Negative Marijuana-related Consequences among College Students in Five Countries: Measurement Invariance of the Brief Marijuana Consequences Questionnaire

Adrian J. Bravo[*],

Center on Alcoholism, Substance Abuse, and Addictions University of New Mexico, USA

Matthew R. Pearson,

Center on Alcoholism, Substance Abuse, and Addictions University of New Mexico

Angelina Pilatti,

Facultad de Psicología Universidad Nacional de Córdoba, Facultad de Psicología Instituto de Investigaciones Psicológicas, IIPsi, CONICET. Córdoba, Argentina

Laura Mezquita,

Department of Basic and Clinical Psychology and Psychobiology Universitat Jaume I, Castelló de la Plana, Castellón, Spain

Cross-Cultural Addictions Study Team[**]

Abstract

Background and aims: The 21-item Brief-Marijuana Consequences Questionnaire (B-MACQ) has been shown to be a valid measure to assess negative marijuana-related consequences among U.S. college students. The present study aimed to: (a) examine measurement invariance of the B-MACQ across college student marijuana users in five countries, (b) evaluate latent mean differences on the B-MACQ as a function of sex and country if invariance is met, and (c) compare criterion-related validity across different countries and sex.

Design: Online survey.

Setting: Argentina, Netherlands, Spain, Uruguay, and USA.

Participants: A subsample of last-month marijuana users who completed the B-MACQ (*n*=1,145; 62.9% female).

[*]Corresponding Author: Center on Alcoholism, Substance Abuse, and Addictions, 2650 Yale Blvd SE, Albuquerque, NM, USA 87106, Phone: 505-925-2344, ajbravo@unm.edu.
[**]This project was completed by the Cross-cultural Addictions Study Team (CAST), which includes the following investigators (in alphabetical order): Adrian J. Bravo, University of New Mexico, USA (Coordinating PI); James M. Henson, Old Dominion University, USA; Manuel I. Ibáñez, Universitat Jaume I de Castelló, Spain; Laura Mezquita, Universitat Jaume I de Castelló, Spain; Generós Ortet, Universitat Jaume I de Castelló, Spain; Matthew R. Pearson, University of New Mexico, USA; Angelina Pilatti, National University of Cordoba, Argentina; Mark A. Prince, Colorado State University, USA; Jennifer P. Read, University of Buffalo, USA; Hendrik G. Roozen, University of New Mexico, USA; Paul Ruiz, Universidad de la República, Uruguay.

Measurements: The B-MACQ, several dimensions of marijuana use, and perceptions of marijuana use.

Findings: Results supported configural and scalar invariance (all ΔCFI/TLI ≤ .01; ΔRMSEA ≤ .015) of a 20-item B-MACQ across sex and four countries (Netherlands being the exception). In examining latent mean differences, Spanish students reported a higher number of consequences than U.S (p<.001) and Argentinian students (p=.003). In examining criterion-related validity, marijuana use indicators (.01<rs<.64), descriptive norms (.04<rs<.49), and injunctive norms for best friend (.06<rs<.28) largely had small-to-moderate positive correlations with negative marijuana-related consequences.

Conclusions: The 20-item B-MACQ accurately assesses marijuana-related negative consequences among male and female college student marijuana users across the U.S., Argentina, Spain, and Uruguay. The B-MACQ could be used effectively to identify marijuana-related consequences in college students from different countries or cultures.

Keywords

Introduction

Marijuana (or cannabis) is the most widely used illicit drug in the world [1,2]. Considering the increased medicalization/legalization of marijuana around the globe (U.S.: [3]; Canada: [4]; Uruguay: [5]), there is a need to quantify the full range of risks from marijuana use. Rates of marijuana use and cannabis use disorder peak in young adulthood [6,7] and college students are at a significantly higher risk for marijuana use initiation compared to same-aged individuals not enrolled in college [8]. Globally, marijuana use among college students is prevalent (e.g., U.S.: [9, 10]; Argentina: [11]) and heavy marijuana use is associated with increased negative consequences [12–15], including lower academic achievement [16] and increased rate of dropout [17]. A crucial factor for early detection/intervention targeting these at-risk students is the accurate and efficient assessment of these negative marijuana-related consequences.

Modelled after the Young Adult Alcohol Consequences Questionnaire [18], the Marijuana Consequences Questionnaire (MACQ; [19]) is a comprehensive measure developed to assess a wide range of negative marijuana-related consequences among college students. Both the full 50-item and the brief 21-item (B-MACQ) versions encompass diverse negative consequences of differing severity that fall along a continuum from mild, relatively frequent consequences (e.g., lack of energy) to more severe, generally infrequent, consequences (e.g., reports of physical fights) [19]. Although several studies have used the MACQ (or B-MACQ) to assess marijuana-related negative consequences [20–26], no published study to date has examined the MACQ outside of North America (i.e., U.S and Canada). Notably, two other standardized measures to assess negative marijuana-related consequences, the Cannabis Problems Questionnaire [27] and the Cannabis Abuse Screening Test [28], have been adapted for their use with Spanish-speaking youth from Spain [29, 30] and Argentina

[31]. These were reliable and valid measures yet, unlike the MACQ, were not specifically designed to capture consequences of marijuana use in college students. Moreover, a recent meta-analysis demonstrated that marijuana use is more strongly related to the MACQ than two other widely used consequences measures [32]. Thus, it is important to determine if the strong psychometric properties of the MACQ are maintained among students in other parts of the world, including countries/regions with different cultures and marijuana-related policies.

