Validation of the scale to evaluate physical damages related to the Abusive Use of Technology in daily life (PDAUTS).

Mariana Spear King Lins de Pádua[I]; Anna Lucia Spear King[I]; Eduardo Guedes[I]; Flávia Leite Guimarães[I]; Lucio Lage Gonçalves[I]; Hugo Kegler dos Santos[II]; Douglas Rodrigues[II]; Antonio Egidio Nardi[I].

[I] Delete - Uso Consciente de Tecnologias; Instituto de Psiquiatria (IPUB), Universidade Federal do Rio de Janeiro (UFRJ), Rio de Janeiro, Brasil.
[II] Departamento de Estatística-Instituto de Matemática e Estatística, Universidade Federal Fluminense (UFF), Rio de Janeiro, Brasil.

BACKGROUND INFORMATION: New computer technologies, namely smart cellphones and tablets, among others, interacting along the daily life of individuals may contribute toward the rise of problems: depression, stress and physical damage (undue postures, upper and lower extremity disorders, vision problems, obesity), all of them related to excessive time spent on technological equipment; together with inadequate furniture, quality of life can be seriously affected.

OBJECTIVE: To validate a scale to evaluate physical damage related to the Abusive Use of Technology (PDAUTS) in daily life.

METHODS: Validation of the PDAUTS was performed through 5 phases: (1) initial scale construction with 20 questions; (2) expert evaluation of questions; (3) application to 200 volunteers; (4) statistical analysis of the results; (5) preparation of the final validated version, retaining the 20 questions.

RESULTS: We used the R statistical program, version 3.4.2 and the "dplyr" package to present the descriptive statistics, the hypothesis tests of mean differences and the factor analysis. The results provided a validated final version for PDAUTS. The last step of the study was to calculate Cronbach's alpha parameter, in order to measure the internal consistency of the scale. The value found was 0.897, which in is considered very good.

CONCLUSION: The validated PDAUTS allowed us to evaluate physical damage in each subject and design adequate training and treatment programs, reducing overall impairments and contributing to the improvement in quality of life.

KEYWORDS: Digital dependency; physical damage; ergonomics; digital technologies; reduction.

■ INTRODUCTION

Technological advances have contributed significantly to the evolution and development of individuals in the fields of knowledge, communication and human relations;[1] however, there is concern about human body maintenance in relation to the handling of new computer technologies, cellphones , tablets, among others (CT&O). Every day new functional pathologies and limitations associated with the misuse of these modern technologies of modernity arise, causing physical losses, diminishing productivity and consequently distancing thousands of people from the labor market, which can be minimized if there are adequate prevention and awareness programs [2] Therefore, it is a public health problem and of interest to the entire population.

Everyday life is increasingly more dependent on CT&O.[3] This leads to a steady increase in the number of people connected and of hours spent on the devices, with the consequent appearance of physical and emotional problems associated with abusive users, whether for reasons of leisure or work, through virtual relationships or participation in social networks.[4] It is well known that improper postures of the body, repetitive movements, use of technologies together with inappropriate furniture and sleep loss are risk factors for various physical problems[5]

(disturbances in the spine, muscles, joints, upper and lower limbs, vision, among others), as well as emotional problems (anxiety, depression, stress, among others)

Anyone can develop postural defects[5] because of misuse of furniture and equipment. This is why it is important to understand the physiological and emotional changes[6] that are specifically present in each individual, so that we can outline and plan treatments recommended for each case.

We aim to validate the scale to evaluate physical damages related to the abusive use of technologies in everyday life (PDAUTS).

■ MATERIALS AND METHOD

Five phases of work were necessary during the elaboration and validation of the scale to evaluate physical losses related to the abusive use of digital technologies in daily life (PDAUTS): 1 - construction of an initial scale with 20 questions, 2 - evaluation of questions by specialists, 3 - application of the scale in 200 volunteers, being: Group 1 Main (100 participants with abuse of CT&O) and Group 2 CONTROL (100 participants without CT&O abusive use), 4-statistical analysis and results and 5- elaboration of a final validated scale.

The validation of a scale requires that its content be fully developed according to the topic addressed and the objectives of the research, and then submitted to the judgment of a group of experts trained in the area of digital dependency. In the present study these experts have produced 20 questions intended to be the initial scale to be evaluated by second group of experts, able to validate the instrument as to its content, pertinence, clarity, presentation and comprehension.

