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Internet addiction in adolescents: Development and validation of Internet Addiction Diagnostic Questionnaire (KDAI)

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ABSTRACT

Internet addiction (IA) is an emerging behavioral problem that constitutes a major health threat to vulnerable populations, including adolescents. However, there is a paucity of IA screening tools specifically designed for adolescents, especially in Indonesia. Therefore, the current study developed and validated the IA Diagnostic Questionnaire (KDAI) in adolescents while acknowledging local cultural influences. The KDAI was conceived through extensive literature reviews, expert discussions based on Delphi methods, a face validity study, focus group discussion ($N = 31$) for initial reliability testing, and a recruited pilot study ($N = 385$) and main study ($N = 643$) for exploratory and confirmatory factor analyses, respectively. The multi-sample analyses demonstrated that the KDAI model with the best fit and reliability comprised a seven-factor structure, including withdrawal, loss of control, increase of priority, negative consequences, mood modification, salience, and impairment. These factors were scrutinized against domains of IA Test, and concurrent validity was ascertained. Subsequently, a receiver operating characteristic curve and area under the curve determined a cutoff score of 108 to discern adolescents with IA. Taken together, the KDAI displayed excellent psychometric indices and sensitivity as a screening tool for IA in adolescents.

Abbreviations

AGFI	adjusted goodness-of-fit index
AIC	Akaike Information Criterion
AUC	area under the curve
CFA	confirmatory factor analysis
CFI	comparative fit index
DSM	diagnostic and statistical manual of mental disorders
EFA	exploratory factor analysis
FGD	focus group discussion
IA	internet addiction
IAT	internet addiction test
KDAI	*Kuesioner Diagnostik Adiksi Internet/*Internet Addiction Diagnostic Questionnaire
RMSEA	root mean square error of approximation
ROC	receiver operating characteristic
SRMR	standardized root mean residual
TLI	Tucker-Lewis index

1. Introduction

The Internet has become an omnipresent necessity in this ever-evolving digital age. Internet accessibility poses a risk of Internet over-use, particularly in adolescents, and can lead to Internet addiction (IA)

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through the influence of biological, psychological, and social factors (Karacic and Oreskovic, 2017; Shek and Yu, 2016). The prevalence of IA worldwide varies between 4.5–19.1% in adolescents and 0.7–18.3% in young adults (Mak et al., 2014). Indonesia has the highest number of Internet users in Southeast Asia, with a total of 143 million users in 2018 (Indonesia Internet Service Provider Association, 2018). The rapid rise in Internet usage has increased the need for detection of IA among adolescents in Indonesia in order to offer immediate treatment and implement nationwide prevention programs. Importantly, the international community has assigned many terms to the disorder, including problematic internet use, pathological internet use, compulsive internet use, internet dependence, and IA disorder. Generally, IA is characterized by excessive uncontrolled urges and impulses to use the Internet, leading to distress and impairment (Cash et al., 2012). IA is a broader term encompassing numerous digital activities, while gaming disorder, introduced by the World Health Organization, has similar characteristics but only pertains to a specific addictive stimulus, i.e., gaming (either online or offline). To note, WHO had also incorporated the Internet as a specific modifier and residual categories for patients with non-specific or broader Internet stimuli (Stein et al., 2020).

Several instruments have been used for identifying IA, with the IA Test (IAT) being the earliest and most widely used tool. IAT was conceived by Kimberly Young in 1998 as an instrument to diagnose IA. It was developed based on the pathological diagnostic criteria for gambling listed in the Diagnostic and Statistical Manual of Mental Disorders (DSM)-IV. This test consists of 20 questions in English regarding problematic behaviors that occur due to excessive Internet use (Young, 1998; Young and de Abreu, 2010). The IAT has been widely translated and validated in various languages (Fernández-Villa et al., 2015; Khazaal et al., 2008; Korkeila et al., 2010). It has also been translated into Bahasa Indonesian and demonstrated to be psychometrically sound (Siste, 2019).

At present, there is no gold standard regarding the criteria for diagnosing IA; thus, a universal instrument to accurately detect and measure IA does not exist (Kuss et al., 2014). Although the IAT has been translated into multiple languages and has good internal validity, further scrutiny (Pawlikowski et al., 2013; Tran et al., 2017) has indicated several drawbacks: (a) it does not account for the duration of symptoms of the disorder; (b) it does not adequately correspond with the current advances in the digital age (it is uncommon nowadays to repetitively perform log-ins to access the Internet and surfing the Internet extends well beyond checking emails); (c) the IAT was designed for adult populations (adolescents rarely check emails in the morning); (d) it does not include biopsychosocial factors (the premature emotional and cognitive control, identity exploration, and influence of peer and family) that influence the identification of IA in adolescents.

The development of a comprehensive IA diagnostic questionnaire that incorporates biopsychosocial and cultural factors and can be used as a screening tool to identify adolescents with IA worldwide and Indonesia is critically needed. Therefore, the aim of this study was to develop a valid and reliable screening tool to identify IA among adolescents.

