



The digital addiction scale for children: psychometric properties of the Turkish version

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Abstract

The increase in the use of digital devices among children in recent years has revealed the problem of digital addiction. The Digital Addiction Scale for Children (DASC) is used for early detection of the risk of digital addiction among children. The purpose of the current study was to investigate the psychometric properties of the Turkish version of the DASC. The data were collected from 670 children aged 9–14. Results supported acceptable goodness-of-fit indices for the one-dimensional factor structure of the DASC. Multi-group confirmatory factor analysis showed measurement invariance across gender. The Turkish version of the DASC indicated excellent internal consistency reliability, composite reliability, test-retest reliability, and adequate convergent and criterion-related validities. The results provided strong validity and reliability evidence, in line with the previous study, showing that the DASC is a psychometrically sound instrument to assess digital addiction in Turkish children and early adolescents.

Keywords Digital addiction · Scale · Psychometric properties · Validity · Reliability · Children

Introduction

Digital addiction is a field of cyberpsychology identified as the problematic or obsessive usage of digital devices despite the harmful consequences of overuse of digital technologies (Basel Almourad et al., 2020; Singh & Singh, 2019). In digital addiction, the individual has an intense desire to repeat the behavior of entering applications/websites such as games, social media, and shopping that can be accessed online or offline through digital devices. Difficulty in controlling the obsessive usage of digital devices, intense desire for using digital devices when not using them and feeling pleasure when using them constitute the indicators of digital addiction (Basel Almourad et al., 2020; Grant, Brewer, & Potenza, 2006; Singh & Singh, 2019). Although digital

addiction is not included as a mental health condition by World Health Organization (WHO) and the American Psychiatric Association (APA, 2013), Internet gaming disorder (IGD) is defined by the APA (2013) in Section 3 of the Diagnostic and Statistical Manual of Mental Disorders (DSM-5) as a condition for further study. In addition, the WHO (2019) recognized “Gaming disorder” in the eleventh revision of the International Statistical Classification of Diseases (ICD-11). However, the concept of “Gaming disorder” is limited to gaming as it does not include general problematic uses of digital devices such as social media use or watching videos. In addition, some concepts such as Internet addiction (Young, 2015), pathological Internet use (Davis, 2001), problematic Internet use (Caplan, 2003), or problematic smartphone use (Elhai et al., 2020) are frequently used in the literature. The concept of digital addiction differs from the others, as it includes the problem of an individual using a digital device without necessarily having an active Internet connection on that device (Basel Almourad et al., 2020).

Children are increasingly using digital technologies at younger ages (Chaudron et al., 2018; Hooft Graafland, 2018). The rise in Internet access is an important factor in increasing the use of digital technologies. Ofcom (2021), a regulator for communication services, provides a detailed report periodically dealing with the United Kingdom

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nations of Scotland, Wales, and Northern Ireland on media use, attitudes, and understanding among children and young people aged 5–15 since 2005. According to the latest report of Ofcom (2021), 66% of 8–11 years old children have their own tablet, 49% have their own smartphone, 78% play games online, 44% use social media apps, 64% messaging apps, 96% use video-sharing platforms, 39% use live-streaming apps. In addition, 59% of 11–15 years old children have their own tablet, 91% have their own smartphone, 80% play games online, 87% use social media apps, 91% messaging apps, 99% use video-sharing platforms, and 60% use live-streaming apps. In Turkey, the Turkish Statistical Institute (TURKSTAT) publishes research results on household Internet access rates of individuals aged 16 years old and over every year. According to the TURKSTAT (2021) report, while Internet usage of individuals aged 16 years old or over was 79.0% in 2020, it increased to 82.6% in 2021. The rise in Internet access is a factor that increases the use of digital devices. Although these data are related to individuals aged 16 and over, they indicate that children are in the risk group.

As a result of the worldwide pandemic process and the associated social distance, the problem of excessive use of digital technology in both children and adolescents has become a more serious problem (Montag & Elhai, 2020). Children's inappropriate usage of technological devices in terms of content, duration, or frequency causes some risks such as developmental problems, musculoskeletal system problems, physical inactivity, obesity, poor sleep quality, low life satisfaction, and poor academic performance (Amez & Baert, 2020; Ayten & Acat, 2019; Mustafaoğlu et al., 2018; Schulz van Endert, 2021; Turan, 2021).

