**Title**

Validity and reliability of the Brazilian Portuguese version of the Readiness to Change Questionnaire – RCQ-BR.

## Introduction

The stages of change model proposed by Prochaska and DiClemente (1982) is one of the most popular models to change health related behaviors, including alcohol abuse and dependence (Norcross, Krebs, & Prochaska, 2011). Prochaska and DiClemente proposed a series of stages that changes overtime: precontemplation, contemplation, preparation, action and maintenance. Precontemplation is the stage which the patients are not seeking any behavior modification. Contemplation is the stage which the patients are aware of their problems but are not committed to change. Preparation is the stage which the patients plan to take action and are making some minor behaviors changes. Action is the stage which the patients modify behaviors to solve their health problems. Maintenance is the stage which the patients work to avoid relapse and keep the modified behavior accomplished in the action stage.

Some instruments were developed to assist clinicians in classifying their patients with alcohol abuse and dependence such as the Readiness to Change Questionnaire - RCQ (Rollnick, Heather, Gold, & Hall, 1992), the Stages of Change Readiness and Treatment Eagerness Scale - SOCRATES (Miller & Scott, 1996), and the Rhode Island Change Assessment – URICA (McConnaughy, DiClemente, Prochaska, & Velicer, 1989). The Readiness to Change Questionnaire is the shortest scale to assess readiness to change with 12 items and have shown reasonable psychometric properties (Budd & Rollnick, 1996; Defuentes-Merillas, Dejong, & Schippers, 2002; Forsberg, Ekman, Halldin, & Rönnberg, 2004; Forsberg et al., 2004; Heather, Rollnick, & Bell, 1993; Napper et al., 2008; Rodríguez-Martos et al., 2000; Rollnick et al., 1992).

One of the problems of the RCQ is its non-well established factor structure. Different studies have identified a different number of components. Using a principal components approach, Rollnick et al. (1992) and Rodríguez-Martos et al. (2000) found a three component structure that was not confirmed by studies from Hannöver et al (2002) and Defuentes-Merillas et al (2002), that found a two component structure (precontemplation + contemplation; and action). These later two studies, divided the component one items by its loading signals and scored the scale following the original study.

Two studies using confirmatory factors analyzes reached different results. Budd and Rollnick (1996) found poor fit indexes for the 3 factor model treating them as correlated and proposed as an alternative an one factor model that measures readiness to change. On the other hand, Forsberg et al. (2003) found that the 1 factor model had a poor fit (RMSEA = .12; CFI = .83) and the 3 factor solution had a better fit (RMSEA = .06; CFI = .96).

However, most of the RCQ validation studies have used the the method of principal components

analysis(Defuentes-Merillas et al., 2002; Hannöver et al., 2002; Rodríguez-Martos et al., 2000; Rollnick et al., 1992). The principal component analysis is not the most appropriated method to study the factorial structure of scales as pointed out by Fabrigar, Wegener, MacCallum and Stragan (1999). Moreover, the RCQ studies used Pearson's correlations, which are not recommended to deal with polytomous items (Holgado–Tello, Chacón–Moscoso, Barbero–García, & Vila–Abad, 2010). To overcome these caveats, we propose the use of polychoric correlations and the use of factorial analysis in this study.

For its length and reasonable psychometric properties, RCQ-12 was included as an instrument in the Drinkless intervention to classify them into the stages of change. The Drinkless is a fully automated web-based intervention developed and maintained by the World Health Organization. The original Dutch version is translated to Portuguese, Spanish, Russian, Hindi, and English. We aimed in this study: (1) to evaluate the psychometric properties of the Brazilian Portuguese version of “Readiness to change questionnaire” (RCQ); (2) to compare the factorial structure found in the first objective with models proposed by literature using a confirmatory factor analysis; and (3) to create a more appropriate score that can be used in future comparisons among Drinkless versions.

