



## Research article

## Altitude and latitude variations in trait-impulsivity, depression, anxiety, suicidal risk, and negative alcohol-related consequences in Argentinean adolescents

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## ABSTRACT

The aims of this research were threefold: 1) to analyze mental health state both general (GMHS, i.e., self-perceived health and psychological distress) and specific (SMHS; i.e., depression, trait-anxiety, negative alcohol-related consequences, and suicidal risk), and impulsivity-related traits (i.e., negative urgency, positive urgency, [lack of] perseverance, [lack of] premeditation, and sensation seeking) in a sample of Argentinean adolescent college students, in function of sex (women, men) and three different altitude-latitude regions (high-north, middle-center, low-south), for identifying common and specific features; 2) to analyze relationships between impulsivity-related traits and indicators of GMHS and SMHS, in the entire sample and in each altitude-latitude region, for understanding the importance of impulsivity-related traits in these forms of mental disorders; and 3) to analyze bivariate relationships between depression, trait-anxiety, negative alcohol-related consequences, and suicidal risk, in the entire sample and considering the three altitude-latitude regions, for testing two-disorder comorbidities. Scores on impulsivity-related traits differed by sex and by altitude-latitude region. GMHS and SMHS differed by sex but not by altitude-latitude region. Several relationships were found between impulsivity-related traits, GMHS, and SMHS as well as between indicators of SMHS. Some of these relationships were dependent on altitude-latitude regions, and implications of these findings were discussed.

## 1. Introduction

Impulsivity is a multidimensional construct, involving various personality traits, which include negative urgency, (lack of) premeditation, (lack of) perseverance, sensation-seeking (Whiteside and Lynam, 2001), and positive urgency (Cyders et al., 2007). In adolescents, some impulsivity-related traits have been found as linked to externalizing behaviors, e.g., substance abuse, antisocial behavior, and aggression (Carlson et al., 2012; Maneiro et al., 2017; Stautz and Cooper, 2013), alcohol use (Coskunpinar et al., 2013; Stautz and Cooper, 2013), and suicidal risk, alongside depressive (d'Acremont and Van der Linden, 2007; Klonsky & May, 2010; Saddichha and Schuetz, 2014) and anxiety disorders (Moustafa et al., 2017). However, pathogenetic hypotheses that link impulsivity, aggression, substance abuse, and suicidal behavior are

difficult to disentangle (Costanza et al., 2020), and studies differ on what traits of impulsivity are significantly related to such behaviors and disorders. This is comprehensible since impulsivity is a psychological construct, which appear, in one form or another, in every major system of personality and plays a main role in the understanding and diagnosis of several forms of mental disorders (Whiteside and Lynam, 2001).

Adolescence is the phase of life that extends between childhood and adulthood. According to updated viewpoints, a definition of 10–24 years corresponds more closely to adolescent growth (Sawyer et al., 2018), rather than 10–19 years, as previously defined (Sawyer et al., 2012). Relative to other phases of the lifespan, adolescence is a high vulnerability period for developing mental disorders due to the changes and transitions that take place. The maturation of neuronal systems underpinning emotional processes is one of the relevant neurobiological

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components of the transition that occurs during adolescence (Chambers et al., 2014; Luciana, 2013; Paus et al., 2008). Particularly, there are different schedules between the full maturation of impulse control neuronal circuitry and the affective system promoting reward-seeking and risk-taking (Steinberg, 2010); consequently, adolescents may be limited, relative to adults, in their abilities to inhibit impulsive behaviors (Geier and Luna, 2009). These normal adolescent increases in risk-taking may contribute to an increased susceptibility to developing mental disorders, such as alcohol use disorders (Dougherty et al., 2015). Mental disorders, such as depression, anxiety, drinking behaviors, suicidal behaviors (SB), and their comorbidities are prevalent during adolescence and early adulthood (e.g., Costello et al., 2011; Dyer et al., 2019; Gomes et al., 2019; Gustavson et al., 2018). Notwithstanding, adolescence is also the period in which everyone establishes social, cultural, emotional, educational, and economic resources for maintaining their health and well-being throughout life (Engström, 2008).

When studying mental disorders and impulsivity, sex differences must be considered. Sex differences in mental disorders are reported globally (Seedat et al., 2009), including within Argentina (Cía et al., 2018), although now they appear to be more narrow than formerly believed. As for impulsivity, it has been postulated that males show higher levels than females (Waldeck and Miller, 1997). However, it was also found that although males tend to report higher levels of sensation-seeking and positive urgency, the relationships between the impulsivity-related traits – as determined by the UPPS-P Impulsive Behavior Scale, which measures risk taking and impulsive behavior (Whiteside and Lynam, 2001) – and the risk outcomes are generally invariant across sex (Cyders, 2013).