2. Methods

2.1. Questionnaire development overview

The *Kuesioner Diagnostik Adiksi Internet/*Internet Addiction Diagnostic Questionnaire (KDAI), was formed and validated in five steps. First, an extensive literature review was performed and the current diagnostic criteria for IA were reviewed to identify potential items; then, a panel of addiction experts was invited for discussion. Second, the nascent instrument was tested on a small sample for face validity, followed by focus group discussions (FGD) with the expert panel and participants separately. Third, the in-development KDAI was tested in a pilot study to analyze the reliability and factor structure through exploratory factor analysis (EFA). Fourth, a main study to confirm

construct validity by confirmatory factor analysis (CFA) was conducted. Lastly, the final KDAI was contrasted with the Indonesian version of the IAT to derive convergent validity and the cutoff criterion.

2.2. Construction of scale

Initially, a comprehensive literature analysis was performed to include all present nosology and criteria in the field, as well as to appraise all major IA screening tools. The instruments reviewed included IAT (Young, 1998), Chinese IA Scale (Chen et al., 2003), Compulsive Internet Use Scale (Meerkerk et al., 2009), Generalized Problematic Internet Use Scale (Caplan, 2002), Generalized Problematic Internet Use Scale 2 (Caplan, 2010), IA Proneness Scale-Short Form (Kim et al., 2008), DRM-52 Scale of Internet Use (Xu et al., 2012), Internet Related Experiences Questionnaire (Casas et al., 2013), Assessment for Computer and IA Screener (Wölfling et al., 2013), Chinese IA Inventory (Huang et al., 2007), IA Scale (Cho et al., 2014), Problematic Mobile Phone Use Questionnaire (Billieux et al., 2008), Problematic Online Gaming Questionnaire (Demetrovics et al., 2012), Problematic Online Gaming Questionnaire-Short Form (Pápay et al., 2013), Video Game Addiction Questionnaire (Gunuc, 2015), and Game Addiction Scale (Lemmens et al., 2009). Other definitions used previously, such as excessive Internet use (Morrison and Gore, 2010; Mythily et al., 2008) and pathological technological use (Cao et al., 2011; King et al., 2013a), proposed criteria for IA or Internet Gaming Disorder (American Psychiatric Association, 2013; Ko et al., 2005; Tao et al., 2010; World Health Organization, 2018), and various critical reviews in the field were jointly considered (Andreassen, 2015; Billieux et al., 2015; D'Hondt et al., 2015; Griffiths et al., 2016; Kuss et al., 2014; Paulus et al., 2018; Petry et al., 2014; Sim et al., 2012). Domain categorization was evolved based on the earlier proposed domains, and items were assigned accordingly. A review of the literature produced 12 potential domains and 105 probable items, which were reviewed by a panel of 15 experts (two child and adolescent psychiatrists, four substance addiction psychiatrists, two behavioral addiction psychiatrists, three neuropsychiatrists, a pediatrician, and two addiction psychologists) in three rounds of expert discussions, adhering to the Delphi methods (Thangaratinam and Redman, 2005). Statements with content validity ratio (CVR) $\geq$ 0.51 and that had a scale-level index/average (S-CVI/Ave) $\geq$ 0.90 (Lawshe, 1975; Polit et al., 2007) were selected to be included in the initial KDAI form, which resulted in 11 domains and 56 items. However, items 54—"My academic performance or productivity has reduced due to Internet use"—and 56—"My productivity at school has decline because of my Internet usage"—were considered identical and merged; thus, 55 items were retained. The 11 domains were as follows: preoccupation, withdrawal, tolerance, loss of control, social isolation, interpersonal conflicts, quality of life consequences, loss of other interests, escape and modification of adverse mood, deception, and social repercussions. The biological impact domain was removed as no items within it were agreed upon by experts.

The duration of symptoms of IA in KDAI was determined at 12 months to correspond to the time frame suggested by the American Psychiatric Association (Kuss et al., 2017) and WHO (Stein et al., 2020). A linguist from the Faculty of Literature, Universitas Indonesia was consulted to assess each item's wording. Terms regarding work performances were substituted to better reflect adolescent's daily life, such as school-work, and local terms for being 'online' and 'offline' were added instead of replaced since these English terms are widely used by local adolescents. The nascent KDAI was discussed with a psychometric psychologist and suggested to be formulated as a 7-point Likert scale, with 0 (= 'Not Applicable'), 1 (= 'Very Rarely'), and 6 (= 'Always') and a 6-point Polar scale, with 'Never' and 'Always' as extreme poles.