The importance of identifying digital addiction

In Turkey, where primary and secondary school is compulsory and the schooling rate is 95% and above, an inclusive education system is adopted, and studies are being carried out to improve this system. In inclusive education, all children are educated together in schools and the developmental progress of all children can be supported by using teaching methods that respond to individual differences and that all children benefit from (Global Education Monitoring Report, 2020). It is also important to carry out developmental and preventive guidance and counseling studies for the development needs of all students in inclusive education. Since digital addiction negatively affects the academic success of students, it is essential to carry out studies to prevent digital addiction in schools in the scope of guidance and counseling programs.

Digital addiction is a disorder with some symptoms similar to Internet addiction. Researchers focused on Internet

addiction draw attention to the importance of prevention studies in the early stages of the problem rather than treating Internet addiction (Bağatarhan & Siyez, 2022; Yu & Shek, 2013). In order to carry out prevention or intervention studies, children with digital addiction or in the risk group for digital addiction should be identified. To our knowledge, although there are some Turkish measurements to determine the symptoms of digital game addiction (Hazar & Hazar, 2017), computer game addiction (Horzum, Ayas, & Balta, 2008), and video-game addiction (Yılmaz et al., 2017) for children, there is no Turkish measure to identify digital addiction in children. Internet game addiction includes addiction to games on the Internet, while digital addiction does not require the Internet. Therefore, it might be more common. In addition, game addiction is only one dimension of digital addiction. Digital addiction, unlike Internet gaming disorder, includes problematic use of digital devices in different areas such as watching videos (Basel Almourad et al., 2020). For this reason, a Turkish measurement tool is required to assess digital addiction in children.

The Digital addiction scale for children

As stated above, children's access to digital devices has become easier, and excessive or inappropriate use of digital technologies among children is pervasive nowadays. This situation can cause digital addiction which is associated with many health risks in children. A Turkish measurement tool is required to identify children with digital addiction or in the risk group in terms of digital addiction. Thus, prevention and intervention studies can be carried out for digital addiction in children. It would be an important tool for mental health professionals. In addition, quantitative studies investigating digital addiction in children can be conducted in Turkey.

The Digital Addiction Scale for Children (DASC) was developed by Hawi et al. (2019) to identify digital addiction in children. The DASC has 25 items based on nine diagnostic DSM-5 Internet Game Addiction criteria and Griffiths' six-core addiction criteria. These criteria are as follows: (1) preoccupation [it refers to when the particular activity becomes the most important activity in the person's life and begins to dominate their thinking, feelings, and behaviors]; (2) tolerance [it refers to the need to spend increasing amounts of time on a particular activity]; (3) withdrawal [it refers to the unpleasant feeling states or physical effects occurring when the particular activity is taken away or reduced]; (4) mood modification [it refers to the use of the particular activity to escape or relieve a negative mood]; (5) conflict [it refers to the conflicts between the addict and those around them or from within the individual themselves which are concerned with the particular activity]; (6) relapse [it refers to the

unsuccessful attempts to control participation in a particular activity or the tendency for repeated reversions to earlier patterns of the particular activity to recur]; (7) problems [it refers to having problems with issues such as sleeping, using time effectively, or school success]; (8) deception [it refers to deception of family members, therapists, or others regarding the amount of the particular activity]; (9) displacement [it refers to the loss of interest in hobbies and entertainment as a result of and with the exception of a particular activity]. The DASC has two factors. While most of the items in factor 1 represent interpersonal factors, most of the items in factor 2 represent intrapersonal factors. It has excellent internal consistency reliability, and adequate concurrent and criterion-related validities; however, some psychometric properties such as measurement invariance across gender and test-retest reliability were not investigated. Therefore, the psychometric properties of the DASC are needed to examine in detail.

The present study

The Digital Addiction Scale has good psychometric properties. However, some psychometric properties of the DASC have not been examined. Adapting the DASC into Turkish and examining its psychometric properties in detail can both provide a scale in Turkish and contribute to the literature on the psychometric properties of the DASC.

The purpose of the present study was to adapt the DASC into Turkish and investigate the psychometric properties of the Turkish version of the DASC. For this purpose, it was tested whether the two-factor structure of the original DASC is replicated in the Turkish version of the DASC, measurement invariance across gender, criterion-related validity, and convergent validity with video game addiction and life satisfaction. Since life satisfaction is negatively associated with addictions including Internet addiction or video game addiction (e.g., Ayten & Acat, 2019; Turan, 2021), a negative relationship was expected between life satisfaction and digital addiction as well. As video games are played on digital devices, video game addiction was expected to be positively related to digital addiction. In addition to these, internal consistency, composite reliability, and test-retest reliability of the Turkish version of the DASC were examined. The following five hypotheses have been developed, taking into account the previous literature.