Several studies have highlighted that increasing altitude of residence raises the risk or worsens the symptoms of mental disorders, such as SB (e.g., Brenner et al., 2011; Ha and Tu, 2018; Reno et al., 2018), depression, bipolar disorders, anxiety disorders (e.g., Huber et al., 2018; Hwang et al., 2019; Kious et al., 2019; Roth et al., 2002), behavioral and cognitive disturbances (e.g., Bahrke and Shukitt-Hale, 1993), among others. In Argentina, there has been some evidence supporting such a relationship between altitude and suicide (López Steinmetz et al., unpublished). Besides altitude, people living in extreme latitudes have reported more negative effects on mental health. Regions closer to Arctic and Antarctic latitudes typically have greater inter-seasonal sunlight variations than regions farther to the Poles. Light of enough intensity and suitable spectral composition is the main factor maintaining the 24-hour period of human circadian rhythms (Arendt, 2012) and their alteration is related to mental disturbances, e.g., depression (Zaki et al., 2018).

In Argentina, research on adolescent mental health in non-clinical populations are scarce and typically based on samples from the largest cities (i.e., Buenos Aires and Córdoba). Concerning impulsivity, it has been broadly studied in the Argentinean population, but, predominantly, in its relationship to alcohol drinking behaviors (Pilatti et al., 2017; Vera et al., 2018) and not in its relationship to other mental disorders. Moreover, studies analyzing altitude and latitude effects and/or differences on adolescent mental health are almost non-existent worldwide.

In this context, the aim of this research were threefold: 1) to analyze mental health state both general (i.e., in terms of self-perceived health and psychological distress) and specific (i.e., in terms of depression, trait-anxiety, negative alcohol-related consequences, and suicidal risk), and impulsivity-related traits (i.e., negative urgency, positive urgency, [lack of] perseverance, [lack of] premeditation, and sensation seeking) in a sample of Argentinean adolescent college students, while examining sex and three different altitude-latitude regions, in order to identify common and specific features; 2) to analyze relationships between impulsivity-related traits and indicators of mental health state both general and specific, in the entire sample and in each of three different altitude-latitude regions, in order to weigh the importance of impulsivity-related traits in these forms of mental disorders; and 3) to analyze bivariate relationships between depression, trait-anxiety, negative alcohol-related consequences, and suicidal risk, in the entire sample and

considering the three different altitude-latitude regions, in order to test two-disorder comorbidities.

## 2. Method

### 2.1. Sample and procedure

A convenience sampling was used. Data collection was carried out during October and November 2019 (Spring). The sample was composed of 448 adolescent college students (73% women, 27% men), ages between 18 and 24 (mean = 21.75, sd ± 1.82, median = 22), and residing in one of three Argentinean provinces, i.e., Jujuy (56.03%), Córdoba (37.72%), and Tierra del Fuego (6.25%), which are located in the north westernmost, in the center and in the south end of this country, and are characterized by being located at high (average: 1259 meters above sea level [masl]), middle (average: 409 masl), and low (average: 58 masl) geographical altitude regions, respectively. From hereon, we will name them as *high-north*, *middle-center*, and *low-south*, respectively. Data collection was carried out online, using Lime Survey software (UNC license). Prior to participation, informed consent was asked to each subject. This research was conducted in accordance with the Helsinki Declaration as revised 1989 and was approved by the Ethics Committee of the Institute of Psychological Research (IIPsi-UNC-CONICET).

### 2.2. Measures

#### 2.2.1. General Mental Health State (GMHS)

**2.2.1.1. General Health Questionnaire (GHQ-12).** The GHQ-12 (Goldberg et al., 1997; Goldberg and Williams, 1991) is a 12-item measure, which evaluates the general dimension of self-perceived health. The higher the score, the worse it is the self-perceived health. The total score of self-perceived health, as it is measured by the Argentinean validation of the GQH-12 (Burrone et al., 2015), was analyzed.

**2.2.1.2. Kessler Psychological Distress Scale (K-10).** The K-10 (Kessler and Mroczek, 1994) is a 10-item global dimensional measure of non-specific psychological distress, which evaluates symptoms related to depression and anxiety, indicating the risk to suffer psychological distress but does not specify the disorder. The Argentinean validation of the K-10 was used (Brenlla and Aranguren, 2010).

#### 2.2.2. Specific Mental Health State (SMHS)

**2.2.2.1. Beck Depression Inventory (BDI-II).** The BDI-II (Beck et al., 1996) is a 21-item instrument measuring depression and its severity. Its items do not correspond to a particular theory on depression; instead, they describe the most frequent clinical symptoms of depressed subjects. The Argentinean version of the BDI-II was used (Brenlla and Rodríguez, 2006). In non-clinical populations, scores above 20 indicate clinical depression (Kendall et al., 1987).