2.3. Participants and procedures

The current study was conducted in three phases to establish

concurrent validity and reliability along with factor structure ratification: a face validity study, a pilot study, and a main study. Overall, 554 schools around Central Jakarta, Indonesia were approached, and a total of 39 schools agreed to participate. They were selected based on cluster random sampling, based on the type of schools: public, private, religious, or vocational. Students were further randomized from each school by stratified randomized sampling based on their school grade (grades 7–9 among junior high schools and grades 10–12 among high schools). We sent out letters to the principal of each of the selected schools before the visit. We then went to each school to obtain the data and were able to collect all distributed questionnaires. Participants were verbally briefed by the investigator on the study, and written informed consent was obtained from participants and/or the family or guardian if they were below 18 years of age. This study received ethical clearance from the Institutional Ethics Committee of Faculty of Medicine, Universitas Indonesia—Cipto Mangunkusumo Hospital (318/UN2.F1/ETIK/2016). First, a face validity study was conducted with 31 adolescents randomly selected from the seven schools. Then, FGDs were conducted among experts and participants to evaluate the contents of and difficulties faced in answering the initial questionnaire; the respondents preferred the scale format and suggested some inputs pertaining detail of items, particular wordings, and other pastime examples. Following a consultation with a linguist from the Faculty of Literature, Universitas Indonesia, the diction and terminologies were refined, the in-development KDAI then had 10 domains and 47 items. Items' positions were randomized so that items within a domain did not appear consecutively. Second, a pilot study retested the in-development KDAI recruiting 385 randomized subjects from eight schools; this was then analyzed using EFA, producing the factorial domains and model variations. Finally, the main study was performed among 643 subjects (from nine schools) to confirm the factor structure and validity through CFA. The final KDAI had seven domains and 44 items, which were compared against the Indonesian version of the IAT to establish concurrent validity and determine the criterion cutoff point. The Indonesian version of the IAT, consisting of three domains and 18 items with a Cronbach's α of 0.855, was validated within the adolescent population by Siste (2019).

2.4. Data and statistical analysis

Statistical calculations were performed using SPSS 22.0 for Windows (IBM, USA). The reliability of KDAI was analyzed using the internal consistency value (Cronbach's alpha) and factorial validity by inter-item Pearson correlation and EFA, utilizing orthogonal rotation/varimax. The factorial structure, ascertained through EFA, was based on eigenvalue (eigenvalue $\geq$ 1) and by observing the break in the scree plot. Items with factor loads < 0.4 were removed. CFA was assessed using Linear Structure Relations (Lisrel) version 8.8 and conducted to confirm the construct validity of the KDAI obtained in the EFA. The construct validity of the model was based on several parameters, such as the *p*-value of the chi-square test > 0.05, root mean square error of approximation (RMSEA) < 0.06, comparative fit index (CFI) ≥ 0.9, standardized root mean residual (SRMR) < 0.08, Tucker-Lewis Index (TLI)/ Non-Normed Fit Index > 0.95, adjusted goodness-of-fit index (AGFI) > 0.95, and lower Akaike Information Criterion (AIC; Hooper et al., 2008; Hu and Bentler, 1999). Concurrent validity was then analyzed between KDAI and IAT using the Pearson's correlation coefficient for each domain of the two instruments. The cutoff determination of the KDAI was determined using IAT (Siste, 2019) as a comparison by generating a receiver operating characteristic (ROC) curve.

The IAT score used as a cut-off was 45. From the ROC curve, the cutoff was selected by analyzing the area under the curve (AUC), sensitivity, specificity, and negative and positive likelihood ratios.

3. Results

3.1. Questionnaire characteristics and respondents demographics

The respondents' characteristics across the three phases of the study are presented in Table 1. Throughout the face validity study, pilot study, and main study, most of the respondents were female (64.5%, 52.5%, and 53.7%, respectively). Overall, almost three-fourths of the respondents were online for more than 20 hours a week. Through the FGD, the Likert-scale was found to be more straightforward for respondents; there were several concerns from the respondents, such as 'addiction' being hard to understand; they also suggested that examples be provided when a circumstance is proposed.

3.2. Reliability

The Likert-scale version of the KDAI initial form (55 items) had a Cronbach's alpha of 0.964 and the Polar-scale version 0.967, demonstrating analogous internal consistency; the Likert scale was selected following the subjects' preference. A Pearson inter-item correlation of 55-item KDAI demonstrated that six items had poor correlation (*r* ranged from 0.188–0.296); thus, they were excluded. The resulting deception domain only preserved two items; hence, the domain and items were removed. Reevaluation of reliability for the 47-item KDAI (10 domains) exhibited a Cronbach's alpha of 0.947 and acceptable inter-item correlation, ranging 0.303–0.652. The final KDAI, consisting of seven domains and 44 items, had very high internal consistency with a Cronbach's alpha of 0.942. Within factors, withdrawal had the highest reliability ($\alpha = 0.874$) and lowest impairment ($\alpha = 0.616$). The corrected total inter-item correlation ranged from 0.390–0.651. The inclusive results of each domain and item are detailed in Table 2.