Purpose of Present Study

To inform a better understanding of how college marijuana users embedded in particular cultural contexts experience negative marijuana-related consequences, the present study aimed to adapt and validate a Spanish version of the B-MACQ across three distinct Spanish-speaking countries (Spain, Uruguay, and Argentina) and a Dutch version of the B-MACQ in a Dutch-speaking country (i.e., Netherlands) and examine the measurement invariance of the B-MACQ among college student marijuana users in five countries (the U.S., Spain, Argentina, Uruguay, and Netherlands). Specifically, the aims of the present study were: 1) test the extent to which negative marijuana-related consequences are captured using the same items (i.e., measurement invariance) across different countries and sex (men vs women); 2) examine how men vs. women (controlling for country and marijuana use frequency and quantity) and individuals from different countries/cultures (controlling for sex and marijuana use frequency and quantity) compare on the number of negative marijuana-related consequences experienced (i.e., latent mean differences across factors); and 3) examine how negative marijuana-related consequences relate to marijuana use behavior and perceived norms (both descriptive and injunctive) across sex and different countries/cultures (i.e., comparing criterion-related validity).

Method

Design

This is an instrumental study [33] that examines the psychometric properties of the B-MACQ. To test study aims, college students from the U.S. (four universities across four states: Colorado, New Mexico, New York, Virginia), Argentina (one university located in the Central region), Spain (one university located in the autonomous community of Valencia), Uruguay (one university located in the largest city of the country, situated on the southern coast of Uruguay), and Netherlands (one university located in the province of North Brabant) completed an online survey to measure several dimensions of marijuana use, negative consequences, and perceptions of marijuana use. Across all sites, students completed the same core battery of measures translated into the native language. Given the focus of examining the psychometric properties of the B-MACQ, analyses were conducted among a subsample of last-month marijuana users.

For the U.S. sites, students were recruited from Psychology Department pools and received research participation credit. In Argentina and Uruguay students were recruited disseminating an invitation through online social networks and e-mail listings. In Argentina, participants who completed the survey took part in a raffle of 7 prizes (one stay in a cottage

located in a tourist center and six cash prizes [each of ≈US$ 36 at the time]). In Uruguay, participants did not receive compensation for participation. In Spain an email was sent to all the students of the university inviting them to participate in the research. Participants who completed the battery received 5 euros for their participation. In the Netherlands, students were recruited from the School of Social and Behavioral Sciences and received research participation credit. Study procedures were approved by the institutional review boards (or their international equivalent) at the participating universities.

Participants

A total of 3,482 (67.9% females; Mean age=21.07, SD=4.61) college students participated in the study (see Table 1 for demographics across countries). Across countries, lifetime marijuana use prevalence ranged from 54.6% to 85.0 and past month prevalence ranged from 22.2% to 69.9% (see Table 1 for a breakdown of marijuana use across countries). For the present study only data from students that reported past month (i.e., past 30-day) marijuana use and completed the B-MACQ (n=1,145; 62.9% females; Mean age=20.88, SD=3.90) were included in the final analysis from each country (U.S., n=697; 64.4% female, Mean age=19.53, SD=2.72; Argentina, n=153; 60.1% female, Mean age=24.58, SD=4.60; Spain, n=174; 54.6% female, Mean age=21.24, SD=3.47; Uruguay, n=55; 80.0% female, Mean age=26.24, SD=5.33; Netherlands, n=66; 60.6% female, Mean age=20.83, SD=2.41).

Measurement Translation

All measures were translated into Spanish and Dutch by native speakers that are also proficient in English. Then, members of the research team compared the versions (e.g., adjusted the items to be equivalent in Spain, Uruguay and Argentina), and after a thorough discussion, composed a preliminary version of the instrument. Colleagues of the research team unfamiliar with the inventories conducted back translations for both the Spanish and Dutch versions of the B-MACQ. Then, members of the research team compared the original and translated versions to create a final version of the instrument based on consensus (see Appendix A for Spanish/Dutch versions of the B-MACQ).

Measures

Negative marijuana-related consequences.—Negative marijuana-related consequences were assessed using the 21-item B-MACQ [19]. Each item was scored dichotomously to reflect presence/absence of the marijuana-related problem in the past month (0=*no*, 1=*yes*). Because of the dichotomous scoring structure, the total score reflects the total number of consequences that the individual has experienced in that period. Table 2 summarizes endorsement of consequences across countries and sex (men typically endorsed more consequences). Differences across countries were relatively few with the largest discrepancy being that U.S. students endorsed driving a car while high (36.7%) more frequently than students from other countries.

