Validation of the Cell Phone Dependence Scale

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BACKGROUND INFORMATION: The boundary between cellphone use and abuse is quite tenuous. Research is required to evaluate the use of this device interacting in the everyday life of users, whether to speak or to perform tasks.
OBJECTIVE: To construct a novel and specific scale to evaluate cellphone dependence checking its psychometric properties for clarity, accuracy and reliability.
METHODS: Validation of a Cellphone Dependence Scale (CPDS) was performed in 5 phases: 1- initial scale construction with 20 questions, 2- expert evaluation, 3- application to 200 volunteers, 4- statistical analysis and results, and 5- elaboration of the final version of the CPDS.
RESULTS: We used the R statistical program Version 3.4.2 and the "dplyr" package to present the descriptive statistics, the hypotheses tests of differences of means and the factorial analysis. The results provided a validated and accepted final version for CPDS. The last step of the study was to calculate Cronbach's alpha, in order to measure the internal consistency of the questionnaire. The value found was 0.897, which is considered very good.
CONCLUSIONS: This project resulted in the construction of the final CPDS version suitable for the clinical context and to be used in the conduct of research on cellphone dependence. CPDS may contribute to future studies, conscious use of cellphones, harm reduction, and improved quality of life vis-à-vis the cellphone.

KEYWORDS: Digital dependence; cellphone; digital technologies; behavior; disorder.

■ INTRODUCTION

The cellphone[1] is an electromagnetic wave communication device that allows the transmission of voice and/or data within a certain geographic area and managed by an operator.

In 1947, Bell Telephone Laboratories[2] developed a high-capacity telephone system interconnected by several antennas, each antenna being defined as a Cell, adding the word "Cellular" or "cell" to "telephone" or "phone". Each cell represents the radius of action of each of the base stations (transmit/receive antennas) of the system. The fact that they are contiguous causes them to become a transmission network that resembles a beehive.

The mobile phone system started with basic handsets with the sole functions of voice telephony and messaging. From there, it improved over the years, offering more and more features such as earphone jacks, picture viewing, videos, camera, internet access, connections to other devices, amongst many other features. The list grows all the time.

Today cellphones seduce us with so many possibilities of sound, image, color, touches and mobility that they have become as indispensable as housekeys or the card/money containing wallet. However, this daily prolonged interactivity with the device[3] is causing personal, behavioral and social changes. Thus we must not lose sight of both the beneficial and the harmful effects of this relationship.[3]

Many people have come to use the cellphone without the slightest shade of manners,[4] indiscriminately in permitted and in prohibited places, such as driving cars, in wakes, classrooms, theaters, gas stations, losing hours of sleep, working with it after office hours, among others.

The boundary between use and abuse is tenuous;[5] It has become increasingly obvious that research is urgently required to allow us to accurately evaluate its use, aiming at the prevention of physical losses[6] (spine, vision , joints, among others) and emotional losses[7] (anxiety, depression, nomophobia, among others) that may arise in the future. There is no specifically validated scale to evaluate the interactivity of the individual with the cellphone, as to duration and frequency of use, behaviors and symptoms. At present, there is a need for an evaluation scale directed to this subject, which can be applied individually to assess dependence and lead to solutions, regarding all aspects of the problem. Research results have been limited due to the lack of a specific validated instrument for the cellphone. Creating such a scale i.e. an instrument recognizable by all professionals in the field, may contribute to future studies investigating dependence and promote conscious cellphone use, thereby reducing harm and improving quality of life.

At the time of writing health professionals are witnessing in their practices an ever increasing flow of complaints of possible "pathological" relationships with cellphones; this problem must be better investigated whenever cellphone use deviates from the natural relationship of comfort and convenience.

The objective of this study is the validation of a scale to evaluate cellphone dependence[9], checking its psychometric properties in terms of accuracy and reliability.

We intend to construct an instrument that can define the profile of subjects who use the cellphone only for leisure or work and differentiate them from those who may have acquired a mental disorder[10] associated with its use. We hope our labors may improve service and provide appropriate treatment and guidance for both normal and abnormal conditions.