**2.2.2.2. State-Trait Anxiety Inventory (STAI).** The STAI (Spielberger et al., 1983) is a 40-item measure to obtain reliable and fast information on anxiety-related symptoms, such as restlessness, nervousness, and agitation. We used the 20-items subscale for trait-anxiety, in its Argentinean validation (Leibovich de Figueroa, 1991). Higher scores indicate more anxiety-related symptoms, but there are no cutoff scores for the STAI.

**2.2.2.3. Brief Young Adult Alcohol Consequences Questionnaire (B-YAACQ).** The B-YAACQ (Kahler et al., 2005), is a 24-item measure on negative alcohol-related consequences over the past year among college students. The Argentinean version of the B-YAACQ was used (Pilatti et al., 2014). There are no cutoff scores for the Argentinean population.

Summed scores provide an indication of the severity of alcohol-related consequences. Higher total scores on the B-YAACQ correspond with more severe experiences of consequences overall, as the B-YAACQ was designed to be a unidimensional representation of negative alcohol-related consequences (Kahler et al., 2005). However, cutoff scores reported in other populations may be used as a reference: cutoff scores of 8 in men and 10 in women differentiate those at low risk from those at moderate risk, while a cutoff of 16 differentiates between moderate and high risk (Read et al., 2016).

**2.2.2.4. Inventory of Suicide Orientation (ISO-30).** The ISO-30 (King and Kowalchuk, 1994) is a 30-item evaluation tool, which helps identifying suicidal risk in adolescents. The Argentinean validation of the ISO-30 was used (Fernández Liporace and Casullo, 2006). Raw scores  $\leq 30$  indicate low risk, raw scores between 30-44 indicate moderate risk, and raw scores  $\geq 45$  indicate high risk (King and Kowalchuk, 1994).

### 2.2.3. Trait-impulsivity

**2.2.3.1. Short Spanish version of the UPPS-P Impulsive Behavior Scale (UPPS-P).** The short Spanish version of the UPPS-P (Whiteside and Lynam, 2001) is a 20-item measure composed of five subscales (4 items each): Negative Urgency, (lack of) Premeditation, (lack of) Perseverance, Sensation Seeking (Whiteside and Lynam, 2001), and Positive Urgency (Cyders et al., 2007). Each of these subscales measures personality features leading to impulsive behavior. The Argentinean psychometric validation (Pilatti et al., 2015) of the Spanish version of the short UPPS-P (Verdejo García et al., 2010) was used.

### 2.3. Data analysis

For data analysis, R Studio version 3.5.3 (R Core Team, 2019) was used. Skewness and kurtosis were calculated in all indicators of GMHS, SMHS, and impulsivity-related traits. Since these scores were in the range of acceptable values or near to (-3 and +3; Brown, 2006), parametric tests were applied. For scores on impulsivity-related traits, GMHS, and SMHS, sex differences (i.e., in biological terms: women-men) were analyzed with T Student test (t; alternative hypothesis: two-tailed), while differences by altitude-latitude regions were analyzed with one-way between-group ANOVA. When a significant difference was found with ANOVA, Tukey's post hoc test was calculated.

Pearson's correlation coefficient (r; alternative hypothesis: two-tailed) was used to analyze bivariate relationships between: a) impulsivity-related traits and indicators of GMHS and SMHS, and b) depression, trait-anxiety, negative alcohol-related consequences, and suicidal risk. Both a) and b) were analyzed in the entire sample and in each group by altitude-latitude regions (high-north, middle-center, and low-south). When statistically significant correlations were found, coefficient of determination ( $r^2$ ) was informed. When interpreting Pearson's correlation coefficient as a measure of effect size (Field et al., 2012), we adopted the Cohen's effect size conventions:  $r = 0.10$  (small effect),  $r = 0.30$  (medium effect), and  $r = 0.50$  (large effect).

In addition, we ran multiple linear regressions for each SMHS indicator considering the entire sample, in order to find out how impulsivity might predict each of these mental health outcomes. For this purpose, we created an initial model for each SMHS indicator including all the impulsivity-related traits as predictors (i.e., negative urgency, positive urgency, [lack of] premeditation, [lack of] perseverance, and sensation seeking). We performed a stepwise selection (direction: both) for each initial model by using the *stepAIC* function from the *MASS* package. This function performs stepwise selection by using exact Akaike's Information Criteria (AIC) to compare fitted models, where the smaller the AIC indicates a better fit. For each SMHS indicator, we tried only additive models. For the models best fitting, we reported the coefficient of determination ( $r^2$ ), and the adjusted R-squared (adj  $r^2$ ). Likewise, we

computed effect sizes (ES) measures by using the *effectsize::cohens f* function from the *sjstats* package. We adopted the Cohen's effect size conventions, for multiple regression:  $f = 0.02$  (small effect),  $f = 0.15$  (medium effect), and  $f = 0.35$  (large effect).

In all analyses, statistical significance level was set at  $\leq 0.05$  and exact p-values were informed (except for p-values under 0.001, when the legend  $p < 0.001$  was informed). Likewise, 95% confidence interval (CI) was informed when corresponded.