Marijuana Use.—To determine lifetime marijuana user status, we asked, "In your lifetime, have you ever used marijuana in any form?". If participants responded with "yes," they were branched to two additional questions: 1) "How old were you the first time you used marijuana?", and 2) "On how many days during the last 30 days did you use marijuana?" If

participants responded with 1 or greater to this second question, they were then asked the remainder of the marijuana-related questions.

Participants were presented with a visual guide (the same guide in all countries) showing different amounts of marijuana in grams. The Marijuana Use Grid (MUG; [34]) was used to assess typical marijuana use. Participants estimate the amount of grams they use in each 4-hour time period of each day of a typical week (12p-4p on Monday, 4p-8p on Monday, etc.). By counting all non-zero values, we obtained an estimate of typical frequency of marijuana use reflecting the number of time periods used in a typical week (possible range: 0–42). By summing all values, we obtained an estimate of typical quantity of marijuana use reflecting total number of grams used in a typical week. To address outliers, we Winsorized quantity estimates >3SDs above the mean. To assess subjective intoxication, participants were asked to indicate how high they get on a "typical marijuana use day" (typical subjective intoxication) on a visual analog scale ranging from 0=*not at all* to 100=*completely*, and reported the number of hours they typically "stay high" on a typical marijuana use day (length of typical intoxication).

Marijuana Norms.—Marijuana descriptive norms were assessed using the same marijuana use frequency/quantity measure to assess one's own marijuana use (see MUG above); however, the grids for typical use weeks were filled out in reference to their "close friends." Marijuana injunctive norms were assessed using the same grid measure but in reference to the frequency/quantity of marijuana use that "close friends" would approve of in a typical week. Moreover, injunctive norms were also assessed using nine additional items on a 7-point scale (1=*strongly disapproving*, 7=*strongly approving*) for three marijuana behaviors (using marijuana, using marijuana to get high, and using marijuana daily) for three reference groups (best friends, college students, parents). Averaging across the three behaviors, injunctive norms composites were created for the three reference groups.

Statistical Analysis—To examine the internal structure of the B-MACQ across sites, we conducted confirmatory factor analyses (CFA) using a diagonally weighted least squares (WLSMV) estimator in M*plus* 7.4 [35]. To evaluate overall model fit, we used model fit criteria suggested by Marsh, Hau, and Wen [36] including the Comparative Fit Index (CFI) >.90 (acceptable) > .95 (optimal), Tucker-Lewis Index (TLI) >.90 (acceptable) > .95 (optimal), Root Mean Square Error of Approximation (RMSEA) < .06. Within the total sample and across sites, we estimated Cronbach's alpha from test scores using tetrachoric correlations, a procedure that is better suitable for dichotomously-scored measures [37].

To determine the factorial invariance of the B-MACQ across sex (men vs. women) and countries (i.e., U.S., Argentina, Uruguay, Netherlands and Spain), we conducted multi-group confirmatory factor analyses (MG-CFA) using M*plus* 7.4 with WLSMV. As recommended by the measurement invariance literature [38, 39] when examining indicators that are dichotomous, we tested only two levels of measurement invariance: configural (i.e., whether all items load on the proposed factor) and scalar (i.e., whether the unstandardized item thresholds are similar across groups) using the theta parametrization in M*plus* [40]. Since the χ^2 test statistic is sensitive to sample size [41] and estimation method [42], we used model comparison criteria of   CFI/ TFI   .01 [43] and   RMSEA   .015 [44] to indicate

significant decrement in fit when testing for measurement invariance (as is typically done in cross-national surveys [45]). If findings support both configural and scalar invariance of the models, then B-MACQ factor mean scores (and item endorsement) could be compared across groups. Evidence of criterion-related validity was assessed using correlation analyses among the latent factor of B-MACQ and marijuana use indicators and perceived norms.

Results

CFAs and Measurement Invariance of the Brief-MACQ

The 21-item B-MACQ showed adequate to excellent fit to the data on most indices for the total sample (see Supplemental Table 1). Despite adequate fit in the total sample, there was overall poor fit (e.g., CFIs/TLIs < .90) among most international sites (model fit was acceptable in the U.S. pooled sample and sites; see Supplemental Table 1). Based on model modification indices, item 5 ("I have gotten into physical fights because of my marijuana use") had the biggest impact on model fit due to low endorsement across all samples (1% endorsed in Argentina, Spain, U.S.; no endorsement in Uruguay and Netherlands). Upon deleting this item, model fit improved significantly and was adequate in all sites except the Netherlands (see Supplemental Table 1). The standardized loadings (available from the authors upon request) were all salient (i.e. .30; [41]). Reliability coefficients for the scores was .95 in the total sample and ranged between .93 and .96 across country subsamples. Based on the findings reported above, measurement invariance testing was conducted among all countries except the Netherlands (due to poor fit of the measure in this sample) using the 20-item B-MACQ (i.e., omitting item 5). The 20-item B-MACQ was found to be invariant (i.e., configural and scalar invariance was met; see Table 3) across sex, the four countries, and all sites (i.e., U.S. sites not pooled in analyses). It is important to note that the 21-item version was also invariant across sex and the U.S. sites. Further, exploratory test of invariance omitting item 2 ("I have driven a car when I was high") was conducted given cultural differences about access to personal automobiles across countries; nevertheless, invariance was also met when omitting this item across sex, countries, and sites (see Supplemental Table 2).