3.3. Factor structure and construct validity

The 47-item KDAI was applied to the pilot study sample and scrutinized with EFA employing principal axis factoring and constricting factors into orthogonal (varimax) rotation. The eigenvalues of the ten factors were all above one and cumulatively elucidated 59.02% of the total variance (Figure S1). Around three items, two of which were within the tolerance domain, had a factor load < 0.4 and were deleted. Following EFA, quality of life consequences, loss of other interests, tolerance, and escape and modification adverse mood domains retained less than three items. To maintain construct validity, only the domains were removed, while the items within were redistributed. EFA on the 44-items KDAI produced a Kaiser-Meier-Olkin normalization of 0.929,

Table 1
Demographics of research subjects.

Variable	Face Validity n (%)	Pilot Study n (%)	Main Study n (%)
Sex			
Male	11 (35.5)	183 (47.5)	298 (46.3)
Female	20 (64.5)	202 (52.5)	345 (53.7)
Age			
Early adolescent[a]	12 (38.7)	145 (37.7)	307 (47.7)
Middle Adolescent[b]	12 (38.7)	184 (47.8)	254 (39.5)
Late adolescent[c]	7 (22.6)	56 (14.5)	82 (12.8)
Education			
Junior high school	17 (54.8)	145 (37.7)	318 (49.5)
Senior high school	14 (45.2)	240 (62.3)	325 (50.5)
Duration of Internet use (hours/week)			
$\leq$ 20	7 (22.6)	83 (21.6)	212 (32.9)
> 20	24 (77.4)	302 (78.4)	431 (66.9)

Notes:
[a] 10-14 years old.
[b] 15-17 years old.
[c] 18-20 years old.

Table 2

Reliability and exploratory factor analysis of final KDAI consisting of 7 domains and 44 items.

Domain	KDAI Item	Corrected Total Inter-Item Correlation	EFA Factor Loading
Withdrawal	8. I feel very disturbed if forced to stop using the Internet	0.500 – 0.735	0.579
(Eigenvalue = 12.89, Variance Percentage = 29.29, Cronbach's α = 0.874)	15. I feel angry towards the person who asked me to stop using the Internet		0.694
	16. I feel worried if I am not on the Internet		0.625
	19. I feel irritated after I stop using the Internet		0.676
	26. I feel irritated at that moment after I stop using the Internet		0.764
	27. I often show my annoyance when others disturb me while I am on the Internet		0.519
	35. I am easily agitated when someone tells me to stop using the Internet		0.763
	36. I feel anxious if I cannot use the Internet		0.599
Loss of Control	2. I forgot about time when I am on the Internet	0.486 – 0.657	0.497
(Eigenvalue = 2.52, Variance Percentage = 5.72, Cronbach's α = 0.853)	4. My sleep duration is reduced because I spent most of my time on the Internet		0.591
	31. Most of my time in a single day is spent on the Internet		0.628
	34. I am on the Internet for much longer than I had planned		0.587
	38. I persist on using the Internet even though my daily activities are in disarray		0.547
	40. I keep on using the Internet even when my parents or family has forbidden me to		0.509
	41. I feel annoyed when the Internet connection is problematic		0.533
	42. I keep on using the Internet leisurely even though I realized I have other tasks		0.609
	44. I keep on using the Internet even after I made up my mind not to		0.579
Increase of Priority	21. I reduced time for other hobbies or interests because I want to be on the Internet longer	0.388 – 0.666	0.446
(Eigenvalue = 1.93, Variance Percentage = 4.38, Cronbach's α = 0.792)	24. I choose to be on the Internet rather than going out with my friends (e.g., to the mall, playing sports together, etc.)		0.741
	25. I feel more comfortable to communicate through the Internet than in real life		0.443
	33. I spend more time on the Internet than to physically play with my friends (e.g., playing football, watching		0.757

Table 2 (*continued*)

Domain	KDAI Item	Corrected Total Inter-Item Correlation	EFA Factor Loading
	movies, eat out together, etc.)		
	39. To forget my problems, I choose to be on the Internet than other things		0.451
	43. I feel using the Internet gives me more excitement than my previous interests		0.599
Negative Consequences	6. My tasks are neglected (e.g., procrastinating on homework, failed to submit schoolwork, etc.) because I spend too much time on the Internet	0.485 – 0.577	0.42
(Eigenvalue = 1.76, Variance Percentage = 4.00, Cronbach's α = 0.789)	12. I stop doing my daily chores because I am on the Internet		0.514
	13. I communicate less with my family since I am more often on the Internet		0.634
	14. My relationship with my family is troubled since I am more often on the Internet		0.662
	18. I neglect my school tasks, so I have more time to be on the Internet		0.483
	28. I have fought with my parents/friends/partners regarding using the Internet		0.502
	30. My daily chores are in disarray because I spent too much time on the Internet		0.463
Mood Modification	3. My life feels more comfortable when I am on the Internet	0.437 – 0.569	0.653
(Eigenvalue = 1.42, Variance Percentage = 3.22, Cronbach's α = 0.736)	5. I feel annoyed if I am not on the Internet and it goes away when I am back on the Internet		0.563
	7. I anticipate the time I can be on the Internet		0.571
	9. I constantly think about using the Internet even when I am doing something else		0.471
	10. I resist uncomfortable emotions in real life with pleasant feelings when on the Internet		0.448
Salience	17. I imagine being on the Internet when I am doing something else	0.310 – 0.553	0.74
(Eigenvalue = 1.30, Variance Percentage = 2.95, Cronbach's α = 0.708)	20. I lose my concentration when doing other tasks because I constantly think of being on the Internet		0.439
	22. My relationship with my friends/partners turn problematic as I spend more time on the Internet		0.582
	23. I think of using the Internet even when I am doing other tasks		0.441
	29. I plan my next time to use the Internet when I am currently doing something else		0.539