There is no consensus as to the number of specialists who should participate in the validation of a scale, leaving the definition of the quantity at the discretion and accessibility of the researcher. The greater the number of specialists, the greater the tendency to disagree between them, whereas a smaller selection (less than 3) has a greater risk of a 100% agreement. In the present study, 6 specialists were selected for the development of the scale.

In the 20 questions of the initial version of PDAUTS dependence was rated as mild, moderate and severe physical loss. 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.

The resulting sum obtained classified the volunteers in the following categories: 0 to 10 (without disturbances); 11 to 20 (mild disorders); 21 to 30 (moderate); 31 to 40 (severe).

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, not being considered by the specialists for the validation of PDAUTS.

Sample and Inclusion Criteria. The sample consisted of 200 volunteers who came the nucleus Delete with Conscious Use of Technologies of the Institute of Psychiatry (IPUB) of the Federal University of Rio de Janeiro (UFRJ) with abusive (daily/many hours) of use of cellphone, tablet, computers, among others (CT&O). In addition we included to Institute staff, University students and people interested in participating in the research. Recruitment was implemented through posters at the institution, verbal invitation and via social networks. Participants were aged between 16 and 69 years who make daily use of CT&O technologies. All participants agreed to voluntarily respond to the survey. Individuals were divided into two groups: Main Group (100 participants with abusive use of CT&O) and Control Group (100 participants without daily or abusive use of CT&O). Abusive use of CT&O was determined through the Internet Addiction Test (IAT) scale.[7] Main Group participants scored ≥ 50 points on the IAT scale while the Control Group included volunteers scoring < 50 points

Inclusion Criteria. The Main Group was composed of individuals who used the technologies for at least three consecutive hours daily, whether for internet consultations, message exchanges, social networking or electronic games on tablets, desktops or cell phones, and also by volunteers previously submitted to the Internet Addiction scale (IAT)[7] with scores in the ≥ 50 point range. The Group Control was composed of volunteers who scored < 50 points.

Exclusion criteria. Illiterates, or individuals with severe clinical comorbidity that interfered with the interview protocol, such as personality disorders, bipolar disorder and substance abuse, were excluded from the study.

Of the initial sample, 95 volunteers from Group 1 Principal and 90 from Group 2 were effectively used. The discards were due to participant withdrawal, incomplete scales or lack of responsible escort when underage. The results of the survey were entered into a database for statistical analysis.

■ RESULTS

Below we present the results of the descriptive statistics, the results of the tests of hypotheses of differences of means and the factor analysis. For the analysis of the data we used the packages "dplyr,[8] "psy"[9] and "paran"[10] and the Program R, version 3.4.2.[11] Throughout the work, the data were divided into Control Group and Main Group (Table 1).

Table 1 presents demographic data and exhibits the characteristics of the sample, especially in terms of the random selection of volunteers: this can be perceived, for example, by age groups with relevant variability; analogously, by the variability of the levels of instruction showing very few volunteers in Masters and PhD levels. In addition, the two groups of volunteers also presented significantly different percentages between the male and female genders. All this reinforces the random criterion of choice of volunteers, although it was not a research objective to link any of these variables to the results or the validation of the scale itself.

Scores for the 20 original question scale. The mean ± standard deviation score for the Control group was 5.19 ± 4.61, while the corresponding value for the Main group was 15.00 ± 8.21 The t-test of means between the two groups produced a p-value < 0.001 (t-statistic = 10.05); this indicates a significantly higher level of physical loss in the Main group vs. no loss in Control group. Thus, the differentiation of the Control vs. Principal qualifies,

prima facie, the effectiveness of the 20 questions included in the test, and allowed us to proceed with the required statistical tests to validate to the PDAUTS questionnaire.

Factorial analysis. The first test performed was the Bartlett sphericity test to verify if the variables are correlated with each other. In this test, the null hypothesis is that the correlation matrix is equal to the identity matrix. For our data set, a statistic of 1917.96 (p < 0.001) was found, implying that the covariance matrix was not equal to the identity.

The criterion used to verify the adequacy of the factor analysis was the Kaiser-Meyer-Olkin (KMO) test. The value found was 0.799, which is practically equal to 0.8, a value that, in the literature, [12] is considered good.

Due to the results found for both the Bartlett test and the Kaiser-Meyer-Olkin (KMO) test, it was appropriate to perform the factorial analysis for the scale. We therefore checked the factorial loads to determine the number of relevant factors. We used 3 criteria: Factorial Load, Screeplot and Parallel Analysis. Table 2 shows the factor loads:

Table 1. Descriptive Statistics of the Sample.