Latent Mean Comparisons

Based on the results of our measurement invariance analyses, we conducted latent mean comparisons to test for differences by country (not including the Netherlands) and sex (controlling for the effects of the other factor as well as typical marijuana use frequency and quantity). We used dummy-coded indicators for country and sex (0= men, 1=women) as predictors of a latent factor the 20-item B-MACQ. A statistically significant result indicates a significant mean difference in the latent factor between the reference group and the predictor group (these results are available upon request). Of all possible mean differences, there were only two significant latent mean differences (findings were inconclusive as to whether or not a statistical difference was present for all other comparisons including sex differences). Specifically, Spanish students reported a higher number of marijuana-related consequences than U.S. (b=.33, p<.001) and Argentinian students (b=.28, p=.003).

Criterion-related validity

Bivariate correlations were conducted between the latent factor of the 20-item B-MACQ and marijuana use indicators and perceive norms. These analyses were conducted by country (except the Netherlands) and sex and results are summarized in Table 4. Across the four countries and sex, marijuana use indicators, descriptive norms, and injunctive norms largely had small-to-moderate positive correlations with negative marijuana-related consequences, supporting criterion-related validity of the 20-item B-MACQ scores across different countries and sex. We also examined differences in correlation coefficients across countries and sex (see Table 4) to determine if certain variables were differentially related to negative marijuana-related consequences. Given that statistical tests of these differences may be over-sensitive to small differences including differences in sample sizes across countries, we focused on the magnitude of these differences. Across 75 possible comparisons, we found that the average difference in correlations was .14 (*SD*=.10). We considered a difference greater than 2 SD above the mean substantial (bolded and underlined in Table 4). Overall, we found 3 substantial differences with the largest difference being with length of typical intoxication (in hours), showing a medium-sized positive correlation in Spain (*r*=.49) and near-zero correlations in the U.S. (*r*=.01). The only other substantial differences were for typical subjective intoxication, showing a strong-sized positive correlation in Uruguay (*r*=.51) but weak correlation in the U.S. (*r*=.13) and for descriptive norms (quantity), showing a moderate-sized positive correlation in Uruguay (*r*=.43) but weak correlation in the U.S. (*r*=.09).

Discussion

Considering rates in marijuana use have been consistently growing [46–49] and the variability in the impact of legalization of marijuana on marijuana use and marijuana-related variables [46, 50], it is necessary to efficiently quantify negative marijuana-related consequences across countries/cultures with diverse marijuana policies. However, these comparisons are only possible if measures convey the same meaning across languages and cultures of administration. The MACQ has shown to accurately and comprehensively measure a broad spectrum of marijuana-related problems among English-speaking college students; however, studies outside North-America have been largely absent. Therefore, a central aim of the present study was to adapt and validate a Spanish and Dutch version of the B-MACQ across three distinct Spanish speaking countries (Spain, Uruguay, and Argentina) and a Dutch speaking country (i.e., Netherlands) and examine the measurement invariance of this measure across college student marijuana users from five different countries/cultures.

Overall, our findings supported the configural and scalar invariance of the 20-item B-MACQ across sex and countries/cultures (Netherlands were not examined in these analyses) indicating the B-MACQ captures negative marijuana-related consequences in the same way, regardless of sex, country/culture or language. Only when measurement invariance is met is it legitimate to infer that mean differences are due to true latent difference and not a consequence of measurement bias. In this case, the overall latent mean differences in marijuana consequences across countries were small. Thus, despite rather large differences in marijuana use prevalence across these countries, college student marijuana users

experienced a remarkably similar level of negative consequences across these countries. Even the pattern of specific consequences was quite similar across countries, suggesting that the type of negative consequences experienced by college students is not particularly culturally-laden. Although some differences did emerge, we suggest that these findings need to be replicated before strong conclusions can be made. It is possible that some negative consequences of marijuana use can be ameliorated or exacerbated by cultural factors.

Our findings also supported criterion-related validity of the B-MACQ. Specifically, we found small-to-moderate positive correlations between the B-MACQ scores with a diverse set of marijuana outcomes and marijuana-related variables. The magnitude of these correlations was fairly similar across countries with only 3 (out of 75) correlations showing substantial differences. Notably, two of these associations involve reported subjective intoxication. This could be related, at least partially, to variations in routes of administration that might modulate the association between marijuana outcomes and marijuana-related consequences. Some routes of administration, like the use of edibles, might lead to greater consumption due to the delayed onset of the effects [51] or to variations in the length and intensity of intoxication [52], likely affecting the type or number of experienced consequences. Illustrating this point, the preference for vaping or using edibles for outdoors consumption increased the likelihood of driving under the influence [53]; while combining marijuana with tobacco increase the number of negative consequences [54].