Table 2 (*continued*)

Domain	KDAI Item	Corrected Total Inter-Item Correlation	EFA Factor Loading
	32. I constantly think of using the Internet before I do a task		0.54
Impairment	1. I tried to limit my time on the Internet, but I failed	0.270 – 0.523	0.447
(Eigenvalue = 1.23, Variance Percentage = 2.80, Cronbach's α = 0.616)	11. My grades fall because of my time spent on the Internet		0.725
	37. My academic achievements decline because I spent too much time on the Internet than school activities		0.625

Bartlett's Test of Sphericity $p < 0.001$, and seven factors were obtained, which accounted for 52.36% of the total variance. The detailed EFA results are presented in Table 2.

Results from the main study sample were analyzed by CFA. We explored three different models: Model 1 (literature-based) consisted of ten domains and 55 items; Model 2 (EFA result) consisted of seven domains and 44 items; and Model 3 (modified EFA result) was composed of six domains and 44 items. Considering that items within the impairment domain were irrelevant, they were allotted to the loss of control and negative consequences domains. The analysis outcomes are compared in Table 3. Fit indices indicated that Model 2 ($\chi2/df = 4.09$, RMSEA = 0.069, CFI = 0.95, AIC = 3842.6, SRMR = 0.065, TLI = 0.95, AGFI = 0.77) was superior with the lowest AIC and higher scores on CFI, TLI, and AGFI. The CFA factor loadings of Model 2 are depicted in Fig. 1. Altogether, the final KDAI contains seven domains (withdrawal, loss of control, increase of priority, negative consequences, mood modification, salience, and impairment) and 44 items (Table A1).

3.4. Concurrent validity

An inter-domain Pearson correlation test was performed between KDAI and IAT to determine concurrent validity of the KDAI. The Indonesian version of the IAT was previously validated by Siste (2019).

The results suggest a statistically significant correlation between all factors ($p < 0.001$). All correlation values between the KDAI and IAT were strong ($r > 0.3$); however, the impairment domain of the KDAI and salience domain of IAT displayed a weak correlation. Specific correlation values are shown in Table 4.

3.5. Cutoff determination

IAT was used to determine the criterion cutoff of the KDAI. Based on the ROC curve generated (Fig. 2), the cut-off for the KDAI was 108 with an AUC of 92%, sensitivity of 91.8% (95% CI = 83.77%–96.62%), and specificity of 77.8% (95% CI = 74.10%–81.16%). The positive and negative likelihood ratios of the KDAI were 4.13 (95% CI = 3.49–4.88),

Chi-square=3644.60, df=891, p-value=0.00000, RMSEA=0.069

Fig. 1. Parameter estimates of the seven-factor confirmatory factor analysis of KDAI Model 2.

and 0.11 (95% CI = 0.05–0.22), respectively. The possible minimum score was 0 and the maximum was 264 with the final KDAI (consisting of 44 items with a 6-point Likert scale); this was achieved by summing all the items' scores. Among the participants, the minimum score was 0 and the maximum was 226, and neither a ceiling nor floor effect was observed (not more than 15% at either possible extreme scores; McHorney and Tarlov, 1995).

Table 3
Comparison of goodness of fit indices between the three models of KDAI.

Model	χ2	df	χ2/df	RMSEA	CFI	AIC	SRMR	TLI	AGFI
Model 1[a]	7879.58	1417	5.56	0.084	0.94	8125.58	0.076	0.93	0.66
Model 2[b]	3644.60	891	4.09	0.069	0.95	3842.60	0.065	0.95	0.77
Model 3[c]	4111.88	896	4.59	0.075	0.95	4299.88	0.086	0.95	0.75

Notes:
[a] KDAI with 10 domains and 55 items.

[b] KDAI with 7 domains and 44 items.