## Methods

### *Sample characteristics*

We invited to enroll in the study users from the web-based intervention “*Beber Menos*” (Drink less) from 10/21/2013 to 03/11/2014. The participants (n = 713) who consented to participate in the research and filled up all the RCQ items were included in analysis. From the 713 included in analyses, 52.6% were males and 47.5% females. The age ranged from 19 to 73 years (M = 39.8, SD ± 10.3). The sample characteristics are described in table 1.

### *Instruments*

Demographic Questionnaire – with questions about sex, age, employment status, educational level, and region of living.

The Alcohol Use Disorders Identification Test (AUDIT) – is a 10-item questionnaire used to identify and classify users into alcohol consumption zones - no risk, low risk, high risk, and dependence. Developed by World Health Organization, AUDIT is used as a screening tool in many countries, including Brazil (Lima et al., 2005; Meneses-Gaya, Zuardi, Loureiro, & Crippa, 2009; Santos, Gouveia, Fernandes, Souza, & Grangeiro, 2012). The audit score is computed as a simply sum of items. Scores fewer than 7, indicate low risk use; between 7 and 15, risk user; between 16 and 19, high risk and above 20, suggestive dependence.

*Readiness to change questionnaire* (RCQ-12) – used to classify alcohol users in three stages of changes: precontemplation, contemplation and action. It was first proposed by Prochaska & DiClemente (1982). The RCQ-12 was created by Rollnick, Heather, Gold & Hall (Rollnick et al., 1992), and has 12 items answered in a 5-point Likert scale which ranges from “Strongly disagree” (-2) to “Strongly agree” (+2). The scores are obtained using a simple sum of the items from each stage – Precontemplation: 3,4,8,9; contemplation: 1,5,10,12; and, action: 2,6,7,11. The person is classify in the stage with larger scores. In case of ties, the the person is classified using the advance stage. As Defuentes-Merillas et al. (2002) proposed in the Dutch validation study, negative items were rewritten in a positive format to enhance comprehension by respondents.

*Procedures*

The English version of Readiness to change questionnaire (RCQ-12) was translated by the authors in Portuguese and made available in Brazilian version of the Drinkless e-health intervention. Drinkless is an electronic screening, brief intervention and referral to treatment (e-SBIRT) developed by World Health Organization. The Drinkless intervention is also available in English, Spanish, Hindi and Belorussian. The RCQ-12 was included as part of the program. After enrollment, users were invited to participate in the study. Participants who agreed filled up the questionnaires. After that, we extracted data and then analyzed. All procedures were approved by the Institutional Review Board of *Universidade Federal de São Paulo*.

*Data analysis*

We extract data using a R script. After extraction, we merged the tables with sociodemographic information, AUDIT and RCQ using a primary identifier. Later on, we conducted descriptive analysis on demographic variables and items of RCQ-12. To perform the exploratory and confirmatory factor analysis, we divided the data from participants randomly into two halves.

- Exploratory factor analysis - we checked sampling adequacy using Kaiser-Meyer-Olkin (KMO) and Bartlett test. To identify the number of factors, we used the method of parallel analysis (Horn, 1965) with polychoric correlations as suggested by Garrido, Abad & Ponsoda (2013) and the method of Very Simple Structured (VSS)(Revelle & Rocklin, 1979). We conducted the factor analysis using polychoric correlations with the oblique rotation “Oblimin”. This analysis is seem as more appropriated to study the underlying structure of the questionnaire (Fabrigar et al., 1999). It also allows the use of fit index Tucker-Lewis Index (TLI) and residuals inspection with the root mean square error of approximation (RMSEA). Cronbach's alpha (Cronbach, 1951) was used as an indicator of reliability. All analysis were performed using the R language (R Development Core Team, 2014) and the

package “psych” (Revelle, 2014).