Limitations

Although the present study had the strength of collecting data from a large sample of college students from five different countries, limitations included differences across countries in recruitment procedures (i.e., participant incentives) and the use of convenience samples in each country (e.g., Psychology Department Pools in the U.S.; which results in an overrepresentation of women in our samples). These procedures lower the likelihood that our sample is representative of the college student population in each country, potentially limiting the generalizability of our results. Given these limitations, we must be careful not to over interpret differences across countries. Another limitation is that our modest sample sizes in some countries resulted in sparse cell counts, leading to poor model fit in testing the 21-item version of the B-MACQ and for a poor model fit of the B-MACQ in the Netherlands sample. Another important limitation is that our recruitment procedures and specific assessments do not allow for parsing larger cultural differences from individual peer group differences. For example, in our assessments of perceived norms of one's close friends, parents, and typical college students across countries, we cannot determine the extent to which these differences are truly reflective of peer group-specific differences or larger local, regional, and/or national differences.

The fact that the English and Spanish versions of the 20-item B-MACQ performed well in the countries that we sampled does not suggest that these measures would perform as well in all English-, Spanish-speaking countries, so additional cross-national research is needed, especially in Dutch-speaking countries. Specifically, it is important to highlight that the B-MACQ represents one list of possible consequences that was derived in a specific culture/ country (further we did not asses the full MACQ) and does not account for cultural

differences in (unmeasured) consequences that are not assessed. It is indeed possible that cultural/idiosyncratic characteristics of each country/region impact the type or content of the spectrum of negative consequences experienced by college students. Further research using mixed-method (qualitative and quantitative) approaches are needed to allow participants from different countries/cultures to derive their own consequences as there may be culturally-specific consequences that are not accounted for in the MACQ (or B-MACQ). Moreover, local campus, community, and state-level (regions for international countries) may impact experience and perception of consequences and thus further research is needed validating this measure across distinct local communities within countries.

Conclusions

Despite substantial differences across countries and cultures in marijuana use prevalence and the legal status of marijuana, our findings suggest that the 20-item B-MACQ accurately assesses marijuana-related negative consequences among male and female college student marijuana users across the U.S., Argentina, Spain, and Uruguay. With validated Spanish versions of the B-MACQ, researchers will be better equipped to compare how various and varying policies around the world impact the negative consequences experienced from marijuana use. Further research is needed with a larger Dutch sample of marijuana users to adequately determine whether the psychometric properties of the B-MACQ are maintained among Dutch students. Still, results suggest that the B-MACQ could be used effectively to identify marijuana-related consequences in college students from different countries or cultures.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

Acknowledgments

Appendix A: Items for the Spanish and Dutch Versions of the Brief-MACQ

Item #	Items- Spanish Version	Items- Dutch Version
1	La calidad de mi trabajo o estudio ha disminuido a causa de mi consumo de marihuana.	De kwaliteit van mijn werk of huiswerk heeft geleden onder mijn marihuanagebruik.
2	He manejado un auto bajo los efectos de la marihuana.	Ik heb auto gereden toen ik high was.

Item #	Items- Spanish Version	Items- DutchVersion
3	Me he sentido confundido/a, aletargado/a, cansado/a o mareado/a la mañana siguiente de haber usado marihuana.	Ik heb me vaag, traag, moe of versuft gevoeld de morgen na marihuanagebruik.
4	Me he sentido decepcionado por mi consumo de marihuana.	Ik heb me ongelukkig gevoeld als gevolg van mijn marihuanagebruik.
5	Me he metido en peleas físicas luego de consumir marihuana.	Ik ben in fysieke gevechten verzeild geraakt als gevolg van mijn marihuanagebruik.
6	He pasado demasiado tiempo consumiendo marihuana.	Ik heb te veel tijd gespendeerd aan het gebruiken van marihuana.
7	He sentido que necesitaba consumir marihuana al levantarme (esto es, antes del desayuno).	Ik voelde dat ik een trekje marihuana nodig had nadat ik was opgestaan (voor het ontbijt).
8	Me he vuelto grosero, pesado, o he insultado después de consumir marihuana.	Ik ben erg onbeleefd, onaangenaam of beledigend geworden na mijn marihuanagebruik.
9	He estado menos activo físicamente por mi consumo de marihuana.	Ik ben minder lichamelijk actief geweest als gevolg van mijn marihuanagebruik.
10	He tenido dificultad para dormir después de detener o reducir mi consumo de marihuana	Ik heb moeite gehad om te slapen na het stoppen of verminderen met gebruik van marihuana.
11	Descuidé obligaciones familiares, laborales o de estudio debido a mi consumo de marihuana	Ik heb de verplichtingen aan familie, werk of school verwaarloosd als gevolg van mijn marihuanagebruik.
12	Cuando estaba consumiendo marihuana he hecho cosas de manera impulsiva que luego lamenté	Tijdens het gebruik van marihuana heb ik impulsieve dingen gedaan waar ik later spijt van had.
13	Me he levantado el día después de haber estado consumiendo marihuana y me di cuenta que no podía recordar una parte de noche anterior.	De dag nadat ik marihuana had gebruikt realiseerde ik me dat ik een gedeelte van de avond ervoor niet kon herinneren.
14	He aumentado de peso debido al consumo de marihuana.	Ik heb overgewicht gehad als gevolg van mijn marihuanagebruik.
15	No he estado tan ágil mentalmente debido a mi consumo de marihuana.	Ik ben geestelijk niet zo scherp geweest als gevolg van mijn gebruik van marihuana.
16	He tenido una nota más baja de lo usual en un examen o en una entrega por haber consumido marihuana.	Ik heb een lager cijfer voor een examen of opdracht gekregen dan ik normaal zou hebben gehad als gevolg van marihuanagebruik.
17	He intentado dejar de consumir marihuana porque pensé que estaba consumiendo mucho.	Ik heb geprobeerd om met marihuana te stoppen omdat ik dacht dat ik teveel gebruikte.
18	Me he sentido ansioso, irritable, o he perdido mi apetito o he tenido dolor de estómago luego de abandonar o disminuir mi consumo de marihuana.	Ik heb me angstig of geïrriteerd gevoeld, of mijn eetlust verloren of buikpijn gehad na het stoppen of verminderen van marihuanagebruik.
19	Usualmente pienso que necesito disminuir o abandonar mi consumo de marihuana.	Ik heb vaak nagedacht of ik niet met marihuana moet stoppen of niet meer moet gebruiken.
20	Me he sentido con menos energía o cansado debido a mi consumo de marihuana.	Ik had minder energie of voelde me moe vanwege mijn marihuanagebruik.
21	He perdido las ganas de hacer cosas debido a mi consumo de marihuana.	Ik heb motivatie verloren om dingen te doen als gevolg van mijn marihuanagebruik.

