MULTICAGE CAD-4 for behavioral addiction screening:
Structural validity after inclusion of a scale on smartphone abuse

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Título: MULTICAGE CAD-4 para la detección de adicciones conductuales: validez estructural después de la inclusión de una escala en el abuso de teléfonos inteligentes.

Resumen: Los comportamientos adictivos no se limitan al uso de drogas, sino que también incluyen ciertos comportamientos diarios que pueden causar gratificación. Su progresión a patrones patológicos más severos conlleva graves consecuencias para el individuo, incluidas múltiples manifestaciones psicopatológicas. La detección temprana de este tipo de comportamiento es de interés para la atención primaria de salud. Por lo tanto, para detectar riesgos en etapas tempranas, las herramientas confiables y válidas para la práctica diaria son esenciales. El cuestionario MULTICAGE CAD-4 es una herramienta de detección para detectar simultáneamente conductas adictivas. Este estudio incluye una nueva escala para la detección del abuso de teléfonos inteligentes. El objetivo es evaluar la adecuación de sus propiedades psicométricas. Una muestra de 2.074 sujetos reclutados en centros de atención primaria de Madrid (España) completó el cuestionario MULTICAGE CAD-4. Se realizó un análisis factorial confirmatorio, utilizando el método de mínimos cuadrados no ponderados. La prueba mostró una buena consistencia interna tanto a nivel del ítem como de las escalas. La estructura del cuestionario fue consistente con las expectativas teóricas. El MULTICAGE CAD-4, incluida la nueva escala para teléfonos inteligentes, es una herramienta robusta y confiable con una estructura válida para evaluar la presencia de comportamientos disfuncionales o potencialmente adictivos, y especialmente útil en servicios de atención primaria de salud.

Palabras clave: Adicciones conductuales; Drogadicción; Cribado; Cuestionario; Análisis factorial; Propiedades psicométricas.

Abstract: Addictive behaviors are not limited to drugs use, but also include certain daily behaviors that can cause gratification. Their progression to more severe pathological patterns entails grave consequences for the individual, including multiple psychopathological manifestations. The early detection of this type of behavior is of concern to primary health care. Therefore, in order to detect risk at early stages, reliable and valid tools for daily practice are essential. The MULTICAGE CAD-4 questionnaire is a screening tool for simultaneously detecting addictive behaviors. This study includes a new scale for the detection of smartphone abuse. The objective is to evaluate the adequacy of its psychometric properties. A sample of 2,074 subjects that were recruited from primary care centers of Madrid (Spain) completed the MULTICAGE CAD-4 questionnaire. A confirmatory factor analysis, using unweighted least squares method, was performed. The test showed good internal consistency both at item and scale levels. The questionnaire structure was consistent with theoretical expectations. The MULTICAGE CAD-4, including the new smartphone scale, is a robust, reliable tool with a valid structure for assessing the presence of dysfunctional or potentially addictive behaviors, and especially useful in primary health care services.

Keywords: Behavioral addictions; Drug addiction; Screening; Questionnaire; Factor analysis; Psychometric properties.

Introduction

Addictive behaviors represent a complex problem for public health that entails adverse consequences for the individual's personal health and growth, family dynamics, and social development and stability. Talking about addictions refers to a complex, multi-determined behavioral phenomenon that involves diverse factors: genetic, epigenetic, development-related, educational, psychological, environmental, and cultural. This phenomenon is characterized by the creation of new habits or repetitive behaviors that escape brain mechanisms supervising conduct, so that they get repeated because of short-term reinforcement, even if they later cause negative consequences (Lewis, 2015; Volkow, & Baler, 2014).

Addictions have traditionally been associated with substance use, but the characteristics described above can also appear in relation to other specific behaviors, the so-called behavioral addictions (Grant, Potenza, Weinstein, & Gorelick, 2010). Recent research has found evidence that the brain circuits implied in addiction, whether involving substances or not, are essentially the same (Brand, Young, & Laier, 2014; Huang, 2017), which corresponds to previous findings that both conditions share genetic predispositions, personality traits, behavior patterns, and complications in diverse daily-life activities. (Grant, Brewer, & Potenza, 2006).

In recent years, the emergence of smartphones has brought about a new revolution, as it has become the most widely used device for Internet access, largely displacing personal computers. Its easy portability and information accumulation capacity have turned the smartphone into a handheld computer, with unlimited utilities (Pedrero-Pérez, Rodríguez-Monje, & Ruiz-Sánchez de León, 2012).