- Confirmatory factor analysis – we compared the fit indices for the three models evaluated by Forsberg, Halldin and Wennberg (2003): 1-factor solution; 3-factors ortogonal, and 3-factors correlated. Additionally, we included the 2 factor model proposed in the exploratory factor analysis. The fit indices used for comparisions were the Comparative Fit Index (CFI) where values greater than .90 indicated good fit. Akaike Information Criterion (AIC) and Bayesian Information Criterion (BIC) were also used, where lower values indicate better model. To check the adjustment of the model, we inspected the residuals using the root mean square error of approximation (RMSEA) considering as a good model those with values lower than .08 (Brown, 2006). Analysis were performed using the R package lavaan (Rosseel, 2012). Modification indices were used to improve the final model fit. The script of analysis and the data are available in this link: (insert link).

**Results**

*Exploratory factor analysis*

The sample was considered adequate for factor extraction according to Kayser-Meyer-Olkin and Bartlett's test of homogeneity of variances (KMO = 0,89 and Bartlett's $\chi^2 = 79.97$, $p < 0{,}001$). Either the parallel analysis and the very simple structure methods suggested the existence of three factors (Eigenvalues of original data: F1 = 5.92; F2 = 1.66; F3 = 0.26; Eigenvalues of simulated data = F1 = 0.84; F2 = 0.29; F3 = 0.24), but due to the small amount between the eigenvalues of simulated and original data, we chose the solution of two factors.

The results of the factor loadings are shown in Table 2. The two factor model explained 68% of variance and the correlation between factors was .26. The fit indexes were considered poor (TLI = . 88; RMSEA = .13 - $CI_{95\%}$ = .123 - .143). The overall Cronbach's alpha was .88 ($CI_{95\%}$ = .85 - .92). For the first and second factors, the alpha was .91 ($CI_{95\%}$ = .87 - .94) and .82 ($CI_{95\%}$ = .75 - .89) respectively.

*Confirmatory factor analysis*

The three factor correlated solution was not converged due to the negative value covariance matrix of latent variables indicating lack of fit. Either the 1-factor and the 2-factor models showed bad fit indexes. To find a better model, we changed the items according to modification indexes. The evaluation of the confirmatory models are described in table 3.

*Final Scale*

The 1-factor improved model was constituted by items 1,4,8,10 and had a Cronbach's alpha value of .90 ($CI_{95\%}$ = .84 - .96). The simple score is made with the sum of the four items. The items 1 and 10 must be reverse coded before summing. The mean raw score was 3, standard deviation of 4.46, skewness -.94 and kurtosis .08.

**Discussion**

This is the first validation study of Readiness to Change Questionnaire with a sample of internet users and that combined either exploratory and confirmatory approaches. The number of factors suggested by either parallel analysis and very simple structure was different from the original study (Rollnick et al., 1992) and from the Spanish version (Rodríguez-Martos et al., 2000), that proposed a 3 factor model using a principal component analysis with an orthogonal rotation. Contemplation and precontemplation seemed to constitute the same factor as found in the Dutch validation study, which also used a principal components approach (Defuentes-Merillas et al., 2002). Differently from Defuentes-Merillas et al. (2002), we preferred to treat the precontemplation and contemplation as one factor, once they had just negative loadings and did not constitute an separated factor.

Although the two factor solution found in this study was comparable with the Dutch validation which had good internal consistences and proportion of explained variances (52.6%), the model estimates of exploratory factor analysis revealed poor fit indexes (TLI = .88; RMSEA = .13 - $CI_{95\%}$ = .123 - .143). This fact led us to compare this two factor model to the other ones proposed in literature (Budd & Rollnick, 1996; Forsberg et al., 2003).

All confirmatory models tested showed poor fit. This finding was different from another two confirmatory studies (Budd & Rollnick, 1996; Forsberg et al., 2003). Budd and Rollnick (1996) found that the three factors solution initially proposed by Rollnick *et al*. (1992) had bad fit indexes and suggested as alternative an one factor model, which evaluates motivation. In this study, the one factor model also had poor indexes (CFI = 720, RMSEA = .196), compared with Rollnick *et al*. (1996) (CFI = , RMSEA = ). Although Forsgerg *et at.* (2003) also found poor indexes (CFI = .83, RMSEA = .12) for the one factor model. On the other hand, they found that the three factors correlated solution showed the best fit (CFI = .96, RMSEA = .06), which was not confirmed in our study because the three factor solution had a negative covariance matrix of the latent variables.