Note. Item numbers refer to the item number of the English Brief-MACQ. Some words (e.g., auto to coche) were reworded to Castilian Spanish for the Spain site.

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Table 1

Demographics and rates of marijuana use across countries

	Total Sample (n = 3482)	United States (n = 1918)	Argentina (n = 375)	Uruguay (n = 133)	Spain (n = 754)	Netherlands (n = 302)
Sex	n (%)	n (%)	n (%)	n (%)	n (%)	n (%)
Men	1105 (31.7)	623 (32.5)	125 (33.3)	26 (19.5)	253 (33.6)	78 (25.8)
Women	2363 (67.9)	1283 (66.9)	250 (66.7)	107 (80.5)	501(66.4)	222 (73.5)
Missing	14 (0.4)	12 (0.6)	0 (0.0)	0 (0.0)	0 (0.0)	2 (0.7)
Age M(SD)	21.07 (4.61)	19.95 (4.16)	24.16 (5.38)	26.56 (6.21)	21.44 (3.99)	20.87 (2.96)
Education	n (%)	n (%)	n (%)	n (%)	n (%)	n (%)
First Year (Freshman)	1568 (45.1)	1012 (52.8)	56 (14.9)	11 (8.3)	260 (34.5)	229 (76.1)
Second Year (Sophomore)	696 (20.0)	404 (21.1)	77 (20.5)	22 (16.5)	181 (24.0)	12 (4.0)
Third Year (Junior)	536 (15.4)	272 (14.2)	100 (26.7)	33 (24.8)	128 (17.0)	3 (1.0)
Four Year (Senior)	408 (11.7)	227 (11.9)	47 (12.5)	31 (23.3)	103 (13.7)	--------
Fifth/Sixth Year	59 (1.7)	--------	31 (8.3)	6 (4.6)	22 (2.9)	--------
Finished Studies (Graduating)	154 (4.4)	--------	64 (17.1)	30 (22.6)	60 (8.0)	--------
Graduate Student	57 (1.6)	--------	--------	--------	--------	57 (18.9)
Lifetime Use	n (%)	n (%)	n (%)	n (%)	n (%)	n (%)
No	1198 (34.4)	672 (35.0)	104 (27.7)	20 (15.0)	265 (35.1)	137 (45.4)
Yes	2284 (65.6)	1246 (65.0)	271 (72.3)	113 (85.0)	489 (64.9)	165 (54.6)
	Total Lifetime Users (n = 2284)	United States (n = 1246)	Argentina (n = 271)	Uruguay (n = 113)	Spain (n = 489)	Netherlands (n = 165)
Last 30 day Use		n (%)	n (%)	n (%)	n (%)	n (%)
No	1109 (48.6)	548 (44.0)	118 (43.5)	34 (30.1)	311 (63.6)	98 (59.4)
Yes	1175 (51.4)	698 (56.0)	153 (56.5)	79 (69.9)	178 (36.4)	67 (22.2)