The limit between use, overuse, and addiction is by no means easy to draw. As previously noted, addiction is currently regarded as a progressing process: from an initial reinforced response, to a habit where some stimulus-response associations prevail that escape the conscious cognitive control (Kuss, & Lopez-Fernandez, 2016). This loss of control

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makes the individual embrace compulsive, constraining behaviors that can interfere with brain, personal, and social development, and is frequently also associated with mood disorders or other psychopathological expressions (Kaess et al., 2014). Therefore, it is essential to detect risk at initial stages of this process, which would in many cases stop the evolution of the loss of control (Lee, & Lee, 2017), especially in the case of new technologies, which primarily affect subjects with increasingly lower ages (Carbonell et al, 2012) and are linked to the emergence of behaviors derived from high social risk (Arnaiz, Cerezo, Giménez, & Maquilón, 2016).

In order to effectively detect addictions at early stages, it is essential to depend on reliable, validated tools that can be applied in the daily practice of primary care. A study that assesses available resources (Rowan, & Galasso, 2000) suggests that current means are inadequate for clinicians, both for detecting drug consumption and pathological gambling, and that access to quick-to-use, validated, reliable tools would be of major help for their detection, analogously to the CAGE for alcohol-abuse disorders. Following these premises, MULTICAGE CAD-4 (Pedrero-Pérez et al., 2007) was proposed as an initial screening tool for the si-multaneous detection of addictive behaviors involving substances (alcohol and drugs) or not (Internet and videogames addictions, or pathological gambling), as well as other impulse control disorders (eating disorders, compulsive spending, or sex addiction). The MULTICAGE CAD-4 questionnaire, formerly aimed at the population suffering addictions and impulse control disorders, has been later validated for the primary care setting (Rodríguez-Monje, Pedrero-Pérez, Fernández-Girón, Gallardo-Alonso, & Sanz-Cuesta, 2009) and has proven to possess adequate psychometric and diagnostic capacities in both cases. The questionnaire, which is based on the CAGE and follows its 4-question original model, evaluates each of the eight studied addictive disorders, and hence comprises 32 items. A study performed on drug-addicted populations has proven its usefulness for the early diagnosis of these behaviors, allowing for the detection of related addictive behaviors that were neither acknowledged by patients nor identified by the health professionals (Pedrero-Pérez, 2010). Additionally, other studies (Calvo-Francés, 2016; Del Prete et al., 2017; Estevez, Herrero-Fernández, Sarabia, & Jauregui. 2015; Estévez, Ozerinjauregi, Herrero-Fernández, & Jauregui, 2016; Garrido-Elustondo, Reneses, Navalón, Martín, Ramos, & Fuentes, 2016; Jauregui, Estevez, & Urbiola, 2016; Navas et al., 2017; Navas, Verdejo-Garcia, Lopez-Gomez, Maldonado, & Perales, 2016; Pedrero-Pérez et al., 2018; Reneses et al., 2015 25-32) have shown its utility as a screening tool.

Given the relevance of smartphone overuse and the high prevalence found in several studies (Pedrero-Pérez et al., 2012), it has been decided to include a new scale to assess this problem, which will also allow to complete the profile of addictions to new technologies. The questions included in the smartphone scale follow, as in all other cases, CAGE's basic scheme, asking about the inability to limit the time of use, complaints from significant others about excessive time

spent, the need to maintain permanent access to the device and failures in attempts to control behavior. This study aims to assess the adequacy of the psychometric characteristics of the new scale, as well as the preservation of the structural validity of the questionnaire after its inclusion.

Method

Design and procedure

A descriptive, transversal, multicentric study to validate diagnostic tests was conducted in the primary care setting. It was performed in 5 urban primary health care centers, within the public health care system of Madrid, which services a population of 162,461 citizens. The study population comprised subjects older than 14 years who attended primary care consultation for any reason in any of the health centers included in this study and selected by random, non-consecutive sampling. Patients suffering from any moderate to severe mental deficiency or disorder were excluded, as well as those who had problems to read, write, or understand Spanish language. Participants were informed about the study and asked for written consent. In the case of minors, further consent was obtained from their parents or guardians.

The questionnaire was anonymous and self-completed. In addition to the MULTICAGE CAD-4, it recorded the following socio-demographic variables: age, gender, educational level, work status, marital status, access to personal computer, access to videogame console, and social relationships.