The one factor improved version (CFI = .99, RMSEA = .04) was created to offer, at least, a way to score the some of the RCQ items and use them as predictor in future analyses. With it, we can confirm its validity across the versions of the Drinkless intervention and use it as a predictor. So we recommend the use of questions 1,4,8, and 10 in electronic screening and brief intervention

interventions. The items 4 and 8 should be reverse coded in order to perform the sum of the scale.

As far as we know, this is the first validation study of a web-based version of the Readiness to Change Questionnaire. We proposed an alternative way to score the questionnaire for researchers and alcohol web interventions developers. We also used the polychoric correlations to perform analyses, suggested as more appropriate to explore the factor structure of questionnaires (Holgado–Tello et al., 2010).

However, this study has caveats. First, this is the first study conducted with users from internet interventions and they may not represent the clinical samples or the general population, aimed in the others validations studies (Defuentes-Merillas et al., 2002; Forsberg et al., 2004; Hannöver et al., 2002; Rodríguez-Martos et al., 2000; Rollnick et al., 1992). We found that 72.1% of the sample had at least a college degree, proportion really far from that found in general population or clinics in Brazil. Second, we included in the analyses low-risk users who also were not included in the other studies. We included this type of users because they are able to enroll in Drinkless program. Third, the data is limited to Brazil, which has a different culture compared with countries where studies of validation were conducted.

In conclusion, the RCQ can be used to estimate motivation as one factor scale with the raw sum of the items. All previous models suggested by literature and the model we created showed poor fit indexes. This indicates that the RCQ is not useful to classify users into motivation stages. For clinical settings in Brazil, we recommend the SOCRATES scale. Future studies should use the 4-item model for web-based alcohol interventions. We point out that the questionnaire must be redesigned.

Table 1 – Sample demographic characteristics

| Items | % |
|---|---|
| Education | |
| College | 72.1 |
| High school | 25.3 |
| Elementary | 2.6 |
| Employment? | |
| Yes | 84.1 |
| No | 15.9 |
| Brazil's region | |
| Southeast | 49.0 |
| Northeast | 22.0 |
| South | 17.1 |
| Middle-west | 11.1 |
| North | 0.9 |
| AUDIT Classification | |
| Dependence | 33.9 |
| Low risk | 31.7 |
| At risk | 22.3 |
| High risk | 11.1 |

Table 2 – Factor loadings with an “Oblimin” rotation separated by factor.

| | Factor** | | |
|---|---|---|---|
| Items* | PC (+) e C(-) | Action | h2 |
| 1. I don't think I drink too much. | -.88 | | .72 |
| 2. I am trying to drink less than I used to. | .40 | .55 | .57 |
| 3. I enjoy my drinking, but sometimes I drink too much. | .84 | | .66 |
| 4. Sometimes I think I should cut down on my drinking. | .87 | | .83 |
| 5. It is a waste of time thinking about drinking. | -.46 | | .80 |
| 6. I have just recently changed my drinking habits. | | .90 | .78 |
| 7. Anyone can talk about wanting to do something about drinking, but I am actually doing something about it. | | .67 | .47 |
| 8. I am at the stage where I should cut down on my drinking. | .84 | | .76 |
| 9. My drinking is a problem sometimes. | .86 | | .70 |
| 10. There is no need for me to think about changing my drinking. | -.88 | | .84 |
| 11. I am actually changing my drinking habits right now. | | .91 | .84 |
| 12. Drinking less alcohol would be pointless for me. | -.84 | | .78 |

* PC – Pre-contemplation and C – Contemplation. Proportion of variances explained by factor: PC-C (47%) and Action (21%).