Hypothesis 1 The two-factor structure of the original DASC would be the best solution for Turkish children and young adolescents.

Hypothesis 2 The factor structure of the DASC would be gender-invariant.

Hypothesis 3 In terms of convergent validity, the Turkish version of the DASC would demonstrate a positive correlation with the Video Game Addiction Scale (VASC) and a negative correlation with the Brief Multidimensional Students' Life Satisfaction Scale (BMSLSS).

Hypothesis 4 In terms of criterion-related validity, the Turkish version of the DASC would demonstrate a positive relationship with daily Internet usage time.

Hypothesis 5 The Turkish version of the DASC would demonstrate robust internal consistency, composite reliability, and test-retest reliability.

Method

Participants

The participants of this study consisted of children from two elementary and three middle public schools which were randomly selected from a small city in western Turkey. The sample size was computed as 597 by using a sample size calculation program with a 95% confidence interval and a 4% margin of error for the population of public elementary and middle school students in the city. This study was carried out in the 2020–2021 school year. Classes within schools were randomly selected for participation. Data were collected from 702 students. In order to determine inaccurate data, several items of the measurement tools were asked to the students again at different places during the data collection process. 32 students who were determined to provide inaccurate data by giving different answers to the same question were excluded from the study group. The final study sample consisted of 670 elementary and middle school students aged 9–14 ($M_{age}=11.34$, $SD=1.61$). The study sample included 355 (53%) girls and 315 boys (47%); 115 (17.2%) were in 3rd, 115 (17.2%) were in 4th, 90 (13.4%) in 5th, 145 (21.6%) were in 6th, 106 (15.8%) were in 7th, 99 (14.8%) were in 8th grade. The descriptive statistics of the study group are presented in Table 1.

Table 1 Descriptive Statistics of the Demographic Variables

	<i>f</i>	%
Gender		
Girl	355	53
Boy	315	47
School Level		
Elementary School	229	34.2
Middle School	441	65.8
Grades		
3rd grade	115	17.2
4th grade	115	17.2
5th grade	90	13.4
6th grade	145	21.6
7th grade	106	15.8
8th grade	99	14.8
Mother education		
Doesn't apply	14	2.0
Elementary school	163	24.3
Middle school	101	15.1
High school	207	30.9
University	164	24.5
Advanced degree (Master or PhD Degree)	21	3.1
Father Education		
Doesn't apply	5	0.7
Elementary school	134	20.0
Middle school	100	14.9
High school	203	30.3
University	204	30.4
Advanced degree (Master or PhD Degree)	24	3.6
Family structure		
Two biological parent family	586	87.5
Other	84	12.5
Most used digital device		
Smart Phone	334	49.8
Computer	184	27.5
Tablet	152	22.7
Most time-spent activity on the Internet		
Watching videos or film	230	34.3
Playing online games	210	31.3
Doing homework	114	17.0
Using social media	71	10.6
Using messaging apps	45	6.7
Daily Internet Usage Time		
1–2 h	229	41.6
3–5 h	227	33.9
More than 5 h	164	24.5

Procedure

The study received human subjects research approval from a University Ethics Board along with approvals from the regional Directorate of National Education. All the participants were recruited via online survey tools because of the COVID-19 pandemic. Participation in the study was completely voluntary. Online survey tools were delivered to

parents via schools. At the beginning of the data collection process, the informed consent of the parents was obtained. Parents who approved their children's participation in the data collection process were requested to ensure that their children participate in the online data collection process. Participants were assured by a written statement that their responses would be anonymous and used only for study purposes.

Measures

Digital addiction scale for children (DASC)

The DASC, a self-report instrument, was developed by Hawi et al. (2019). It consists of 25 items rated on a five-point Likert scale ranging from 1 (Never) to 5 (Always). A total score is obtained by summing all 25 items (ranging from 25 to 125), with higher scores indicating a higher level of digital addiction. The items of the DASC are based on 9 criteria: Preoccupation, tolerance, withdrawal, mood modification, conflict relapse, problems, deception, and displacement. The original version of DASC has two factors, these factors do not have special names. The first factor of the scale consists of 13 items related to conflict (item 9, item 22), problems (item 10, item 13, item 23, item 25), deception (item 4, item 16), displacement (item 6, item 18, item 20), preoccupation (item 14), and relapse (item 17). The second factor consists of 12 items related to tolerance (item 2, item 7), withdrawal (item 3, item 8, item 12, item 21), mood modification (item 5, item 15, item 24), preoccupation (item 1, item 11), and relapse (item 19). The DASC includes statements such as "I do not spend time with my family members because I prefer using my device", and "I am not able to control using my device". The original version of the DASC represents a strong two-factor structure. It also showed excellent internal consistency ($\alpha=0.94$) (Hawi, et al. 2019).

