration of Interest

All authors declare that they have no competing interest

Ethics Approval

This study was performed in line with the principles of the Declaration of Helsinki. Approval was granted by the Ethics Committee of University Pamukkale (2023-E-60116787-020-362798)

Consent to Participate

Informed consent was obtained from all individual participants included in the study.

Abbreviations

HCAS: Hereditary Cancer Awareness Scale
FICC: familial inherited cancer cases
FBOCS: familial breast and ovarian cancer syndrome
EFA Exploratory Factor Analysis
CFA: Confirmatory Factor Analysis

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Appendix A. Hereditary Cancer Awareness Scale

Dear Participants,

This scale is a measurement tool designed to assess medical students' awareness of Hereditary Cancer. It is important that you carefully read and sincerely respond to the scale to contribute to the advancement of science. Your personal information will be kept completely confidential, and your results will not be shared with anyone. Please read each statement on the scale and select the option that best suits you. Completing the scales will take approximately 4 minutes. The data collected by the researchers will not include any information that identifies you, and your participation cannot be traced back to you; thus, the collected information will remain both anonymous and confidential. Thank you for your participation.

Items	Wrong	I don't know	Correct
1. Cancer is divided into three groups: sporadic, hereditary, and familial cancers, with a genetic basis.			
2. If a pathogenic variant is not identified but there is a strong family history of the disease, it is considered familial.			
3. Hereditary cancers cannot be identified through genetic testing since they are not caused by mutations.			
4. Hereditary cancers appear at younger ages than normal.			
5. In hereditary cancers, multiple types of cancer occur in a single individual.			
6. Hereditary cancers are seen in multiple generations.			
7. In Hereditary cancers, cancer is observed in at least two organs.			
8. Familial hereditary cancers, such as breast, prostate, and colon cancers, affect multiple members of the same family.			
9. Hereditary cancers arise from multiple effects.			
10. In familial hereditary cancers, the absence of influence from a single gene creates uncertainty about who will develop the disease.			
11. Hereditary cancer is typically seen between the ages of 30 and 40.			
12. Hereditary cancer is less common than sporadic cancer.			
13. If there is a recurring cancer transmitted across generations within a family, it is considered familial hereditary cancer.			
14. Predicting cancer risk in individuals with a family history is only possible through genetic testing.			