A new version of the MULTICAGE CAD-4 was employed which dispensed with the scales regarding eating disorders, compulsive shopping, and sex addiction, and included a new 4-item scale on smartphone overuse. The final questionnaire (ANNEX I) included 24 items from 6 different scales, with 4 questions each that require dichotomous responses (Yes/No), and assess problems involving alcohol consumption, drug abuse, pathological gambling, Internet, videogames, and smartphone use.

Ethical considerations

The protocol for the present study was approved by the Comisión Central de Investigación de la Gerencia de Atención Primaria de Madrid. It has also been approved by the Ethical Committee for Clinical Research of Hospital Universitario Severo Ochoa in Leganes (Madrid).

Data analysis

A descriptive statistical analysis of the variables of interest was performed. The internal consistency of items and scales was studied firstly to assess the questionnaire. Reliability of scales was tested by Standarized Cronbach's. Since the test items are dichotomous and a normal distribution of re-

sults is not expected, a confirmatory factor analysis was carried out using the unweighted least squares method. Absolute (χ^2/df, GFI, RMR), relative (NFI, RFI), and noncentrality-based (PGFI, PNFI) fit indexes were used to test the model. The correlation between the scales was studied by Pearson's r, applying the Bonferroni correction for multiple correlations. FACTOR 10.5 for the reliability, SPSS 22 for correlation and AMOS 21 for the confirmatory and structural analysis were used.

Results

A sample of 2,074 subjects (875 men and 1,199 women) was obtained, with average age 49.7 years (SD=18.7), in a range from 14 to 94. Of them, 5.2% lacked studies, while 31,0% had elementary studies, 15.0% secondary school studies, 13.6% technical training, 14.8% high school studies, and 20.3% university studies. In total, 72.9% had at least one Internet access device for everyday use.

Table 1. Description and internal consistency of items and scales.

Scale	Item	Mean	Typical error	Standard deviation	Median	Asymmetry	Kurtosis	r_{it}	α_s
Alcohol	1	0.19	0.01	0.39	0	1.59	0.52	0.51	
	2	0.09	0.01	0.29	0	2.88	6.33	0.50	0.88
	3	0.09	0.01	0.29	0	2.82	5.98	0.56	
	4	0.03	0.00	0.18	0	5.29	26.05	0.30	
Gambling	5	0.05	0.00	0.21	0	4.40	17.9	0.45	
	6	0.02	0.00	0.13	0	7.51	54.41	0.51	0.94
	7	0.02	0.00	0.13	0	7.40	52.76	0.53	
	8	0.02	0.00	0.12	0	7.87	59.98	0.59	
Drugs	9	0.05	0.00	0.21	0	4.30	16.47	0.65	
	10	0.03	0.00	0.17	0	5.63	29.67	0.49	0.95
	11	0.02	0.00	0.15	0	6.14	35.78	0.59	
	12	0.03	0.00	0.16	0	5.90	32.82	0.65	
Smartphone	13	0.13	0.01	0.34	0	2.17	2.70	0.52	
	14	0.11	0.01	0.31	0	2.54	4.48	0.51	0.85
	15	0.28	0.01	0.45	0	0.96	-1.09	0.38	
	16	0.12	0.01	0.33	0	2.34	3.48	0.38	
Internet	17	0.13	0.01	0.34	0	2.20	2.84	0.58	
	18	0.08	0.01	0.28	0	2.98	6.90	0.58	0.92
	19	0.09	0.01	0.29	0	2.79	5.81	0.49	
	20	0.05	0.00	0.21	0	4.22	15.83	0.56	
Videogames	21	0.03	0.00	0.18	0	5.29	26.05	0.64	
	22	0.04	0.00	0.20	0	4.57	18.93	0.63	0.95
	23	0.02	0.00	0.13	0	7.29	51.20	0.57	
	24	0.02	0.00	0.14	0	6.73	43.36	0.49	

Note: r_{it}= corrected item-test correlation; αs= Standarized Cronbach's α.

Description and consistency of items of MULTICAGE CAD-4, as well as consistency of the proposed theoretic scales is shown in Table 1, where it can be observed that all scales have a coefficient α_s> 0.85 and all items have a discrimination index r_{it}> 0.30.