In the scale adaptation process, first of all, the DASC was translated from English to Turkish using Brislin's back translation method (1970). The original text was translated into Turkish by two professionals who are experts in the field of psychological counseling, have knowledge of the subject, and have English language proficiency. These professionals also evaluated the suitability of the scale items. Then, another psychology professional who has English language proficiency retranslated it to English. After that, this form was sent to the author to compare the items with the original form. According to the comments of the authors, some modifications were done. Finally, the scale items were examined by a Turkish linguist in order to provide language compatibility of the final form.

Videogame addiction scale for children (VASC)

VASC, developed by Yılmaz et al. (2017), is a self-reported instrument. VASC consists of 21 items rated on a five-point scale ranging from 1 (never) to 5 (very often). The VASC has four factors: self-control, reward/reinforcement, problems, and involvement. It includes statements such as “I cannot resist playing video games even if it negatively affects my life”. A total score is obtained on a scale ranging from 21 to 105. It is stated that a score above 90 indicates possible video addiction. The confirmatory factor analysis results of the VASC were sufficient. The Cronbach’s alpha internal consistency coefficient was 0.89 (Yılmaz et al., 2017). In this study, Cronbach’s alpha internal consistency coefficient of VASC was 0.90.

Brief multidimensional students’ life satisfaction scale (BMSLSS)

BMSLSS was developed by Huebner et al. (2004) as five items. An additional item was included in the BMSLSS as a validity check (Seligson et al., 2005; Zullig et al., 2005). BMSLSS items are rated on a 7-point Likert-type scale ranging from 1 (terrible) to 7 (delighted). The BMSLSS includes statements on family, friends, school, self, and living environment (e.g., I would describe my satisfaction with my friendships as). A total score is obtained by summing all items. Higher scores indicate a higher level of life satisfaction. The Turkish adaptation of the scale was made by Siyez and Kaya (2007). It has acceptable construct validity. All items were found to be loaded on a single factor which accounted for 48% of the total variance, and the eigenvalue was equal to 2.89. The Cronbach’s alpha internal consistency coefficient of the scale was 0.89, the test-retest reliability coefficient was 0.82 (Siyez & Kaya, 2007). In this study, Cronbach’s alpha internal consistency coefficient of BMSLSS was 0.87.

Demographic questionnaire

The demographic questionnaire was used to collect information about the participants’ gender (girl or boy), school level (elementary school or middle school), parents’ education (elementary school, middle school, high school, university, advanced degree, and doesn’t apply), family structure (two biological parent family or other), most used device (smartphone, computer or tablet), most time-spent activity on the Internet (watching video or film, playing online games, doing homework, using social media or messaging apps), and daily Internet usage time (1–2 h, 3–5 h, or more than 5 h).

Data analysis

Prior to analysis, assumptions for the factor analysis including univariate and multivariate normality were examined. Skewness and kurtosis values for each of the study variables were checked for univariate normality which is a precondition for multivariate normality. The acceptable range for skewness and kurtosis was considered as between -2 and $+2$ (George & Mallery, 2016). Multivariate outliers were checked with Mahalanobis distance using the criterion $p < 0.001$ (Tabachnick & Fidell, 2013).

Confirmatory factor analysis (CFA) with the maximum likelihood estimation method was used for the factorial validity of the DASC. CFA was calculated only for boys, girls, and the whole sample. Measurement invariance was tested via multi-group confirmatory factor analyses (MG-CFA) to determine whether the same construct was measured across gender. Configural invariance, metric invariance, scalar invariance, and strict invariance models were tested with MG-CFA (Vandenberg & Lance, 2000). First, no equality restrictions were made in the configural invariance model. Second, factor loadings were constrained to be equal across groups in the metric invariance model. Third, factor loadings and item intercepts were constrained across groups in the scalar invariance model. Finally, factor loadings, item intercepts, and residual variances were constrained to be equal across groups in the strict invariance model. Fit indices and their acceptable thresholds for CFA and MG-CFA were determined as follows: $\chi^2/df \leq 5$ (Hair et al., 2010; Hu & Bentler, 1999; Kline, 2005); RMSEA and SRMR ≤ 0.08 (Hair et al., 2010); CFI ≥ 0.85 (Bollen, 1989); GFI, IFI, TLI, and NFI ≥ 0.90 (Hair et al., 2010). Commonly used criteria for determining if the imposition of equality constraints results in a substantially worse fit than a previous model are $\Delta CFI \leq 0.01$ and $\Delta RMSEA \leq 0.01$. The CFI and RMSEA values between nested models ($\Delta CFI \leq 0.01$, $\Delta RMSEA \leq 0.01$) were used to evaluate the goodness-of-fit of the nested measurement invariance models (Chen, 2007; Cheung & Rensvold, 2002).