[c] KDAI with 6 domains and 44 items; χ2 = Chi-Square; df = Degree of Freedom; RMSEA = Root Mean Square Error of Approximation; CFI = Comparative Fit Index; AIC = Akaike Information Criterion; SRMR = Standardized Root Mean Square Residual; TLI = Tucker-Lewis Index; AGFI = Adjusted Goodness of Fit Index.
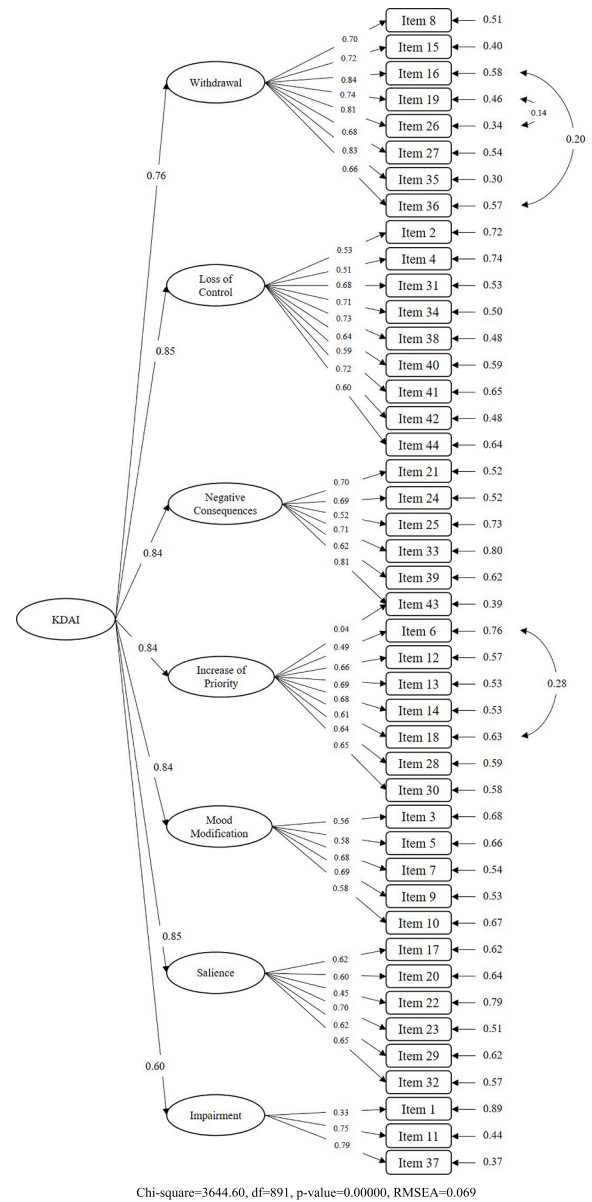
Table A1

Final KDAI scale and items in English.

No	Statement	Scoring Very rarely (1)	Rarely (2)	Sometimes (3)	Often (4)	Very often (5)	Always (6)	Not Applicable (0)
1	I tried to limit my time on the Internet, but I failed							
2	I forgot about time when I am on the Internet							
3	My life feels more comfortable when I am on the Internet							
4	My sleep duration is reduced because I spent most of my time on the Internet							
5	I feel annoyed if I am not on the Internet and it goes away when I am back on the Internet							
6	My tasks are neglected (e.g., procrastinating on homework, failed to submit schoolwork, etc.) because I spend too much time on the Internet							
7	I anticipate the time I can be on the Internet							
8	I feel very disturbed if forced to stop using the Internet							
9	I constantly think about using the Internet even when I am doing something else							
10	I resist uncomfortable emotions in real life with pleasant feelings when on the Internet							
11	My grades fall because of my time spent on the Internet							
12	I stop doing my daily chores because I am on the Internet							
13	I communicate less with my family since I am more often on the Internet							
14	My relationship with my family is troubled since I am more often on the Internet							
15	I feel angry towards the person who asked me to stop using the Internet							
16	I feel worried if I am not on the Internet							
17	I imagine being on the Internet when I am doing something else							
18	I neglect my school tasks, so I have more time to be on the Internet							
19	I feel irritated after I stop using the Internet							
20	I lose my concentration when doing other tasks because I constantly think of being on the Internet							
21	I reduced time for other hobbies or interests because I want to be on the Internet longer							
22	My relationship with my friends/partners turn problematic as I spend more time on the Internet							
23	I think of using the Internet even when I am doing other tasks							
24	I choose to be on the Internet rather than going out with my friends (e.g., to the mall, playing sports together, etc.)							
25	I feel more comfortable to communicate through the Internet than in real life							
26	I feel irritated at that moment after I stop using the Internet							
27	. I often show my annoyance when others disturb me while I am on the Internet							
28	I have fought with my parents/friends/partners regarding using the Internet							
29	I plan my next time to use the Internet when I am currently doing something else							
30	My daily chores are in disarray because I spent too much time on the Internet							
31	Most of my time in a single day is spent on the Internet							
32	I constantly think of using the Internet before I do a task							
33	I spend more time on the Internet than to physically play with my friends (e.g., playing football, watching movies, eat out together, etc.)							
34	I am on the Internet for much longer than I had planned							
35	I am easily agitated when someone tells me to stop using the Internet							
36	I feel anxious if I cannot use the Internet							
37	My academic achievements decline because I spent too much time on the Internet than school activities							
38	I persist on using the Internet even though my daily activities are in disarray							
39	To forget my problems, I choose to be on the Internet than other things							
40	I keep on using the Internet even when my parents or family has forbidden me to							
41	I feel annoyed when the Internet connection is problematic							
42	I keep on using the Internet leisurely even though I realized I have other tasks							
43	I feel using the Internet gives me more excitement than my previous interests							
44	I keep on using the Internet even after I made up my mind not to							