## 3. Results

### 3.1. Analyses of differences on trait-impulsivity, GMHS, and SMHS by sex and by altitude-latitude regions

In impulsivity-related traits, women scored significantly higher than men in negative urgency ( $T = 3.12$ ,  $p = 0.002$ , CI [0.36, 1.58], mean: women = 9.84, men = 8.88) and in (lack of) premeditation ( $T = 4.93$ ,  $p < 0.001$ , CI [0.72, 1.68], mean: women = 7.82, men = 6.62), while the opposite was found in sensation seeking ( $T = -3.84$ ,  $p < 0.001$ , CI [-1.89, -0.61], mean: women = 9.22, men = 10.47). No differences were found between the sexes in the remaining impulsivity-related traits, i.e., positive urgency ( $T = -1.39$ ,  $p = 0.16$ , CI [-0.98, 0.17], mean: women = 6.97, men = 7.38) and (lack of) perseverance ( $T = -0.02$ ,  $p = 0.98$ , CI [-0.50, 0.49], mean: women = 7.90, men = 7.90). Furthermore, women scored significantly higher than men in both GMHS indicators, self-perceived health ( $T = 3.59$ ,  $p < 0.001$ , CI [0.57, 1.97], mean: women = 6.04, men = 4.77) and psychological distress ( $T = 4.20$ ,  $p < 0.001$ , CI [1.93, 5.34], mean: women = 28.26, men = 24.62), as well as in almost all the SMHS indicators, i.e., depression ( $T = 4.63$ ,  $p < 0.001$ , CI [2.97, 7.37], mean: women = 21.54, men = 16.37), trait-anxiety ( $T = 4.11$ ,  $p < 0.001$ , CI [2.59, 7.36], mean: women = 31.46, men = 26.48), and suicidal risk ( $T = 2.54$ ,  $p = 0.01$ , CI [1.00, 7.92], mean: women = 36.24, men = 31.79); as an exception, women and men did not significantly differ in negative alcohol-related consequences ( $T = 1.07$ ,  $p = 0.29$ , CI [-0.40, 1.35], mean: women = 4.13, men = 3.66).

Statistically significant differences were found according to altitude-latitude regions in two of the five impulsivity-related traits: positive urgency ( $F_{(2)} = 7.36$ ,  $p < 0.001$ ) and sensation seeking ( $F_{(2)} = 11.04$ ,  $p < 0.001$ ). For positive urgency, these differences were found between high-north and middle-center (Diff = 0.94, CI [0.34, 1.55],  $p < 0.001$ ), but not between low-south and middle-center ( $p = 0.99$ ), nor between low-south and high-north ( $p = 0.15$ ). Mean scores of positive urgency were 7.50 in high-north, 6.56 in middle-center, and 6.54 in low-south. For sensation seeking, significant differences were found between high-north and middle-center (Diff = 1.29, CI [0.59, 1.99],  $p < 0.001$ ), as well as between low-south and high-north (Diff = -1.54, CI [-2.93, -0.14],  $p < 0.03$ ), but not between low-south and middle-center ( $p = 0.91$ ). Mean scores of sensation seeking were 10.14 in high-north, 8.85 in middle-center, and 8.61 in low-south. Conversely, no significant differences were found by altitude-latitude regions in the impulsivity-related traits: negative urgency ( $F_{(2)} = 1.36$ ,  $p = 0.26$ , mean: high-north = 9.60, middle-center = 9.70, low-south = 8.71), (lack of) perseverance ( $F_{(2)} = 1.38$ ,  $p = 0.25$ , mean: high-north = 7.74, middle-center = 8.07, low-south = 8.25), and (lack of) premeditation ( $F_{(2)} = 0.13$ ,  $p = 0.88$ , mean: high-north = 7.55, middle-center = 7.43, low-south = 7.46). Likewise, no significant differences by altitude-latitude regions were found in the GMHS indicators self-perceived health ( $F_{(2)} = 0.94$ ,  $p = 0.39$ , mean: high-north = 5.51, middle-center = 5.91, low-south = 6.14) and psychological distress ( $F_{(2)} = 1.88$ ,  $p = 0.15$ , mean: high-north = 26.66, middle-center = 28.25, low-south = 26.86), nor in the SMHS indicators, depression ( $F_{(2)} = 0.79$ ,  $p = 0.46$ , mean: high-north = 19.55, middle-center = 20.95, low-south = 20.71), trait-anxiety ( $F_{(2)} = 0.99$ ,  $p = 0.37$ , mean: high-north = 29.49, middle-center = 31.08, low-south = 29.89), negative alcohol-related consequences ( $F_{(2)} = 0.06$ ,  $p = 0.94$ , mean: high-north = 3.95, middle-center = 4.09, low-south = 3.96), and

suicidal risk ( $F_{(2)} = 1.01, p = 0.37$ , mean: high-north = 34.46, middle-center = 36.33, low-south = 32.46).