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Table 2

Endorsement of MACQ items across countries and sex

	United States (U.S.) (n = 697)	Argentina (AR) (n = 153)	Uruguay (UY) (n = 55)	Spain (ES) (n = 174)	Netherlands (NL) (n = 66)	Significant Mean Differences	Men vs Women Significant Differences
MACQ Total (M, SD)	3.51 (4.01)	3.48 (3.39)	3.58 (3.74)	4.38 (4.16)	3.26 (3.36)	No Differences*	Men (M=4.29) > Women (M=3.20)
(Item #) MACQ Item							
(1) The quality of my work or schoolwork has suffered because of my marijuana use.	12.3%	12.4%	16.4%	13.2%	13.6%	No Differences	Men (16.1%) > Women (10.6%)
(2) I have driven a car when I was high.	36.7%	17.6%	7.3%	17.8%	4.5%	USA > AR, UY, ES, NL	Men (32.6%) > Women (24.9%)
(3) I have felt in a fog, sluggish, tired, or dazed the morning after using marijuana.	41.8%	34.0%	34.5%	48.3%	45.5%	No Differences	No Differences (Men = 41.2% Women = 41.8%)
(4) I have been unhappy because of my marijuana use.	12.5%	15.0%	12.7%	22.4%	10.6%	ES > USA	Men (18.0%) > Women (12.0%)
(5) I have gotten into physical fights because of my marijuana use.	1.4%	0.7%	0.0%	0.6%	0.0%	No Differences	No Differences (Men = 1.2% Women = 1.0%)
(6) I have spent too much time using marijuana.	14.4%	15.7%	20.0%	20.1%	12.1%	No Differences	Men (23.0%) > Women (10.9%)
(7) I have felt like I needed a hit of marijuana after I'd gotten up (that is, before breakfast).	14.7%	11.1%	7.3%	9.2%	1.5%	USA > NL	Men (15.0%) > Women (10.3%)
(8) I have become very rude, obnoxious, or insulting after using marijuana.	2.9%	5.9%	3.6%	6.9%	0.0%	No Differences	No Differences (Men = 4.5% Women = 3.2%)
(9) I have been less physically active because of my marijuana use.	25.3%	47.7%	34.5%	50.6%	45.5%	AR, ES, NL > USA	Men (37.3%) > Women (31.5%)
(10) I have had trouble sleeping after stopping or cutting down on marijuana use.	15.4%	9.2%	12.7%	19.0%	15.2%	No Differences	Men (21.0%) > Women (11.3%)
(11) I have neglected obligations to family, work, or school because of my marijuana use.	10.4%	15.7%	12.7%	14.9%	10.6%	No Differences	Men (16.5%) > Women (8.8%)
(12) When using marijuana I have done impulsive things that I regretted later.	8.1%	11.8%	10.9%	16.7%	7.6%	ES > USA	Men (13.2%) > Women (7.8%)
(13) I have awakened the day after using marijuana and found I could not remember a part of the evening before.	19.3%	18.3%	16.4%	21.8%	13.8%	No Differences	No Differences (Men = 20.4% Women = 18.3%)
(14) I have been overweight because of my marijuana use.	5.3%	12.4%	12.7%	5.7%	1.5%	AR > USA	No Differences (Men = 7.8% Women = 5.7%)
(15) I haven't been as sharp mentally because of my marijuana use.	23.0%	27.5%	32.7%	39.1%	42.4%	ES, NL > USA	No Differences (Men = 30.3% Women = 25.9%)

	United States (U.S.) (n = 697)	Argentina (AR) (n = 153)	Uruguay (UY) (n = 55)	Spain (ES) (n = 174)	Netherlands (NL) (n = 66)	Significant Mean Differences	Men vs Women Significant Differences
(16) I have received a lower grade on an exam or paper than I ordinarily would have because of marijuana use.	8.6%	2.6%	7.3%	8.0%	3.0%	No Differences	Men (11.6%) > Women (4.8%)
(17) I have tried to quit using marijuana because I thought I was using too much.	14.7%	19.0%	21.8%	23.6%	10.6%	ES > USA	Men (20.8%) > Women (14.0%)
(18) I have felt anxious, irritable, lost my appetite or had stomach pains after stopping or cutting down on marijuana use.	12.3%	11.1%	10.9%	11.5%	4.5%	No Differences	No Differences (Men = 13.5% Women = 10.0%)
(19) I often have thought about needing to cut down or to stop using marijuana.	24.7%	20.3%	30.9%	26.4%	21.2%	No Differences	Men (32.0%) > Women (20.0%)
(20) I have had less energy or felt tired because of my marijuana use.	30.6%	26.1%	36.4%	43.1%	40.9%	ES > USA, AR	No Differences (Men = 35.0% Women = 31.2%)
(21) I have lost motivation to do things because of my marijuana use.	17.2%	13.7%	16.4%	19.0%	21.2%	No Differences	No Differences (Men = 18.7% Women = 16.2%)

Note. Significant differences for MACQ total scores across countries were determined by an ANOVA with a Bonferroni correction and significant differences for items were determined by differences in proportions using a Z-test with a Bonferroni correction.

*
No Difference = the findings were inconclusive as to whether or not a statistical difference was present.