Convergent validity was examined by calculating the Pearson correlation coefficient between the DASC, VASC, and BMSLSS scores. Criterion-related validity was investigated by calculating the Pearson correlation coefficient between the DASC scores and daily Internet usage time. Correlation coefficients were evaluated according to whether they were significantly positive or negative.

Internal consistency reliability of the DASC was examined by Cronbach’s alpha and composite reliability coefficients. Cronbach’s alpha coefficient was evaluated according to the values as follows: ≥ 0.90 – Excellent, ≥ 0.80 – Good, ≥ 0.70 – Acceptable, ≥ 0.60 – Questionable, ≥ 0.50 – Poor, and ≤ 0.50 – Unacceptable (George &

Table 2 Summary Statistics for the Digital Addiction Scale for Children: Item Means, Standard Deviations, and Corrected Item–Total Correlations

Item	Content	<i>M</i>	<i>SD</i>	<i>CITC</i>
Item 1	When I am not at school, I spend a lot of time using my device	3.18	1.01	0.57
Item 2	I feel the need to spend more time using my device	2.61	1.15	0.61
Item 3	I feel upset when I am not able to use my device	2.43	1.23	0.61
Item 4	I lie to my parents about the amount of time I spend using my device	1.40	0.78	0.49
Item 5	Using my device helps me to forget my problems	2.50	1.34	0.47
Item 6	I do not spend time with my family members because I prefer using my device	2.01	1.11	0.65
Item 7	I have spent more and more time on my device	2.37	1.16	0.64
Item 8	I feel upset when I am asked to stop using my device	2.47	1.31	0.74
Item 9	My parents try to stop or limit me using my device, but they fail	1.92	1.23	0.66
Item 10	I am sleeping less because I am using my device	1.75	1.08	0.55
Item 11	When I do not have my device, I think about what I do on it (video games, social media, texting, etc.)	2.16	1.17	0.55
Item 12	I feel frustrated when I cannot use my device	1.74	1.04	0.69
Item 13	I have problems with my parents about the amount of time I spend using my device	2.23	1.25	0.73
Item 14	Using my device is the most important thing in my life	1.79	1.13	0.65
Item 15	Using my device is more enjoyable than doing other things	2.38	1.22	0.67
Item 16	I lie to my parents about what I do on my device	1.28	0.65	0.46
Item 17	I am not able to control using my device	2.08	1.21	0.65
Item 18	I have lost interest in hobbies or other activities because I prefer using my device	1.65	1.04	0.59
Item 19	When I stop using my device, it is not long before I start using it again	2.36	1.19	0.69
Item 20	I check my device when I am doing homework or other important things	2.38	1.38	0.34
Item 21	I feel frustrated when I am asked to stop using my device	1.91	1.15	0.73
Item 22	I argue with my parents when they ask me to stop using my device	1.69	1.07	0.66
Item 23	I spend too much money on things for my device	1.26	0.68	0.30
Item 24	Using my device makes me feel better when I feel bad	2.70	1.32	0.60
Item 25	I continue using my device despite that my grades at school are getting lower and lower	1.86	1.11	0.58

Mallery, 2016). Composite reliability is an alternative way to Cronbach's alpha is measure internal consistency. It was calculated with the parameters obtained from the confirmatory factor analysis models (Netemeyer, 2003; Peterson & Kim, 2013). Composite reliability was assessed considering coefficients ≥ 0.60 as adequate (Hair et al., 2017). Test-retest reliability was determined by the Pearson correlation coefficient and intraclass correlation coefficient (ICC) between the two sets of results of the DASC on the same participants two weeks apart. All data analyses were completed using AMOS 24 and SPSS 23.

Results

Preliminary analysis

The means, standard deviations, and corrected item-total correlations of the DASC Turkish version are presented in Table 2. Skewness and kurtosis values were checked for univariate normality, and multivariate outliers were checked with Mahalanobis distance. The item with the highest mean was “When I am not at school, I spend a lot of time using my device” ($M=3.18$).