**3.2. Correlations between trait-impulsivity and indicators of GMHS and SMHS**

For the entire sample, results of bivariate correlations between impulsivity-related traits and all GMHS and SMHS indicators are shown in Table 1. These same analyzes, but carried out for each altitude-latitude region, i.e., high-north, middle-center, and low-south are shown in Tables 2, 3, and 4, respectively.

For regression analyses, the initial model for each SMHS indicator included the predictors: negative urgency, positive urgency, (lack of) premeditation, (lack of) perseverance, and sensation seeking. The minimum suitable model best fitting the data was the same as the model from the start, i.e., included all these predictors, for the SMHS indicators: depression ( $F_{(5 \text{ and } 442)} = 42.97, p\text{-value} < 0.001$ , Residuals: -23.69 to 28.14; AIC = 2021.07), anxiety ( $F_{(5 \text{ and } 442)} = 52.72, p\text{-value} < 0.001$ , Residuals: -24.95 to 27.44; AIC = 1982.43), and suicidal risk ( $F_{(5 \text{ and } 442)} = 46.60, p\text{-value} < 0.001$ , Residuals: -32.74 to 45.15; AIC = 2335.10; Table 5). This model explained 32.71% of variance in participants' depression according to  $r^2$  (31.95% according to adjusted  $r^2$ ), with a RSE of 9.48. For anxiety, the model explained 37.36% of variance according to  $r^2$  (36.65% according to adjusted  $r^2$ ), with a RSE of 9.08. For suicidal risk, the model explained 34.52% of variance according to  $r^2$  (33.78% according to adjusted  $r^2$ ), with a RSE of 13.46. For depression, for anxiety, and for suicidal risk, the largest effect size corresponded to the predictor negative urgency (Table 6).

For negative alcohol-related consequences, the best fitting model included the predictors negative urgency, positive urgency, and (lack of) premeditation ( $F_{(3 \text{ and } 444)} = 17.85, p\text{-value} < 0.001$ , Residuals: -6.96 to 13.24; AIC = 1251.04; Table 5). This model explained 10.76% of variance in participants' negative alcohol-related consequences according to  $r^2$  (10.16% according to adjusted  $r^2$ ), with a RSE of 4.02. The largest effect size for this SMHS indicator corresponded to negative urgency (Table 6).

**3.3. Bivariate correlations between depression, trait-anxiety, negative alcohol-related consequences, and suicidal risk**

Depression was positively and significantly correlated with trait-anxiety ( $r = 0.82, p < 0.001, CI [0.79, 0.85], r^2 = 0.67$ ), negative alcohol-related consequences ( $r = 0.28, p < 0.001, CI [0.19, 0.36], r^2 = 0.08$ ), and suicidal risk ( $r = 0.80, p < 0.001, CI [0.76, 0.83], r^2 = 0.64$ ). Likewise, trait-anxiety was positively correlated with negative alcohol-related consequences ( $r = 0.21, p < 0.001, CI [0.12, 0.29], r^2 = 0.04$ ) and suicidal risk ( $r = 0.81, p < 0.001, CI [0.77, 0.84], r^2 = 0.65$ ). By last, negative alcohol-related consequences and suicidal risk were positively and significantly correlated ( $r = 0.20, p < 0.001, CI [0.11, 0.28], r^2 = 0.04$ ). The same analyses were carried out for each of the three altitude-latitude regions and are shown in Table 7. Figure 1 shows the case distributions corresponding to the main bivariate relationships found in the entire sample and in each of the three altitude-latitude regions.

**4. Discussion**

The first aim of this research was to analyze GMHS, SMHS, and impulsivity-related traits in adolescent college students, in the function of sex and three different altitude-latitude regions, in order to identify common and specific features. The relationships between impulsivity-related traits and risk outcomes have been proposed as generally invariant across sex in the literature (Cyders, 2013; Argyriou et al., 2019). In this regard, we have found no sex differences in two of five impulsivity-related traits: positive urgency and (lack of) perseverance. There is evidence indicating that men tend to score higher than women in sensation seeking (Costa et al., 2001; D'Acremont and Van der Linden,

**Table 1.** Bivariate correlations between scores of impulsivity-related traits and scores of mental health state factors (N = 448).