	Gender				
	Male			Female	
Control (90	28 (31.1%)			62 (68.9%)	
Main (95)	35 (36.8%)			60 (63.2%)	
	Age Range				
	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				
	High School	Higher	Graduate	Master	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. Factor Loads of Principal Components.

	PC1	PC2	PC3	PC4	PC5
Standard Deviations	2.65	1.45	1.326	1.158	1.019
Proportion of Variance	0.35	0.11	0.088	0.067	0.052
Cumulative Proportions	0.35	0.46	0.544	0.611	0.663
	PC6	**PC7**	**PC8**	**PC9**	**PC10**
Standard Deviations	1.00	0.922	0.823	0.787	0.733
Proportion of Variance	0.05	0.043	0.034	0.031	0.027
Cumulative Proportions	0.71	0.755	0.789	0.820	0.847
	PC11	**PC12**	**PC13**	**PC14**	**PC15**
Standard Deviations	0.705	0.658	0.620	0.597	0.568
Proportion of Variance	0.025	0.022	0.019	0.018	0.016
Cumulative Proportions	0.871	0.893	0.912	0.930	0.946
	PC16	**PC17**	**PC18**	**PC19**	**PC20**
Standard Deviations	0.558	0.499	0.463	0.4380	0.3309
Proportion of Variance	0.016	0.012	0.011	0.0096	0.0055
Cumulative Proportions	0.962	0.974	0.985	0.989	1.0000

In the literature,[12] it is recommended to use factor loads whose sum results in a value above 0.9, and worst case, above 0.8. However, for the data set, we would have to limit ourselves to 9 questions, which in practice would not adequately solve the problem of data reduction.

We then proceed to the Screeplot criterion of the correlation matrix, where we eliminate the factors related to Eigenvalues greater than 1. The graph below presents this criterion:
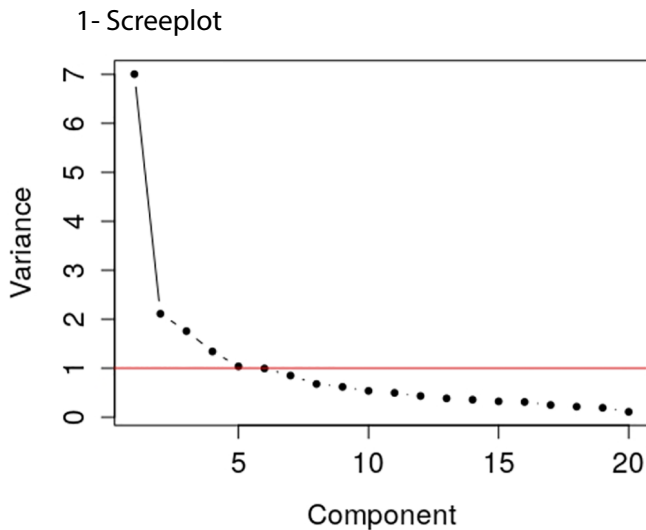
1- Screeplot

Figure 1. Screeplot. Components above the red line and whose variance is greater than 1 are the relevant components.

By this criterion, we must use 5 factors, and in this case, the commonalities of the variables are presented in Table 3:

Analyzing the commonalities, it is may be seen that none of the 20 question of the initial scale had to be excluded because they present commonalities larger than 0.5. Values below 0.5 are considered non-significant.[12] This means that the 20 questions were considered valid to remain on the scale.

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 3, as shown in Table 4:

The problem encountered when using parallel analysis is that commonalities are very low, with only 12 questions reaching the minimum value of 0.5.

Therefore, after the three analyzes we opted for the result of the Communalities for 5 factors (Table 3), which point to the permanence of the 20 items of the scale.

The last step of the study was to calculate Cronbach's alpha parameter,[12] in order to measure the internal consistency of the scale. The value found was 0.897, which in is considered very good.[12] This means that the issues of the scale are aligned with each other, qualifying them as positive to measure the assessment of physical damages related to the abusive use of the technologies.

TABLE 3. Communalities for 5 factors.

PDAUTS 1	PDAUTS 2	PDAUTS 3	PDAUTS 4	PDAUTS 5
0.758	0.624	0.589	0.687	0.833
PDAUTS 6	PDAUTS 7	PDAUTS 8	PDAUTS 9	PDAUTS 10
0.637	0.588	0.602	0.643	0.516
PDAUTS 11	PDAUTS 12	PDAUTS 13	PDAUTS 14	PDAUTS 15
0.780	0.677	0.417	0.629	0.576
PDAUTS 16	PDAUTS 17	PDAUTS 18	PDAUTS 19	PDAUTS 20
0.719	0.702	0.798	0.690	0.787

PDAUTS 1-2: Communalities for 5 factors for each of the 20 questions included in the test
Underlined values > 0.5

TABLE 4. Communalities for 3 Factors.