Table 3

Model fit and measurement invariance testing results of the MACQ across U.S. sites, countries, and sex

Measurement Invariance for a 20-item version (no Item 5) Across U.S., Argentina, Uruguay, and Spain

		Overall Fit Indices					Comparative Fit Indices			
	χ^2	df	CFI	TLI	RMSEA	Model Comparison	CFI	TLI	RMSEA
1. Configural	928.71	680	.966	.962	.037 (.031, .043)				
2. Scalar	1033.76	734	.959	.958	.039 (.033, .044)	1 vs 2	–.007	–.004	.002

Measurement Invariance for a 20-item version (no Item 5) Across U.S. (sites not pooled), Argentina, Uruguay, and Spain

		Overall Fit Indices					Comparative Fit Indices			
	χ^2	df	CFI	TLI	RMSEA	Model Comparison	CFI	TLI	RMSEA
1. Configural	1467.28	1190	.965	.961	.039 (.032, .045)				
2. Scalar	1639.80	1298	.957	.956	.041 (.035, .047)	1 vs 2	–.008	–.005	.002

Measurement Invariance for a 20-item version (no Item 5) Across Sex

		Overall Fit Indices					Comparative Fit Indices			
	χ^2	df	CFI	TLI	RMSEA	Model Comparison	CFI	TLI	RMSEA
1. Configural	717.82	340	.952	.947	.044 (.040, .049)				
2. Scalar	743.84	358	.951	.948	.044 (.039, .048)	1 vs 2	–.001	.001	.000

Measurement Invariance Across U.S. Sites for the 21-item version

		Overall Fit Indices					Comparative Fit Indices			
	χ^2	df	CFI	TLI	RMSEA	Model Comparison	CFI	TLI	RMSEA
1. Configural	1017.73	756	.956	.951	.045 (.037, .051)				
2. Scalar	1084.47	813	.954	.953	.044 (.037, .050)	1 vs 2	–.002	.002	–.001

Measurement Invariance Across Sex for the 21-item version

		Overall Fit Indices					Comparative Fit Indices			
	χ^2	df	CFI	TLI	RMSEA	Model Comparison	CFI	TLI	RMSEA
1. Configural	756.43	378	.950	.945	.042 (.038, .046)				
2. Scalar	782.12	397	.949	.947	.041 (.037, .046)	1 vs 2	–.001	.002	–.001

Note. We relied on the model comparison criteria of RMSEA .015 (increase indicates worse fit; Chen, 2007) and CFI/ TFI .01 (decrease indicates worse fit; Cheung & Rensvold, 2002) to test for measurement invariance.

Table 4

Correlations between the latent 20-item MACQ factor and composite scores of marijuana use variables across sex and countries

| | Negative Consequences | | | | | | Correlation Differences Across Sex and Countries | | | | | | |
	U.S.	AR	UY	ES	Men	Women	Men - Women	U.S.-AR	U.S.-UY	U.S.-ES	AR-UY	AR-ES	UY-ES
Marijuana Use Indicators													
Use Frequency Last 30 Days	.41	.41	.64	.59	.51	.37	.14	.00	.23	.18	.23	.18	.05
Age of First Use*	-.12	-.24	-.17	---	-.18	-.13	.05	.12	.05	---	.07	---	---
Typical Quant.	.26	.31	.42	.30	.28	.26	.02	.05	.16	.04	.11	.01	.12
Typical Freq.	.36	.45	.61	.61	.44	.35	.09	.09	**.25**	**.25**	.16	.16	.00
Typical Subjective Intox.	.13	.38	.51	.41	.15	.22	.07	**.25**	**.38**	**.28**	.13	.03	.10
Length of Typical Intox. (hours)	.01	.26	.26	.49	.14	.17	.03	**.25**	**.25**	**.48**	.00	.23	.23
Marijuana Use Norms													
Descript. Norms Typ. Quant.	.09	.24	.43	.20	.04	.19	.15	.15	**.34**	.11	.19	.04	.23
Descript. Norms Typ. Freq.	.19	.32	.49	.39	.21	.23	.02	.13	.30	.20	.17	.07	.10
Inj. Norms Typ. Quant.	.12	.22	.33	.13	.06	.17	.11	.10	.21	.01	.11	.09	.20
Inj. Norms Typ. Freq.	.19	.28	.35	.14	.20	.17	.03	.09	.16	.05	.07	.14	.21
Injunctive Norms of Others													
Inj. Norms – Best Friend	.06	.26	.28	.20	.10	.09	.01	.20	**.22**	.14	.02	.06	.08
Inj. Norms – College Student	-.11	.03	-.16	-.03	-.06	-.09	.03	.14	.05	.08	.19	.06	.13
Inj. Norms – Parents	-.04	.09	.09	.09	-.08	.00	.08	.13	.13	.13	.00	.00	.00

Note. U.S. =United States (*n* = 697); AR=Argentina (*n* = 153), UY = Uruguay (*n* = 55), ES=Spain (*n* = 174), M = Men (*n* = 403), W = Women (*n* = 699). All correlations were conducted with the 20-item version (item 5 omitted) of the MACQ. In comparison across countries, medium correlation differences are *italicized* (.14 < *r*diff < .24), large differences are **bolded** (.24 ≤ *r*diff < .34), and substantial difference are **bolded and underlined** (*r*diff ≥ .34).