4. Discussion

To the best of our knowledge, this is the first study to develop an IA screening questionnaire for adolescents in Indonesia. There are several compelling features of the KDAI. First, it has good quality in psychometry to evaluate IA. Second, a deductive approach using the Delphi technique was implemented in the development of KDAI, differentiating it from IAT (Young, 1998) and CIAS (Chen et al., 2003). The Delphi technique provides an additional advantage by involving experts from various fields to develop the questionnaire. Experts were

Table 4

Inter-domain correlation matrix between KDAI and Indonesian version of IAT.

KDAI Domains	IAT Domains			
	Salience	Neglect of duty	Loss of control	Total
Withdrawal	0.586*	0.383*	0.451*	0.574*
Loss of control	0.539*	0.647*	0.621*	0.715*
Increase of priority	0.552*	0.402*	0.489*	0.581*
Negative consequences	0.435*	0.511*	0.364*	0.516*
Mood modifications	0.517*	0.339*	0.469*	0.536*
Salience	0.521*	0.362*	0.416*	0.523*
Impairment	0.288*	0.592*	0.350*	0.474*
Overall	0.665*	0.607*	0.611*	0.751*

Notes:

* $p < 0.001$ IAT = internet addiction test; KDAI = *Kuesioner Diagnostik Adiksi Internet/*Internet Addiction Diagnostic Questionnaire.
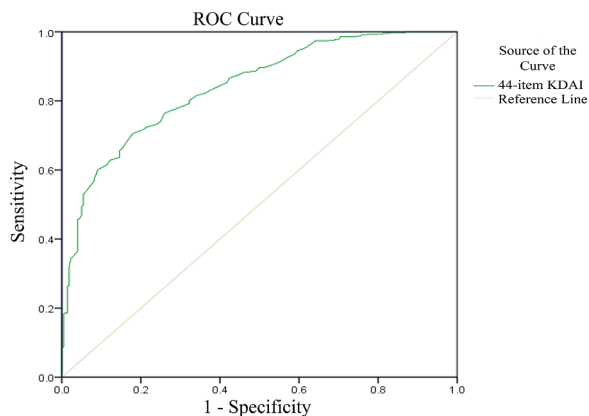
Fig. 2. ROC curve analysis of KDAI and Indonesian version of IAT.

given a chance to deliver their opinions anonymously; thus, they were able to remain objective without being influenced by each other (Thangaratinam and Redman, 2005). Furthermore, repeated rounds of the Delphi technique provided experts with a chance to re-evaluate their opinions. This process and conformity to DSM-5 criteria depict the comprehensiveness of questions integrated within the KDAI to adequately portray IA in adolescents. The development of the KDAI also involved adolescents to voice their opinions for this questionnaire through FGD and accommodates the local cultural aspects of adolescents.

The overall reliability of KDAI was excellent, and the final KDAI Cronbach's alpha was 0.942 (55-item KDAI $\alpha = 0.964$ and 47-item KDAI $\alpha = 0.947$). The factor structure and construct validity from EFA and CFA generated a valid 7-domain model of the KDAI with 44 items and preferable goodness of fit indices compared to the other models. This result showed that the psychometric properties, validity, and reliability of the KDAI were good. Therefore, the KDAI was found to be a valid and reliable instrument to evaluate IA. Questions and domains included in the KDAI were also in line with the diagnostic criteria in the DSM-5 and ICD-11 (American Psychiatric Association, 2013; World Health Organization, 2018). The domains of the KDAI (withdrawal, loss of control, increase of priority, negative consequences, mood modification, salience, and impairment) were all considered clinically vital; therefore preventing over-detection of IA (Griffiths et al., 2016; Kuss and Lopez-Fernandez, 2016; Petry et al., 2014; Van Rooij and Prause, 2014). The domains that were contentious from a previous study (i.e., deception and tolerance) were not included (Griffiths et al., 2016). Our results and earlier research demonstrated that deception does not have definitive diagnostic value in IA and is heavily influenced by alternative factors, such as parents' behavior or relationship with others (King et al., 2013b; Ko et al., 2014; Tao et al., 2010). In addition, Internet usage is not a criminalized behavior in Indonesia (except for pornographic

content, in which access is banned both offline and online); therefore, adolescents do not necessarily have to conceal themselves online.