Factorial validity

The original scale has two factors. The first factor of the scale consists of 13 items, and the second factor consists of 12 items. The original two-factor model of the DASC was examined with CFA. Results showed that fit indices of the two-factor model were not adequate, $\chi^2(274)=1204.12$, $\chi^2/df=4.40$, $p<0.001$, CFI=0.88, RMSEA=0.07 [90% CI=0.07–0.08], SRMR=0.05. Moreover, the correlation between the two factors is extremely high ($r=0.94$). The factors do not separate from each other. For this reason, the factorial validity of the one-factor model of the DASC was tested. Four covariances (between the error terms of item 3 and 8, item 4 and 16, item 5 and 24, item 12 and 21) were added to the model as suggested by modification indices. Modifications should be made with a theoretical justification (Diamantopoulos & Siguaw, 2000). The items of the DASC are based on 9 criteria: Preoccupation, tolerance, withdrawal, mood modification, conflict relapse, problems, deception, and displacement. The items in which covariance was added between error terms are based on the same criteria: Item 3 and item 8 were based on the withdrawal criterion; item 4 and item 16 were based on the deception criterion; items 5 and item 24 were based on the mood modification criterion, and item 12 and item 21 were based on the withdrawal criterion. Since these items are based on the same criteria, they have similar question statements,

Table 3 Factor Loadings of the DASC Items

Items	Loadings	Items	Loadings	Items	Loadings
Item 1	0.58	Item 10	0.57	Item 19	0.71
Item 2	0.62	Item 11	0.56	Item 20	0.35
Item 3	0.64	Item 12	0.72	Item 21	0.76
Item 4	0.50	Item 13	0.76	Item 22	0.68
Item 5	0.46	Item 14	0.67	Item 23	0.31
Item 6	0.67	Item 15	0.68	Item 24	0.59
Item 7	0.67	Item 16	0.46	Item 25	0.60
Item 8	0.77	Item 17	0.67		
Item 9	0.68	Item 18	0.61		

which can be shown as the theoretical justification for the modifications. As a result, findings indicated that fit indices of the one-factor model of the DASC were acceptable, $\chi^2(271)=1009.07$, $\chi^2/df=3.72$, $p<0.001$, CFI=0.90, RMSEA=0.06 [90% CI=0.06–0.07], SRMR=0.04.

The one-factor model was separately tested for boys and girls. Acceptable fit indices were obtained for boys, $\chi^2/df=2.33$, $p<0.001$, CFI=0.90, RMSEA=0.07 [90% CI=0.06–0.07], SRMR=0.05, and girls, $\chi^2/df=2.74$, $p<0.001$, CFI=0.88, RMSEA=0.07 [90% CI=0.06–0.08], SRMR=0.05. The goodness of fit indices was at an acceptable degree for both subsamples.

Finally, the one-factor model displayed adequate fit indices, leading us to adopt it as our baseline for assessing multi-group structural invariance. In addition, results showed that the item loadings of all items displayed substantial saturation (all λ 0.31–0.77, $p<0.001$; see Table 3), which exceeded the recommended cut-off value of 0.30 (Costello & Osborne, 2005).

Measurement invariance

MG-CFA was used to assess the measurement invariance of the DASC across gender. Increasingly restrictive four levels of invariance (Configural invariance, metric invariance, scalar invariance, and strict invariance) were tested (Table 4). Configural invariance was supported by fit indices meeting benchmarks for adequate fit (RMSEA=0.048, CFI=0.889).

The CFI and RMSEA values between nested models ($\Delta CFI \leq 0.01$, $\Delta RMSEA \leq 0.01$) were used to evaluate the goodness-of-fit of the nested measurement invariance models (Chen, 2007; Cheung & Rensvold, 2002). As a result, metric invariance (RMSEA=0.047, $\Delta RMSEA=0.001$, CFI=0.887, $\Delta CFI=0.002$) and scalar invariance (RMSEA=0.046, $\Delta RMSEA=0.001$,

CFI=0.887, $\Delta CFI=0.000$) could be assumed across gender, as evidenced by a non-significant decrease in model fit ($\Delta CFI \leq 0.01$, $\Delta RMSEA \leq 0.01$) for the successively stricter models. For the strict invariance model (RMSEA=0.049, $\Delta RMSEA=0.002$, CFI=0.866, $\Delta CFI=0.021$), the CFI criterion was met ($\Delta CFI \leq 0.01$) while the RMSEA criterion was not ($\Delta RMSEA \leq 0.01$).

Convergent validity

Pearson correlation analysis was used to assess convergent validity. The associations between the DASC, VASC, and BMSLSS total scores were examined for convergent validity. A strong positive correlation was found between the DASC and VASC scores ($r=0.72$, $p<0.01$, 95% CI [0.66–0.77]). In addition, a moderate negative correlation was found between the DASC and BMSLSS scores ($r=-0.37$, $p<0.01$, 95% CI [-0.43 – -0.30]).