PDAUTS 1	PDAUTS 2	PDAUTS 3	PDAUTS 4	PDAUTS 5
0.434	0.511	0.540	0.636	0.661
PDAUTS 6	PDAUTS 7	PDAUTS 8	PDAUTS 9	PDAUTS 10
0.592	0.569	0.396	0.490	0.426
PDAUTS 11	PDAUTS 12	PDAUTS 13	PDAUTS 14	PDAUTS 15
0.615	0.464	0.376	0.360	0.482
PDAUTS 16	PDAUTS 17	PDAUTS 18	PDAUTS 19	PDAUTS 20
0.601	0.646	0.757	0.633	0.684

PDAUTS 1-12: Communalities for 3 factors for each of the 20 questions included in the test
Underlined values > 0.5

■ DISCUSSION

For the elaboration of a final validated scale that met the proposed goals, namely the evaluation of the physical damages related to the abusive use of technologies in everyday life (PDAUTS), it would have been necessary that all evaluation stages be fulfilled and that the suggested final adaptations after all statistical analyzes and by experts, successful.

After assessing the initial scale (20 questions) by all six experts and checking all points of agreement and disagreement on each question and then the statistical analysis of the data, a consensus was reached and it was decided that none of the question of the initial scale would need be excluded.

The construction of this scale was entirely based on ergonomic concepts[13] and on the observation of individuals with daily use of CT&O technologies, whether for leisure or work, and carefully noting the physical and emotional consequences. Maeno[14] stated that repetitive stress injuries (RSI) and work-related musculoskeletal disorders (MSD) are the major causes of work absenteeism and disability caused by work-related illnesses, often caused by keeping inadequate positions for many hours.[14]

This project was the outcome of the need to create specific instruments to evaluate physical losses in order to elaborate Ergonomic strategies,[15] because issues such as these are considered a public health problem and of interest to the entire population, as reported by the Brazilian Institute of Geography and Statistics: a recent National Health Survey reported that RSI/MSD was diagnosed in more than 3.5 million Brazilians over 18 years of age. [16]

We also considered the need for a specific scale, such as reported herein, so that individuals can identify the relationship of his pathologies with the abusive use of the technologies and seek professional guidance as soon as possible. Physical examination[17] is not sufficient for the diagnosis of RSI/MSD. It is necessary to check the ergonomic aspects of the work place (furniture suitability to the employee's physical characteristics, lighting, environmental noise, etc.), as well as the intensity, frequency and duration of the habits related to the physical disorders presented.[17]

The scale may also identify the problems associated with poor posture and inadequate handling of technological devices that can be solved or minimized, provided that the individual is guided by professionals who identify the real problems through examinations and evaluations with appropriate instruments. An important example: when the screens are positioned well below the line of the eyes,[18] the weight of the head causes postural compensations that affect the alignment of the vertebrae of the spine and increase of muscular rigidity for the sustentation of the corporal structures.[19]

Additionally, the identification of problems related to vision[20] caused by the abusive use of CT&O can be checked with the use of this scale, as well as symptoms of dryness, irritation, blurred vision after two consecutive hours of exposure to the violet blue light emitted by screens. King et al[21] observed not only vision problems but also complaints of changes in sleep, dizziness, memory loss and lack of concentration. They reported that many physical problems were related to improper postures and furniture when using the CT&O.[21]

As a limitation of the study, we came across an absence of specific validated instruments capable of investigating behavior using CT&O on a day-to-day basis, which might have helped us in the preparation of the present scale.. Therefore, we only could rely on the IAT,[7] which evaluates general dependence of the internet and was successfully used to pre-detect abusers of CT&O.

New studies are recommended regarding ergonomics, physical damage and digital dependence,[22] so that research can be improved, because these are very scarcely explored and much needed fields of investigation.

■ CONCLUSION

We obtained a validated final version of the PDAUTS scale, adapted to clinical contexts for accuracy and reliability. The final version can be used as a pioneer scale to evaluate what is proposed and whenever it is necessary to perform a specific research of this nature.

The validated PDAUTS allowed us to evaluate physical damage in each subject and design adequate training and treatment programs, reducing overall impairments and contributing to the improvement in quality of life.

■ PDAUTSHOR CONTRIBUTION:

M S K L Pádua: planned, reviewed the literature, applied the scales and wrote this article.