Tolerance was also not included in KDAI because the criterion of tolerance in behavioral addiction is debatable and the result of an imprecise attempt to model IA on substance-related addiction (King et al., 2017; Van Rooij and Prause, 2014). First, tolerance in addiction is related to neuroadaptations produced by substance ingestion (Christie, 2009); however, behavioral activities cannot physically interact to incite such neuromodulation. An element of tolerance associated with behavioral addiction is the gradual increase in duration to attain similar excitement. Nevertheless, the Internet, games, and social media involve other facets of complexity apart from time, with excitement being modified by genres, type of platform, dynamicity of activities, and achievement of goals. For example, once a person has accomplished an objective in goal-oriented games, they tend to experience boredom and will not repeat the same tasks (Griffiths et al., 2016). On the other hand, multiplayer online battle arena games with the exact same repetitive gameplay continuously provide distinct experience and excitement (Debeauvais et al., 2011). In addition, this criterion is challenging to quantify, with some authors proposing an increase in hours, specific hardware upgrades, or advancement of software (King et al., 2017). Furthermore, the presence of tolerance does not necessarily maintain that an individual is addicted and excessively addicted individuals might be so severe that they are unable to physically extend their duration of usage (Ko, 2014). Evidently, the KDAI adopts updated IA diagnostic criteria, attempts to avert over-pathologizing of daily behavior in the present era, and corresponds to the suitability of Asian societies.

Subsequently, all KDAI domains were statistically significant ($p < 0.001$) and strongly correlated with the domain of IAT (Siste, 2019), except that impairment in the KDAI had a significantly weak correlation with salience in IAT ($r < 0.3$). Therefore, the KDAI and its domains are concurrent with IAT, as the first questionnaire evaluating IA, making the KDAI appropriate for evaluating IA. In addition to the remarkable validity and reliability of the KDAI, it also manifested precise screening capacity. Based on the ROC curve generated, the optimal cut-off for KDAI was 108 with an AUC of 92%. With an AUC > 90%, the KDAI had the ability to accommodate the wide range of IA symptoms. Furthermore, the sensitivity and negative likelihood ratios of the KDAI were remarkably high (91.8% and 0.11, respectively), making it very suitable as a screening tool for IA (Trevethan, 2017).

There are some limitations to this present study worth noting. Subjects were only recruited from schooled adolescents, although in the community there are non-schooled adolescents, and they may have different characteristics of Internet utilization. The temporal stability of this instrument should also be explored for test-retest reliability to determine the accuracy of the KDAI over time. Additionally, the KDAI should be employed in patient settings or post-intervention subjects to investigate recovery sensitivity, thus reinforcing the predictive validity of the instrument. The current study also did not analyze subsets of IA associated with other psychiatric comorbidities (e.g., mood disorders, stress-related disorders). Furthermore, the convergent validity and cut-off determination of the current KDAI version were validated against IAT, which ideally should have been replaced by clinical diagnosis but was not due to a lack of resources in the current study. Additional studies involving the KDAI should address these issues and accommodate future changes in IA criteria or definitions.

To conclude, the KDAI demonstrated robust psychometric characteristics for IA detection among adolescents, and the screening accuracies confer the capacity for the KDAI to be utilized in both clinical and research settings. Importantly, the items within the KDAI were able to accommodate the duration of symptoms, the dynamics of peer and family relationships, emotional control capacities, examples of more recent Internet activities, and updates on behavioral addiction theories. Compared to the IAT, the KDAI has yet to be compared to clinical data and scrutinized against neurological correlates, especially considering the sensitive cognitive development period of adolescence. Accounting

for the cultural orientation of the KDAI, it will prove to be a useful tool that can be applied in other cognate countries and will contribute precious data on cross-cultural implementation.

CRediT authorship contribution statement

Kristiana Siste: Conceptualization, Methodology, Formal analysis, Investigation, Resources, Writing – original draft, Writing – review & editing. **Tjhin Wiguna:** Conceptualization, Methodology, Formal analysis, Resources, Supervision, Writing – review & editing. **Saptawati Bardasono:** Conceptualization, Methodology, Formal analysis, Resources, Supervision, Writing – review & editing. **Rini Sekartini:** Conceptualization, Formal analysis, Supervision, Writing – review & editing. **Jacub Pandelaki:** Conceptualization, Formal analysis, Supervision, Writing – review & editing. **Riza Sarasvita:** Conceptualization, Formal analysis, Supervision, Writing – review & editing. **Christiany Suwartono:** Methodology, Formal analysis, Resources. **Belinda Julivia Murtani:** Investigation, Writing – original draft. **Reza Damayanti:** Investigation, Writing – original draft. **Hans Christian:** Investigation, Writing – original draft. **Lee Thung Sen:** Writing – original draft, Writing – review & editing. **Martina Wiwie Nasrun:** Conceptualization, Methodology, Formal analysis, Resources, Supervision, Writing – original draft, Writing – review & editing.

Declaration of Competing Interest

None

Supplementary materials

Supplementary data associated with this article can be found, in the online version, at doi:10.1016/j.psychres.2021.113829.

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