Criterion-related validity

The association between the DASC and daily Internet usage time was examined with Pearson correlation analysis for criterion-related validity. A positive medium correlation was found between the DASC and daily Internet usage time ($r=0.49$, $p<0.01$, 95% CI [0.42–0.54]).

Internal consistency, composite reliability, and test-retest reliability

Cronbach’s alpha coefficient was used to determine the internal consistency of the DASC. Cronbach’s alpha coefficient of the DASC was calculated as 0.94. The composite reliability was calculated as 0.94.

For the test-retest reliability study, the DASC was reapplied to 156 participants 2 weeks later. The Pearson correlation coefficient and intraclass correlation coefficient between the DASC scores obtained from these two applications was calculated. A positive strong Pearson correlation coefficient was found ($r=0.83$, $p<0.01$, 95% CI [0.76–0.89]). In addition, intraclass correlation coefficient was statistically significant, positive, and strong (ICC=0.91, $p<0.001$, 95% CI [0.87–0.93]).

Table 4 Fit Statistics for Multi-Group Confirmatory Factor Analysis by Gender

Model	χ^2	df	RMSEA	$\Delta RMSEA$	CFI	ΔCFI	Δdf
Configural invariance	1374.28	542	0.048	-	0.889	-	-
Metric invariance	1411.72	566	0.047	0.001	0.887	0.002	24
Scalar invariance	1440.57	590	0.046	0.001	0.887	0.000	24
Strict invariance	1619.48	615	0.049	0.002	0.866	0.021	25

Discussion

The main purpose of the current study was to adapt the DASC into Turkish and examine the psychometric properties of the DASC to assess digital addiction among children aged 9–14 years. The study findings are summarized as follows.

First, findings from confirmatory factor analysis showed that the one-factor model of the Turkish version of the DASC displayed satisfactory fit indices. In addition, acceptable fit indices were obtained in the analyzes performed separately for only boys and only girls. The original version of the DASC had a two-factor structure, and the fit indices were very good ($\chi^2/df=2.43$, $p<0.001$, CFI=0.96, RMSEA=0.04). However, the current study determined that the Turkish version of the DASC had a single-factor structure, and the fit indices were good ($\chi^2/df=3.72$, $p<0.001$, CFI=0.90, RMSEA=0.06) (Hair et al., 2010). The current study confirmed the one-factor model of the Turkish version of the DASC contrary to the original version of the DASC which confirmed the two-factor model of the scale. Cultural differences may be the reason why the original and Turkish versions of DASC have different factor structures. In addition, each of the two factors of DASC does not specifically measure a specific dimension of digital addiction such as withdrawal, relapse, or preoccupation. While factor 1 consists of items related to conflict, problems, deception, displacement, preoccupation, and relapse criteria; factor 2 consists of items related to tolerance, withdrawal, mood modification, preoccupation, and relapse criteria. Both factor 1 and factor 2 have items based on preoccupation and relapse criteria. Therefore, DASC may not always show the same factor structure in different research. However, since DASC has not yet been adapted to another culture, a comparison cannot be made. More research is needed to examine the factor structure of the DASC.

Second, study findings indicated that measurement invariance of the Turkish version of the DASC across gender. Measurement invariance suggests that using the same scale in different groups does measure the same construct in the same way (Millsap, 2011). In the current study, while configural, metric, and scalar invariance could be assumed across gender, strict invariance could not. Scalar invariance is usually regarded as adequate to establish measurement invariance and to assume that the factor structure of the scale remained relatively unaltered across groups; namely, the DASC was similarly assessed by boys and girls. Accordingly, the DASC can be used for both genders in different studies comparing the levels of digital addiction of girls and boys, or in studies examining the associations of digital addiction with different variables. The measurement invariance was not tested for the original version of the DASC by

Hawi et al. (2019), therefore the current study provided an essential contribution to the literature.

Third, study findings showed that the Turkish version of the DASC has adequate convergent validity. A significant positive strong correlation was found between the DASC and VASC scores for convergent validity. The VASC is used for identifying video game addiction in children. Since video games are played on digital devices, a positive relationship was expected between video game addiction and digital addiction, and therefore between DASC and VASC scores. In addition, a significant moderate negative correlation was found between DASC and BMSLSS scores. BMSLSS is used for determining the life satisfaction of students. Since life satisfaction is negatively associated with addiction such as Internet addiction or video game addiction (e.g., Ayten & Acat, 2019; Turan, 2021), a negative association was expected between DASC and BMSLSS scores, namely, the study findings are consistent with the previous studies. Hawi et al. (2019) determined that the original version of DASC was moderately correlated with the Revised Child Anxiety and Depression Scale (RCADS-30). The current study provided evidence of the convergent validity of DASC by showing the relationship of DASC with the Videogame Addiction Scale for Children (VASC) and Brief Multidimensional Students' Life Satisfaction Scale (BMSLSS) and contributed to the literature. Future studies may provide new evidence for the convergent validity of the scale with different instruments.