A confirmatory factor analysis was carried out using the unweighted least squares method. An acceptable χ^2/df= 3.34 was obtained, although it may result from using a very large sample size (n). Absolute adjustment indices were also adequate (GFI=0.99; AGFI=0.98; RMR=0.002) but are also affected by sample size. However, indices not sensitive to size sample were also adequate (NFI=0.97; RFI=0.96), and so were the parsimony ones (PGFI=0.78; PNFI=0.83). The resulting structure is shown in Figure 1.

All scales are significantly correlated with each other (Table 2), although the magnitude of the correlations effect varies widely. Maximal correlation is observed between the Internet and videogames scales, Internet and smartphone use, and alcohol and drug abuse.

Table 2. Correlations between the scores of each scale.

	Alcohol	Gambling	Drugs	Cell phone	Internet
Gambling	0.26				
Drugs	0.33	0.22			
Smartphone	0.18	0.11	0.16		
Internet	0.13	0.09	0.15	0.38	
Videogames	0.09	0.21	0.25	0.18	0.45

Note: All correlations reach statistical significance after applying the Bonferroni correction for multiple correlations (p< 0.0014).

Discussion

After controlling for the distribution of items, the internal consistency of all the scales was satisfactory, both at the item level and at the complete scales level. The new scale on smartphone use and overuse displayed good internal consistency, analogous to that of the rest of the scales, which supports the high reliability of the whole test.
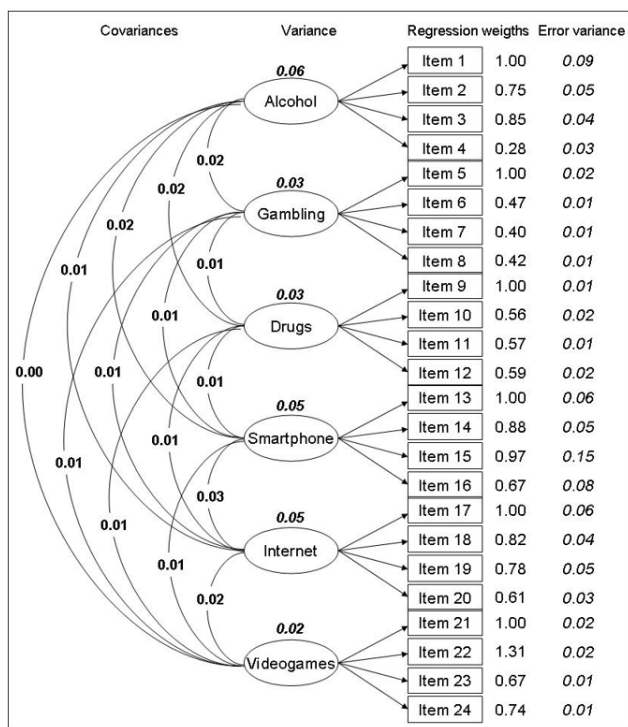
Figure 1. Structure of MULTICAGE.

The outcome of confirmatory factor analysis was fully satisfactory, and all indicators showed an adequate adjustment to the data, especially those not affected by the large sample size. The inclusion of the new scale on smartphone use did not alter the overall structure of the test, which, on the whole, shows a solid structure.

This study has strengths and limitations. Among the first, the use of a non-consecutive sample with an item/subject ratio > 80 allows for applying the most stringent analysis criteria. The age range is very broad, surpassing what is normally included for this type of behavior problems, which is usually limited to samples obtained from young students. As for limitations, the observed evidences of structural validity must be complemented with studies of clinical validity. However, except for pathological gambling, there is a lack of consensus on criteria to determine the degrees of use and overuse in behavioral addictions, and this lack of a gold standard for cut-off points in health practice presents a difficult obstacle to tackle.

This study allows to confirm that MULTICAGE CAD-4 is a quick-to-use, easy-to-answer, robust, and reliable questionnaire with a valid structure to value the presence of dysfunctional behaviors, whether involving substances or not. The inclusion of a scale on problematic smartphone use addresses a current issue of growing worldwide interest, both in the clinical and social realms. The use of screening instruments allows for the early detection of behaviors that can be harmful to the subject, limiting their opportunities for personal development. Just as is the case of other screening tools, it is still necessary to determine its clinical validity, cut-off points, and its sensibility and specificity to detect problematic behaviors. Future studies must draw the limits between normal use, overuse, and dependence on these technologies, find psychopathological correlations between all these addictive behaviors, and define the aims of the research as realistically as possible so that research does not always lag changes in real life.

Conflicts of interests.- The authors declare that they have no conflicts of interest.