* Portuguese translation– 1. 'Eu acho que bebo demais'; 2. 'Estou tentando beber menos do que costumava beber'; 3. 'Eu gosto de beber, mas às vezes eu bebo demais'; 4. 'Às vezes eu acho que deveria reduzir o meu consumo de álcool'; 5. 'É um desperdício de tempo pensar sobre o meu consumo de álcool'; 6. 'Eu mudei recentemente meus hábitos de consumo'; 7. 'Qualquer pessoa pode falar sobre querer fazer algo relacionado ao consumo de álcool, mas eu estou realmente fazendo algo sobre isso'; 8. 'Eu estou em um momento em que eu deveria pensar em beber menos álcool'; 9. 'Algumas vezes, meu consumo é um problema'; 10. 'Sinto necessidade de pensar em mudar minha maneira de beber'; 11. 'Atualmente, eu de fato estou mudando meus hábitos de consumo'; 12. 'Beber menos álcool poderia me beneficiar'.

Table 3 – Comparisons among confirmatory models

| Models | CFI | RMSA | BIC | AIC | $X^2$ | df |
|---|---|---|---|---|---|---|
| One factor | .720 | .196 | 12364.5 | 12271.4 | 794.36 | 54 |
| Two factor | .815 | .161 | 12119 | 12022 | 543.60 | 53 |
| Three factor* uncorrelated | .586 | .238 | 12720 | 12627 | 1150.17 | 54 |
| One factor Model** - improved | .998 | .045 | 3824 | 3793 | 3.44 | 2 |

* The three factor correlated solution not converged because the covariance matrix of latent variables were negative. ** The improved model was constituted by items 1,4,8,10.

**References**


Brown, T. A. (2006). *Confirmatory factor analysis for applied research*. New York: Guilford Press.

Budd, R. J., & Rollnick, S. (1996). The structure of the Readiness to Change Questionnaire: A test of Prochaska & DiClemente's transtheoretical model. *British Journal of Health Psychology*, *1*(4), 365–376. doi:10.1111/j.2044-8287.1996.tb00517.x

Cronbach, L. (1951). Coefficient alpha and the internal structure of tests. *Psychometrika*, *16*(3), 297–334. doi:10.1007/BF02310555

Defuentes-Merillas, L., Dejong, C. A. J., & Schippers, G. M. (2002). Reliability and validity of the Dutch version of the Readiness to Change Questionnaire. *Alcohol and Alcoholism (Oxford, Oxfordshire)*, *37*(1), 93–99.

Fabrigar, L. R., Wegener, D. T., MacCallum, R. C., & Strahan, E. J. (1999). Evaluating the use of exploratory factor analysis in psychological research. *Psychological Methods*, *4*(3), 272.

Forsberg, L., Ekman, S., Halldin, J., & Rönnberg, S. (2004). The Readiness to Change Questionnaire: Reliability and validity of a Swedish version and a comparison of scoring methods. *British Journal of Health Psychology*, *9*(3), 335–346.

Forsberg, L., Halldin, J., & Wennberg, P. (2003). Psychometric Properties and Factor Structure of the Readiness to Change Questionnaire. *Alcohol and Alcoholism*, *38*(3), 276–280. doi:10.1093/alcalc/agg067

Garrido, L. E., Abad, F. J., & Ponsoda, V. (2013). A new look at Horn's parallel analysis with ordinal variables. *Psychological Methods*, *18*(4), 454–474. doi:10.1037/a0030005

Hannöver, W., Thyrian, J. R., Hapke, U., Rumpf, H.-J., Meyer, C., & John, U. (2002). The readiness to change questionnaire in subjects with hazardous alcohol consumption, alcohol misuse and dependence in a general population survey. *Alcohol and Alcoholism (Oxford, Oxfordshire)*, *37*(4), 362–369.

Heather, N., Rollnick, S., & Bell, A. (1993). Predictive validity of the Readiness to Change Questionnaire. *Addiction (Abingdon, England)*, *88*(12), 1667–1677.