■ MATERIALS AND METHODS

The validation of the scale to evaluate cellphone dependence was performed in 5 phases: (1) construction of an initial scale with 20 questions; (2) evaluation by specialists; (3) application of the scale to 200 volunteers, namely a Main Group (n = 100) with abusive use of the cellphone and a Control Group (n = 100), without such abusive use; (4) statistical analysis; (5)- elaboration of a final validated version.

In order for a scale to be validated, it is necessary to develop a content rigorously aligned with the subject and the research objectives and then to request its evaluation by a group of specialists. These specialists, trained in the area of digital dependence[11] and based on previously published studies, constructed an initial scale with 20 questions and submitted them for evaluation by other six specialists qualified to analyze the content in terms of presentation, clarity, pertinence and understanding.

There is no consensus regarding the number of specialists who should participate in the validation of a scale, the definition of this number being at the discretion and accessibility of the researcher. However, the greater the number of specialists, the greater the disagreement; conversely, the smaller the number (less than 3) the greater the risk of agreement being one hundred percent.

In the initial version of the scale we put together 20 questions; dependence was ranked in three levels: mild, moderate and severe dependence. Each question afforded three possible replies: Never/Rarely (0 points); Often (1) and Always (2). Volunteers were asked to insert the corresponding response value next to each question. The scored points should be added so as to allow each person to receive a dependence rank.

For validation, we obtained demographic data, namely (a) age, (b) gender, (c) employment and (c) degree of education; this information was only used to identify the selected volunteers.

Factor analysis was used for the orthogonal model. The method used was Principal Components based on Spearman's correlation matrix. For data analysis we used the "dplyr" .[13] "psy" .[14] "paran" [15] packages into R statistical program, version 3.4.2. [16]

Inclusion and Exclusion Criteria. Volunteers tested of the scale were people who came to our facility with a history of abusive (long hours) cellphone use and other technologies. Students, employees, patient companions, as well as anyone who agreed to participate. Volunteers were recruited through posters at the institution, person to person communication, both verbal or through social networks. Participants should be aged between 16 and 65 years and have a cellphone device with internet access.

The initial 20 question scale was applied, as previously noted, to two groups: Main (n = 100) with abusive cellphones use, and Controls (n = 100) without such abusive use. Main group volunteers should have scored ≥ 50 points in the Internet Addiction Test (IAT) scale.[12] Another criterion for inclusion in the Main Group was an admission of abusive cellphone use, whether to speak, consult the Internet, send messages through social networks or to play games. Control Group volunteers should have scored < 50 points in the IAT scale[12] and make use of the cellphone only when necessary to make calls or read/send messages.

Exclusion criteria for both groups included illiterate people and people with any kind of mental impairment that would have prevented the use of cellphones.

In the Main Group we were able to use 95 out of 100 volunteers and in the Control Group 90 out of 100 were kept. Volunteers discarded in both groups presented incomplete scales, discontinued participation or were unaccompanied minors. Completed results were entered into a database for statistical analysis.

■ RESULTS

Table 1 displays the results of descriptive statistics, showing absolute numbers and their respective percentages.

Scores for the 20 original question scale. The main group scored 20.2 ± 6.7, while the control group scored 9.6 ± 6.7. The t-statistic was 10.77, characterizing a highly significant difference (p <0.001) between the groups. This difference ratifies the characteristics of the main group presenting dependence whereas the control group present no such dependence.

Factor analysis. In order to verify the adequacy of the factorial analysis, two tests were performed. The Bartlett's sphericity tested verified correlation of the variables and produced a p < 0.001, indicating existence of excellent correlation between the variables.

The Kaiser-Meyer-Olkin (KMO) criterion produced a value of 0.887; Any value above 0.8 is considered good.[17] Due to these two results, we decided that it would be appropriate to perform the factorial analysis for the questionnaire. We used three criteria: Factorial Load, Screeplot and Parallel Analysis.

Table 2 shows the factorial loads which allowed us to determine the number of relevant factors.

It is recommended to use factorial loads whose cumulative results exceed 0.9, (0.8 in the worse scenario).[17] However, for our data set, we would have to limit ourselves to 10 questions, which in practice would not solve the problem of adequate data reduction. We then proceeded to the Screeplot criterion of the correlation matrix, which allowed to eliminate questions related to Eigenvalues greater than 1, as shown in Figure 1.

Table 1. Descriptive statistics of the sample.