A L S King: planned, applied scales, wrote this article and co-oriented it.

E Guedes: applied the scales and wrote this article.

F L Guimarães: applied the scales and wrote this article.

H K Santos: analyzed statistically and wrote this article.

D Rodrigues: analyzed statistically and wrote this article.

L L Gonçalves: applied the scales and wrote this article.

A E Nardi: guided and wrote this article.

■ CONFLICT OF INTEREST

All authors declare no conflict of interest.

■ ACKNOWLEDGEMENTS

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ANNEX 1 - FINAL VALIDATED VERSION OF PDAUTS

Scale to evaluate the Physical Damages related to the abusive use of technologies (PDAUTS) (Computer, cell phone, tablet, among others) in daily life.

Date: _ / _ / ___ Age: ___
Volunteer Name: _____
Gender: F:( ); M:( )
Works: Yes:( ); No:( )
Unemployed: Yes:( ); No:( )
Level of Education: Middle:( ); Upper:( ); Postgraduate:( ); Master:( ); Doctoral degree:( )
Signature of Volunteer: _____
E-mail_____
Phone .(__) _____

Interviewer: _____

The test is a 20-question scale that measures the mild, moderate, and severe levels of Physical Damages related to the abusive use of everyday technologies.
Obs. The acronym CT&O refers to technologies: Computer, cell phone, tablet, among others.
Please enter the number corresponding to the answer next to the question, according to:

   a- Never / Rarely (0)
   b- Frequently (1)
   c- Always (2)

QUESTIONS

1) How often do you use mobile phone, tablet, among others (CT&O) throughout each day?
2) How often do you spend more than three consecutive hours of your day using CT&O?
3) How often do you usually experience anxiety or some kind of physical discomfort such as palpitation, dizziness, or shortness of breath when you realize you are not using CT&O?
4) How often do you usually have neck pain when using CT&O?
5) How often do you usually experience spinal pain when using CT&O?
6) How often do you usually experience pain and/or numbness in the upper and/or lower limbs after prolonged use of CT&O?
7) How often do you usually feel pain and/or stiffness in wrists, joints and / or fingers or toes while using CT&O?
8) How often do you usually feel headaches after prolonged use of CT&O?
9) How often do you stop exercising or other activities in your day to stay for longer periods using CT&O?
10) How often do you usually feel tired, burning and/or dry eyes when using CT&O?
11) How often do you usually feel physical tiredness or general body aches after using CT&O for an extended time?
12) How often do you usually have memory loss or lack of focus on your daily chores because of CT&O abuse?
13) How often do you usually have trouble sleeping because you stay in the CT&O until late?
14) How often do you usually wake up in the middle of the night to use CT&O?
15) How often do you forget to feed yourself throughout the day due to prolonged use of CT&O?
16) How often do you forget to drink water throughout the day due to prolonged use of CT&O?
17) How often do you forget to practice some type of stretching, relaxation or breathing exercises during prolonged CT&O use on the day?
18) How often do you forget to correct your posture when using CT&O?
19) How often do you stop adjusting your furniture correctly for comfortable and proper use of CT&O?
20) How often does abusive CT&O affect your personal, social, family, or academic life?

RESULTS

Once you have answered all the questions, add up the numbers you selected for each answer to get a final score. The higher the score, the higher the level of Physical Problems related to CT&O abuse.

Below are the points values obtained in your score:

0 - 10 points: You are a user with no signs of physical problems related to the use of technologies: computer, mobile phone, tablet, among others (CT&O) in your daily live and with full control over their use.

11 - 20 points: Mild - You currently have slight signs of physical problems related to the use of CT&O in everyday life. Be aware of future physical problems related to abusive use of these technologies. You may begin to have occasional problems due to the start of abusive use of CT&O in certain situations. It may present future impacts on your quality of life because it is currently being used more often than necessary. Make sure that the use of CT&O does not cause major damage to your health.

21 - 30 points: Moderate - You show signs of moderate physical damage due to daily and more frequent use of CT&O. You begin to show frequent signs and symptoms of these physical damages related to the abusive use of CT&O in certain situations. You should consider the physical and emotional impacts that are arising so that you do not lose quality of life and health by using CT&O more strongly than recommended. You must learn to deal with all technologies in a more conscious way.

31 - 40 points: Severe - The use of CT&O is already causing physical and/or emotional losses in your life at a serious level. YOU must assess the consequences of these losses and impacts in your personal, social, family, professional and academic areas. The abusive use of the CT&O has been significantly compromising your quality of life in all aspects. We recommend that you seek guidance through professional help in specialized centers.