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Annex I

Spanish	English
Por favor, lea cuidadosamente las siguientes preguntas. Responda SÍ o NO marcando la casilla correspondiente a la respuesta elegida.	**Please read the following questions carefully. Answer YES or NO by checking the box corresponding to the answer chosen.**
1 ¿Ha pensado alguna vez que debería beber menos?	Have you ever thought you should drink less?
2 ¿Se ha sentido molesto cuando alguna persona le ha criticado su manera o forma de beber?	Have you been upset when someone has criticized you for your drinking?
3 ¿Se ha sentido culpable alguna vez por su manera o forma de beber?	Have you ever felt guilty about your way or way of drinking?
4 ¿Alguna vez lo primero que ha hecho por la mañana es beber alguna bebida alcohólica para relajarse o para eliminar la resaca?	Have you ever done the first thing in the morning is to drink any alcoholic beverages to relax or eliminate the hangover?
5 ¿Ha tenido usted la sensación de que debería reducir su conducta de juego?	Have you had the feeling that you should reduce your gambling behavior?
6 ¿Niega u oculta su verdadera conducta de juego ante las posibles críticas de los demás sobre sus supuestos excesos?	Do you deny or hide your true gambling behavior from the possible criticism of others about your supposed excesses?
7 ¿Ha tenido usted problemas psicológicos, familiares, económicos o laborales a causa del juego?	Have you had psychological, family, financial or work problems because of gambling?
8 ¿Se siente con frecuencia impulsado irremediablemente a jugar a pesar de sus problemas?	Do you often feel compelled to play in spite of your problems?
9 ¿Ha pensado alguna vez que debería consumir menos drogas?	Have you ever thought you should use fewer drugs?
10 ¿Niega usted su consumo de drogas a familiares, amigos o compañeros para evitar que le critiquen?	Do you deny your drug use to family, friends or peers to avoid criticism?
11 ¿Ha tenido usted problemas psicológicos, económicos laborales o familiares a causa de su consumo de drogas?	Have you had any psychological, financial, work or family problems because of your drug use?
12 ¿Se siente a veces impulsado a consumir drogas aunque haya decidido no hacerlo?	Do you sometimes feel compelled to use drugs even though you have decided not to?
13 ¿Utiliza el teléfono móvil más a menudo o por más tiempo del que debiera?	Do you use your mobile phone more often or for longer than you should?
14 ¿Le han comentado en alguna ocasión, sus familiares o amigos, que utiliza mucho el móvil para hablar o enviar mensajes?	Have your family or friends ever told you that you use your mobile phone a lot to talk or send messages?
15 Si algún día no tiene su móvil ¿se siente incómodo o como si le faltara algo?	If one day you don't have your mobile phone, do you feel uncomfortable or as if something is missing?
16 ¿Ha intentado reducir el gasto de su móvil sin conseguirlo de forma satisfactoria?	Have you tried to reduce the cost of your mobile phone without successfully achieving it?
17 ¿Dedica más tiempo del que cree que debería a estar conectado a Internet con objetivos distintos a los de su trabajo?	Do you spend more time than you think you should to be connected to the Internet for purposes other than your job?
18 ¿Se han quejado sus familiares de las horas que dedica a Internet?	Have your family members complained about your Internet hours?
19 ¿Le resulta duro permanecer alejado de Internet varios días seguidos?	Do you find it hard to stay away from the Internet for days at a time?
20 ¿Tiene problemas para controlar el impulso de conectarse a Internet, o ha intentado sin éxito reducir el tiempo que dedica a estar conectado?	Do you have trouble controlling the urge to connect to the Internet, or have you tried unsuccessfully to reduce the time you spend online?
21 ¿Dedica más tiempo del que cree que debería a jugar a la videoconsola o juegos del ordenador?	Do you spend more time than you think you should, playing game consoles or computer games?
22 ¿Se queja su familia de que pasa demasiado tiempo jugando con la videoconsola o el ordenador?	Does your family complain that you spend too much time playing with the game console or computer?
23 ¿Le cuesta trabajo estar varios días sin usar su videoconsola o sus juegos de ordenador?	Do you find it hard to spend several days without using your game consoles or computer games?
24 ¿Ha intentado sin éxito reducir el tiempo que dedica a jugar con su videoconsola o su ordenador?	Have you tried unsuccessfully to reduce the amount of time you spend playing with your game console or computer?