Mental health state factors	Impulsivity-related traits <sup>a</sup>				
	Negative urgency	Positive urgency	(Lack of) perseverance	(Lack of) premeditation	Sensation seeking
Self-perceived health <sup>b</sup>	$r = 0.38, p < 0.001$ [CI: 0.30, 0.46]. $r^2 = 0.14$	$r = 0.17, p < 0.001$ [CI: 0.08, 0.26]. $r^2 = 0.03$	$r = 0.11, p = 0.02$ [CI: 0.01, 0.20]. $r^2 = 0.01$	$r = 0.26, p < 0.001$ [CI: 0.17, 0.34]. $r^2 = 0.07$	$r = -0.03, p = 0.48$ [CI: -0.13, 0.06]
Psychological distress <sup>c</sup>	$r = 0.52, p < 0.001$ [CI: 0.45, 0.58]. $r^2 = 0.27$	$r = 0.26, p < 0.001$ [CI: 0.17, 0.34]. $r^2 = 0.07$	$r = 0.10, p = 0.04$ [CI: 0.007, 0.19]. $r^2 = 0.01$	$r = 0.29, p < 0.001$ [CI: 0.20, 0.37]. $r^2 = 0.08$	$r = -0.02, p = 0.6$ [CI: -0.12, 0.07]
Depression <sup>d</sup>	$r = 0.52, p < 0.001$ [CI: 0.45, 0.59]. $r^2 = 0.27$	$r = 0.25, p < 0.001$ [CI: 0.16, 0.34]. $r^2 = 0.06$	$r = 0.15, p = 0.001$ [CI: 0.06, 0.24]. $r^2 = 0.02$	$r = 0.31, p < 0.001$ [CI: 0.23, 0.39]. $r^2 = 0.10$	$r = -0.01, p = 0.77$ [CI: -0.11, 0.08]
Trait-anxiety <sup>e</sup>	$r = 0.56, p < 0.001$ [CI: 0.49, 0.62]. $r^2 = 0.31$	$r = 0.24, p < 0.001$ [CI: 0.15, 0.33]. $r^2 = 0.06$	$r = 0.14, p = 0.003$ [CI: 0.05, 0.23]. $r^2 = 0.02$	$r = 0.29, p < 0.001$ [CI: 0.21, 0.38]. $r^2 = 0.09$	$r = -0.09, p = 0.06$ [CI: -0.18, 0.005]
Negative alcohol-related consequences <sup>f</sup>	$r = 0.28, p < 0.001$ [CI: 0.20, 0.37]. $r^2 = 0.08$	$r = 0.23, p < 0.001$ [CI: 0.14, 0.31]. $r^2 = 0.05$	$r = 0.06, p = 0.20$ [CI: -0.03, 0.15]. $r^2 = 0.004$	$r = 0.19, p < 0.001$ [CI: 0.10, 0.28]. $r^2 = 0.04$	$r = 0.13, p = 0.006$ [CI: 0.04, 0.22]. $r^2 = 0.02$
Suicidal risk <sup>g</sup>	$r = 0.52, p < 0.001$ [CI: 0.45, 0.58]. $r^2 = 0.27$	$r = 0.28, p < 0.001$ [CI: 0.19, 0.36]. $r^2 = 0.08$	$r = 0.18, p < 0.001$ [CI: 0.09, 0.27]. $r^2 = 0.03$	$r = 0.35, p < 0.001$ [CI: 0.27, 0.43]. $r^2 = 0.13$	$r = -0.001, p = 0.98$ [CI: -0.09, 0.09]

Notes: r = Pearson correlation coefficient; CI = 95% confidence interval;  $r^2$  = coefficient of determination.

<sup>a</sup> Impulsivity-related traits as measured by the Short Spanish version of the UPPS-P Impulsive Behavior Scale (Verdejo García et al., 2010; Whiteside and Lynam, 2001).

<sup>b</sup> Self-perceived health as measured by the General Health Questionnaire (Goldberg et al., 1997; Goldberg and Williams, 1991).

<sup>c</sup> Psychological distress as measured by the Kessler Psychological Distress Scale (Kessler and Mroczek, 1994).

<sup>d</sup> Depression as measured by the Beck Depression Inventory (Beck et al., 1996).

<sup>e</sup> Trait-anxiety as measured by the State-Trait Anxiety Inventory (Spielberger et al., 1983).

<sup>f</sup> Negative alcohol-related consequences as measured by the Brief Young Adult Alcohol Consequences Questionnaire (Kahler et al., 2005).

<sup>g</sup> Suicidal risk as measured by the Inventory of Suicide Orientation (King and Kowalchuk, 1994).



**Table 2.** Bivariate correlations between scores of impulsivity-related traits and scores of mental health state factors in a high-altitude and north westernmost region (n = 251).