	Gender				
	Male			**Female**	
Control	28 (31.1%)			62 (68.9%)	
Main	35 (36.8%)			60 (63.2%)	
	Age ranges				
	15-25	26-36	37-47	48-58	59-69
Control	29 (32.2%)	23 (25.6%)	11 (12.2%)	11 (12.2%)	16 (17.2%)
Main	45 (47.4%)	23 (24.2%)	20 (21.1%)	5 (5.3%)	2 (2.1%)
	Instruction level				
	MIddle	**Higher**	**Graduate**	**Masters**	**Doctoral**	**NI**
Control	21 (23.3%)	26 (28.9%)	37 (41,1%)	2 (2.2%)	3 (3.3%)	1 (1.1%)
Main	54 (56.8%)	26 (27.4%)	9 (9,5%)	5 (5,3%)	0 (0%)	1 (1.1%)

NI: not informed

Table 2. Factorial loads of principal components (PC).

	PC 1	PC 2	PC 3	PC 4	PC 5
Std. Dev.	2.65	1.55	1.136	1.089	0.971
Proportion of Variance	0.35	0.12	0.065	0.059	0.047
Cumulative Proportion	0.35	0.47	0.534	0.594	0.641
	PC 6	PC 7	PC 8	PC 9	PC 10
Std. Dev.	0.89	0.868	0.831	0.782	0.757
Proportion of Variance	0.04	0.038	0.035	0.031	0.029
Cumulative Proportion	0.68	0.718	0.753	0.783	0.812
	PC 11	PC 12	PC 13	PC 14	PC 15
Std. Dev.	0.745	0.708	0.683	0.642	0.63
Proportion of Variance	0.028	0.025	0.023	0.021	0.02
Cumulative Proportion	0.840	0.865	0.888	0.909	0.93
	PC 16	PC 17	PC 18	PC 19	PC 20
Std. Dev.	0.585	0.577	0.518	0.506	0.474
Proportion of Variance	0.017	0.017	0.013	0.013	0.011
Cumulative Proportion	0.946	0.963	0.976	0.989	1.000

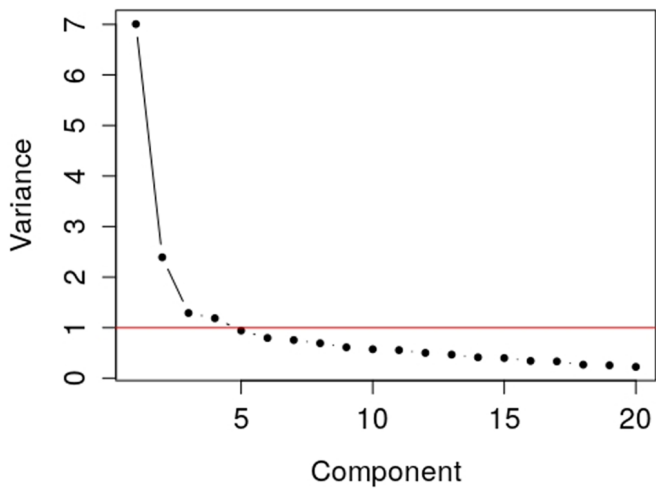PC for Q: Principal component for Question; Std. Dev: standard deviation

Figure 1. Screeplot.

it should be noted in the chart the components in which the points are above the red line and whose variance is greater than 1, because these are the components you consider relevant (Table 3).

It is clear that 4 of the 20 questions of the initial version should be withdrawn because they have a value below 0.5, considered low and not significant[17]. Therefore, 16 questions were left in the final version. This problem will be taken up in the discussion.

The third criterion used to find the number of factors was the Parallel Analysis. By this criterion, the number of factors found was equal to 2, as we see in the table with the commonalities presented below (Table 4).

The problem encountered when using parallel analysis is that commonalities are very low, with only 9 questions reaching the minimum value of 0.5.

Thus, after the analyzes we opted for the Screeplot result that pointed to the withdrawal of 4 items from the scale.

The last step of the study was to calculate Cronbach's alpha,[17] in order to measure the internal consistency of the questionnaire. The value found was 0.897, which is considered very good.[17] This means that the questions of the scale are aligned with each other, qualifying it as positive to measure the dependence on the cellphone.