The fourth finding of the study indicated that the Turkish version of the DASC has adequate criterion-related validity. The current study examined criterion-related validity by calculating the correlation between the DASC scores and daily Internet usage time. Since digital devices are generally used with the Internet, the DASC scores are expected to be positively associated with daily Internet usage time. A positive medium correlation coefficient was found between the DASC scores and daily Internet usage time. Hawi et al. (2019) demonstrated the criterion-related validity of the original DASC by calculating the correlation between DASC scores and weekday/weekend playtime. Since digital devices are not used only for playing games and are generally used with the Internet, Internet usage time was thought as a more appropriate criterion instead of game playtime for criterion-related validity of the DASC in the present study. In conclusion, the finding of this study is consistent with the previous study.

The fifth finding of the study showed that Cronbach's alpha internal consistency coefficient of the DASC is 0.94. Cronbach's alpha internal consistency coefficient of the original DASC (Hawi et al., 2019) is also 0.94. Similarly, a study conducted by Schulz van Endert (2021) found the internal consistency coefficient of the German translation of

the DASC as 0.94. The finding of the current study is consistent with previous studies. Since Cronbach's alpha value above 0.90 shows excellent internal consistency (George & Mallery, 2016), the Turkish version of the DASC has excellent internal consistency. In addition, the composite reliability of the Turkish version of the DASC was found as 0.94. Since a composite reliability coefficient higher than 0.60 shows adequate reliability (Hair et al., 2017), the Turkish version of the DASC has excellent internal consistency. The composite reliability of the original DASC was not examined by Hawi et al. (2019). Therefore, the present study provided an important contribution to the literature.

Finally, the findings showed that the test-retest reliability of the Turkish version of the DASC, measured using the Pearson coefficient and the intraclass correlation coefficient, was 0.83 and 0.91, respectively. A test-retest reliability coefficient higher than 0.80 provides evidence of the test's reliability (Cozby & Bates, 2012). Accordingly, the Turkish version of the DASC exhibited high test-retest reliability. A high test-retest reliability coefficient is an important reference, showing consistent results when the same test is repeated on the same sample at a different time. The test-retest reliability was not tested for the original version of the DASC (Hawi et al., 2019), therefore the current study contributed to the literature by providing evidence of the test-retest reliability of the DASC.

Limitations

Although the present study provides an important contribution to the literature about the psychometric properties of the Turkish version of the DASC, it contains some limitations. First, the study sample is limited to children from a western city center of Turkey, which limits the generalizability of the findings. Second, research data were collected with online survey tools due to the COVID-19 pandemic process. Third, this study was carried out only with a sample without any psychiatric diagnosis. Future studies can test the validity and reliability of the scale for a sample with a psychiatric diagnosis. In addition to these, the use of the Internet for learning purposes has increased in recent years with COVID-19 pandemic. Therefore, in future studies, it would be more accurate to investigate the relationship between digital addiction and only recreational Internet use that excludes learning. Finally, future research needs to use more comprehensive and representative samples. Future research can also test the measurement invariance of the scale across different cultures.

Conclusion

The present study confirmed that the Turkish version of the DASC is a valid and reliable instrument to identify digital addiction in children, consistent with the original version of the DASC (Hawi et al., 2019). It was concluded that the one-dimensional structure of the DASC is more appropriate, contrary to the original version of the DASC (Hawi et al., 2019). Study findings show that the Turkish version of the DASC has adequate convergent and criterion-related validity, excellent internal consistency, composite reliability, and very good test-retest reliability. In addition, measurement invariance across gender was confirmed.

The current study more comprehensively examined the psychometric properties of the DASC. It also provided evidence for some psychometric properties that were not investigated in the original version of the DASC such as convergent validity, measurement invariance by gender, composite reliability, and test-retest reliability. In addition, it contributed to the cross-culture validity and reliability of the DASC. Study implications include that DASC is a valid and reliable instrument that might be used by school counselors and mental health professionals to identify digital addiction in children and thus conduct prevention/intervention studies. In addition, the DASC might be used by researchers in studies on digital addiction in children.

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