Mental health state factors	Impulsivity-related traits <sup>a</sup>				
	Negative urgency	Positive urgency	(Lack of) perseverance	(Lack of) premeditation	Sensation seeking
Self-perceived health <sup>b</sup>	r = 0.38, p < 0.001 [CI: 0.27, 0.48]. r <sup>2</sup> = 0.14	r = 0.20, p = 0.001 [CI: 0.08, 0.32]. r <sup>2</sup> = 0.04	r = 0.08, p = 0.20 [CI: -0.04, 0.20].	r = 0.27, p < 0.001 [CI: 0.15, 0.38]. r <sup>2</sup> = 0.07	r = 0.03, p = 0.61 [CI: -0.09, 0.16].
Psychological distress <sup>c</sup>	r = 0.55, p < 0.001 [CI: 0.45, 0.63]. r <sup>2</sup> = 0.30	r = 0.28, p < 0.001 [CI: 0.17, 0.39]. r <sup>2</sup> = 0.08	r = 0.06, p = 0.36 [CI: -0.07, 0.18].	r = 0.29, p < 0.001 [CI: 0.18, 0.40]. r <sup>2</sup> = 0.09	r = 0.09, p = 0.15 [CI: -0.03, 0.21].
Depression <sup>d</sup>	r = 0.54, p < 0.001 [CI: 0.44, 0.62]. r <sup>2</sup> = 0.29	r = 0.29, p < 0.001 [CI: 0.17, 0.40]. r <sup>2</sup> = 0.08	r = 0.18, p = 0.004 [CI: 0.06, 0.30]. r <sup>2</sup> = 0.03	r = 0.31, p < 0.001 [CI: 0.19, 0.42]. r <sup>2</sup> = 0.31	r = 0.06, p = 0.32 [CI: -0.06, 0.19].
Trait-anxiety <sup>e</sup>	r = 0.56, p < 0.001 [CI: 0.47, 0.64]. r <sup>2</sup> = 0.31	r = 0.32, p < 0.001 [CI: 0.21, 0.43]. r <sup>2</sup> = 0.10	r = 0.12, p = 0.06 [CI: -0.01, 0.24].	r = 0.29, p < 0.001 [CI: 0.17, 0.40]. r <sup>2</sup> = 0.09	r = 0.01, p = 0.82 [CI: -0.11, 0.14].
Negative alcohol-related consequences <sup>f</sup>	r = 0.28, p < 0.001 [CI: 0.16, 0.39]. r <sup>2</sup> = 0.08	r = 0.22, p < 0.001 [CI: 0.10, 0.34]. r <sup>2</sup> = 0.05	r = 0.12, p = 0.07 [CI: -0.01, 0.24].	r = 0.27, p < 0.001 [CI: 0.15, 0.38]. r <sup>2</sup> = 0.07	r = 0.21, p < 0.001 [CI: 0.09, 0.33]. r <sup>2</sup> = 0.05
Suicidal risk <sup>g</sup>	r = 0.53, p < 0.001 [CI: 0.43, 0.61]. r <sup>2</sup> = 0.28	r = 0.31, p < 0.001 [CI: 0.19, 0.41]. r <sup>2</sup> = 0.09	r = 0.15, p = 0.02 [CI: 0.03, 0.27]. r <sup>2</sup> = 0.02	r = 0.35, p < 0.001 [CI: 0.24, 0.46]. r <sup>2</sup> = 0.12	r = 0.02, p = 0.75 [CI: -0.10, 0.14].

Notes: r = Pearson correlation coefficient; CI = 95% confidence interval; r<sup>2</sup> = coefficient of determination.

<sup>a</sup> Impulsivity-related traits as measured by the Short Spanish version of the UPPS-P Impulsive Behavior Scale (Verdejo García et al., 2010; Whiteside and Lynam, 2001).

<sup>b</sup> Self-perceived health as measured by the General Health Questionnaire (Goldberg et al., 1997; Goldberg and Williams, 1991).

<sup>c</sup> Psychological distress as measured by the Kessler Psychological Distress Scale (Kessler and Mrozeck, 1994).

<sup>d</sup> Depression as measured by the Beck Depression Inventory (Beck et al., 1996).

<sup>e</sup> Trait-anxiety as measured by the State-Trait Anxiety Inventory (Spielberger et al., 1983).

<sup>f</sup> Negative alcohol-related consequences as measured by the Brief Young Adult Alcohol Consequences Questionnaire (Kahler et al., 2005).

<sup>g</sup> Suicidal risk as measured by the Inventory of Suicide Orientation (King and Kowalchuk, 1994).

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**Table 3.** Bivariate correlations between scores of impulsivity-related traits and scores of mental health state factors in a middle-altitude and center region (n = 169).