■ DISCUSSION

A final validated scale was constructed, with the purpose of being used in clinical practice which fully met what was proposed, namely the evaluation of dependence to the cellphone. This required five stages to be completed, which in turn pointed the way to final adjustments. These were performed after expert approval and statistical analysis.

Table 3. Communalities for 4 factors. Cellphone dependence scale (CPDS) for questions 1 - 20.

CPDS Q1	CPDS Q2	CPDS Q3	CPDS Q4	CPDS Q5
0.625	0.564	0.674	0.614	0.581
CPDS Q6	CPDS Q7	CPDS Q8	**CPDS Q9**	**CPDS Q10**
0.457	0.667	0.604	**0.467**	**0.490**
CPDS Q11	CPDS Q12	CPDS Q13	CPDS Q14	CPDS Q15
0.575	0.618	0.689	0.688	0.695
CPDS Q16	CPDS Q17	CPDS Q18	CPDS Q19	CPDS Q20
0.670	0.662	0.518	0.569	0.449

CPDS Q(N): Cellphone dependence scale question(n). Bold type denotes a value < 0.5.

Table 4. Communality for 2 factors. Cellphone dependence scale (CPDS).

CPDS Q1	CPDS Q2	CPDS Q3	CPDS Q4	CPDS Q5
0.470	0.362	0.457	0.584	0.525
CPDS Q6	CPDS Q7	CPDS Q8	CPDS Q9	CPDS Q10
0.426	0.597	0.559	0.449	0.371
CPDS Q11	CPDS Q12	CPDS Q13	CPDS Q14	CPDS Q15
0.264	0.615	0.682	0.543	0.622
CPDS Q16	CPDS Q17	CPDS Q18	CPDS Q19	CPDS Q20
0.469	0.586	0.244	0.148	0.426

CPDS Q(N): Cellphone dependence scale question(n).

Upon completion of the evaluation of the initial 20-question scale by the six experts, all points of agreement and disagreement were verified for each question and a consensus was reached, suggesting the withdrawal of four apparently irrelevant questions. Statistical analysis of the commonalities carried out on the initial 20 questions confirmed the removal of the same four questions, because of low (< 0.5), non-significant values. The excluded questions were:[17]

1. "How often did you feel some kind of physical discomfort, such as a tightness in the chest, a sore throat, palpitation, shortness of breath or dizziness when you realize that you were without your cellphone?" The question had been initially proposed because it occurred in two reports,[18,19] where it related to a pathological dependence on cellphones,[3] namely the presence of such symptoms in the absence of the device.

2. "How often did you feel devalued when you realized that your friends received more cellphone calls or messages than you did?" This question was present in reports[20,21] which found that increases or reductions of self-esteem could sometimes be related to comments and posts in social networks.

3. "How often did you feel unsafe without the cellphone at hand or when you ran out of battery or found yourself out of range?" This had been included based on studies[1,22] showing that individuals with some mental disorders[23] associated with cellphone dependence felt insecure when for any reason they were unable to communicate through the device.

4. "How often do you have the cellphone in your hands and feel you have company?" This question was inserted because studies[9,18,24] suggested the individuals felt they had company (hence felt secure) with the cellphone in hands.

Guimarães et al[25] in a study on scale validation required an instrument able to specifically assess heart rate anxiety as an essential tool. We did not consider it appropriate to evaluate something so specific through a general instrument; we rather preferred a scale to evaluate the daily interaction of individuals vis-à-vis the cellphone.

As a limitation of the study, we came across an absence of specific validated instruments capable of investigating behavior using a cellphone on a day-to-day basis, which might have helped us in the preparation of the present scale. Thus, we could only rely on the IAT[12], which evaluates general dependence on the Internet: this we very successfully used for our preliminary identification of who should be in the Main or Control groups.

Future studies are recommended so that we can refine the research in all areas and especially on the subject of digital dependence,[11] a very scarcely explored, but so necessary theme in today's world. We are now , all of us, witnesses of very young children[26] interacting with cellphones without sufficient concern of parents or guardians regarding the potential physical and emotional problems[7] that may be lurking in the future.