Holgado–Tello, F. P., Chacón–Moscoso, S., Barbero–García, I., & Vila–Abad, E. (2010). Polychoric versus Pearson correlations in exploratory and confirmatory factor analysis of ordinal variables. *Quality & Quantity*, *44*(1), 153–166. doi:10.1007/s11135-008-9190-y

Horn, J. L. (1965). A rationale and test for the number of factors in factor analysis. *Psychometrika*, *30*(2), 179–185. doi:10.1007/BF02289447

Lima, C. T., Freire, A. C. C., Silva, A. P. B., Teixeira, R. M., Farrell, M., & Prince, M. (2005). Concurrent and Construct Validity of the Audit in an Urban Brazilian Sample. *Alcohol and Alcoholism*, *40*(6), 584–589. doi:10.1093/alcalc/agh202

McConnaughy, E. A., DiClemente, C. C., Prochaska, J. O., & Velicer, W. F. (1989). Stages of change in psychotherapy: A follow-up report. *Psychotherapy: Theory, Research, Practice, Training*, *26*(4), 494–503. doi:10.1037/h0085468

Meneses-Gaya, C. de, Zuardi, A. W., Loureiro, S. R., & Crippa, J. A. S. (2009). Alcohol Use Disorders Identification Test (AUDIT): an updated systematic review of psychometric properties. *Psychology & Neuroscience*, *2*(1), 83–97. doi:10.3922/j.psns.2009.1.12

Miller, W. R., & Scott, J. (1996). Assessing drinkers' motivation for change: The Stages of Change Readiness and Treatment Eagerness Scale (SOCRATES). *Psychology of Addictive Behaviors*, *10*(2), 81–89. doi:10.1037/0893-164X.10.2.81

Napper, L. E., Wood, M. M., Jaffe, A., Fisher, D. G., Reynolds, G. L., & Klahn, J. A. (2008). Convergent and discriminant validity of three measures of stage of change. *Psychology of Addictive Behaviors: Journal of the Society of Psychologists in Addictive Behaviors*, *22*(3), 362–371. doi:10.1037/0893-164X.22.3.362

Norcross, J. C., Krebs, P. M., & Prochaska, J. O. (2011). Stages of change. *Journal of Clinical Psychology*, *67*(2), 143–154. doi:10.1002/jclp.20758

Prochaska, J. O., & DiClemente, C. C. (1982). Transtheoretical therapy: Toward a more integrative model of change. *Psychotherapy: Theory, Research & Practice*, *19*(3), 276–288. doi:10.1037/h0088437

R Development Core Team. (2014). *R: A language and environment for statistical computing*. Viena: R Foundation for Statistical Computing. Retrieved from http://www.R-project.org

Revelle, W. (2014). *psych: Procedures for Psychological, Psychometric, and Personality Research*. Evanston, Illinois. Retrieved from http://CRAN.R-project.org/package=psych

Revelle, W., & Rocklin, T. (1979). Very Simple Structure: An Alternative Procedure For Estimating The Optimal Number Of Interpretable Factors. *Multivariate Behavioral Research*, *14*(4), 403–414. doi:10.1207/s15327906mbr1404_2

Rodríguez-Martos, A., Rubio, G., Aubà, J., Santo-Domingo, J., Torralba, L., & Campillo, M. (2000). Readiness to change questionnaire: reliability study of its Spanish version. *Alcohol and Alcoholism (Oxford, Oxfordshire)*, *35*(3), 270–275.

Rollnick, S., Heather, N., Gold, R., & Hall, W. (1992). Development of a short “readiness to change” questionnaire for use in brief, opportunistic interventions among excessive drinkers. *British Journal of Addiction*, *87*(5), 743–754.

Rosseel, Y. (2012). lavaan: An R Package for Structural Equation Modeling. *Journal of Statistical Software*, *48*(2), 1–36.

Santos, W. S. dos, Gouveia, V. V., Fernandes, D. P., Souza, S. S. B. de, & Grangeiro, A. S. de M. (2012). Alcohol Use Disorder Identification Test (AUDIT): exploring its psychometric parameters. *Jornal Brasileiro de Psiquiatria*, *61*(3), 117–123. doi:10.1590/S0047-20852012000300001