■ CONCLUSION

The results obtained provided a validated final version of a Scale to Evaluate Cellphone Dependence (CPDS) with 16 clear, accurate and reliable questions, appropriate to clinical contexts. After all the analyzes performed upon the initial scale with 20 questions, 4 questions were considered irrelevant; this ensured a more qualified final version. Statistical results showed that the questions kept in the final version of the CPDS showed alignment among them, qualifying the complete scale as adequate to measure cellphone dependence. The final version can be used as a pioneer scale to evaluate cellphone dependence whenever a specific research of this nature is required. We recommend that the study be replicated in a larger sample and representative of the target population.

■ AUTHOR CONTRIBUTION

ALS King: planned, reviewed the literature, applied the scales, worked with the database
and wrote the article.
E Guedes: applied the scales and wrote the article.
FL Guimarães: applied the scales, worked in the database and wrote the
the Article.
M K Pádua: applied the scales and wrote the article.
HK Santos: statistical analysis and wrote the article.
D Rodrigues: statistical analysis and wrote the article.
L L Gonçalves: statistical analysis and wrote the article.
AE Nardi: guided and wrote the article.

■ CONFLICT OF INTEREST

Authors declare no conflict of interest.

■ ACKNOWLEDGEMENTS

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Annex 1 - Validated final version:

Cell Phone Dependence Scale (CPDS)

IDENTIFICATION

Date: ___/___/____Age: _____
Your Name:_____
Gender: F ( ) M ( )
Works: Yes ( ) No ( )
Unemployed: Yes ( ) No ( )
Level of Education: ( ) Middle ( ) Upper ( ) Postgraduate ( ) Master
( ) Doctorate degree
Signature of Volunteer:_____
Email:_____
Phone(s) _____

INTERVIEWER

_____

INTRUCTIONS

The test is a 16-question scale that measures mild, moderate, and severe cellphone (cellphone) dependence.

Enter the value corresponding to your answer next to each question, as follows:
a- Never/Rarely (0)
b- Frequently (1)
c- Always (2)

QUESTIONS:

1- How often do you use your cellphone in daily life?
2- How often can you not leave without taking the cellphone?
3- How often do you return if you forget to take the cellphone?
4- How often do you access the internet on the cellphone?
5- How often do you feel anxious when you realize that you are without the cellphone?
6- How often do you feel sad or depressed when you are disconnected from the internet or social networks through your cellphone?
7- How often do you feel nervous about not having the cellphone with you to communicate?
8- How often are you afraid of leaving without the cellphone and feeling sick in the street without the means to ask for immediate "help" or make contact with someone you trust?
9- How often do you keep the cellphone close at hand?
10- How often do you keep the cellphone switched on 24 hours a day?
11- How often do you sleep with the cellphone switched on?
12- How often do you access the cellphone more than 30 times a day to view messages, emails, etc?
13- How often do you keep connected to the cellphone when you are with friends or family?
14- How often do you feel lonely if you do not participate in social networks or when you are not in groups while others are?
15- How often do you keep in the agenda of the cellphone the number of a doctor, psychologist or hospital for fear of feeling sick in the street?
16- How often do you play on the cellphone?

RESULTS:

Once you have answered all the questions, add up the values chosen for each answer to get a final score. The higher the score, the higher the dependence level of the Cell Phone and related issues.

Below are the values referring to the sum of the points obtained:

Up to 2 points: You use the cell phone in a natural way, show no signs of abuse and have full control over your day-to-day use.

3 - 12 points: Light. You have signs of a possible reliance on mobile phones at a light level. You start having occasional problems due to the start of abusive use of the Cellular Phone in certain situations. You may have future impacts on your personal, social, family, academic or professional life by using your cell phone more often than is necessary in your daily life. Be aware that abusive use of the cell phone will not harm your quality of life.

13 - 22 points: Moderate. You have signs of a possible cell phone dependence on a moderate level. You start to have frequent problems due to the abusive use of the Cellular Phone in certain situations. You should consider the present impacts related to your personal, social, family, academic or professional life by using your cell phone on a day-to-day basis with greater intensity than recommended. You should learn to handle the Cell Phone more consciously to prevent future problems (physical and emotional) related to daily use and for many hours of the device.

23 - 32 points: Serious. Cellular phone use is causing significant problems in your personal, social, family, academic or professional life at a serious level. You should evaluate the consequences of the physical and emotional impacts and losses that are occurring in the present. The abusive and persistent use of the Cellular Phone in your daily life has significantly compromised your quality of life. We recommend seeking guidance through professional help in specialized centers.