Mental health state factors	Impulsivity-related traits <sup>a</sup>				
	Negative urgency	Positive urgency	(Lack of) perseverance	(Lack of) premeditation	Sensation seeking
Self-perceived health <sup>b</sup>	r = 0.36, p < 0.001 [CI: 0.22, 0.48]. r <sup>2</sup> = 0.13	r = 0.16, p = 0.03 [CI: 0.01, 0.31]. r <sup>2</sup> = 0.03	r = 0.12, p = 0.14 [CI: -0.04, 0.26]. r <sup>2</sup> = 0.01	r = 0.21, p = 0.005 [CI: 0.07, 0.35]. r <sup>2</sup> = 0.05	r = -0.09, p = 0.22 [CI: -0.24, 0.06].
Psychological distress <sup>c</sup>	r = 0.44, p < 0.001 [CI: 0.31, 0.56]. r <sup>2</sup> = 0.20	r = 0.28, p < 0.001 [CI: 0.14, 0.42]. r <sup>2</sup> = 0.08	r = 0.07, p = 0.34 [CI: -0.08, 0.22].	r = 0.26, p < 0.001 [CI: 0.11, 0.39]. r <sup>2</sup> = 0.07	r = -0.14, p = 0.06 [CI: -0.29, 0.006].
Depression <sup>d</sup>	r = 0.49, p < 0.001 [CI: 0.37, 0.60]. r <sup>2</sup> = 0.24	r = 0.24, p = 0.001 [CI: 0.10, 0.38]. r <sup>2</sup> = 0.06	r = 0.08, p = 0.33 [CI: -0.08, 0.22].	r = 0.29, p < 0.001 [CI: 0.15, 0.42]. r <sup>2</sup> = 0.09	r = -0.09, p = 0.26 [CI: -0.23, 0.07].
Trait-anxiety <sup>e</sup>	r = 0.56, p < 0.001 [CI: 0.44, 0.65]. r <sup>2</sup> = 0.31	r = 0.18, p = 0.02 [CI: 0.03, 0.32]. r <sup>2</sup> = 0.03	r = 0.10, p = 0.18 [CI: -0.05, 0.25].	r = 0.27, p < 0.001 [CI: 0.13, 0.41]. r <sup>2</sup> = 0.07	r = -0.19, p = 0.01 [CI: -0.33, -0.04]. r <sup>2</sup> = 0.04
Negative alcohol-related consequences <sup>f</sup>	r = 0.29, p < 0.001 [CI: 0.15, 0.42]. r <sup>2</sup> = 0.08	r = 0.23, p = 0.003 [CI: 0.08, 0.37]. r <sup>2</sup> = 0.05	r = 0.03, p = 0.67 [CI: -0.12, 0.18].	r = 0.13, p = 0.09 [CI: -0.02, 0.28].	r = -0.03, p = 0.67 [CI: -0.18, 0.12].
Suicidal risk <sup>g</sup>	r = 0.49, p < 0.001 [CI: 0.37, 0.60]. r <sup>2</sup> = 0.24	r = 0.28, p < 0.001 [CI: 0.13, 0.41]. r <sup>2</sup> = 0.08	r = 0.18, p = 0.02 [CI: 0.03, 0.32]. r <sup>2</sup> = 0.03	r = 0.33, p < 0.001 [CI: 0.19, 0.46]. r <sup>2</sup> = 0.11	r = -0.04, p = 0.57 [CI: -0.19, 0.11].

Notes: r = Pearson correlation coefficient; CI = 95% confidence interval; r<sup>2</sup> = coefficient of determination.

<sup>a</sup> Impulsivity-related traits as measured by the Short Spanish version of the UPPS-P Impulsive Behavior Scale (Verdejo García et al., 2010; Whiteside and Lynam, 2001).

<sup>b</sup> Self-perceived health as measured by the General Health Questionnaire (Goldberg et al., 1997; Goldberg and Williams, 1991).

<sup>c</sup> Psychological distress as measured by the Kessler Psychological Distress Scale (Kessler and Mrozeck, 1994).

<sup>d</sup> Depression as measured by the Beck Depression Inventory (Beck et al., 1996).

<sup>e</sup> Trait-anxiety as measured by the State-Trait Anxiety Inventory (Spielberger et al., 1983).

<sup>f</sup> Negative alcohol-related consequences as measured by the Brief Young Adult Alcohol Consequences Questionnaire (Kahler et al., 2005).

<sup>g</sup> Suicidal risk as measured by the Inventory of Suicide Orientation (King and Kowalchuk, 1994).

**Table 4.** Bivariate correlations between scores of impulsivity-related traits and scores of mental health state factors in a low-altitude and south end region (n = 28).

Mental health state factors	Impulsivity-related traits <sup>a</sup>			
	Negative urgency	Positive urgency	(Lack of) perseverance	(Lack of) premeditation
Self-perceived health <sup>b</sup>	r = 0.58, p = 0.001 [CI: 0.27, 0.79]. r <sup>2</sup> = 0.34	r = 0.21, p = 0.29 [CI: -0.18, 0.54]. r <sup>2</sup> = 0.04	r = 0.18, p = 0.37 [CI: -0.21, 0.52]. r <sup>2</sup> = 0.02	r = 0.46, p = 0.01 [CI: 0.10, 0.71]. r <sup>2</sup> = 0.21
Psychological distress <sup>c</sup>	r = 0.70, p < 0.001 [CI: 0.44, 0.85]. r <sup>2</sup> = 0.47	r = 0.23, p = 0.23 [CI: -0.15, 0.56]. r <sup>2</sup> = 0.01	r = 0.43, p = 0.02 [CI: 0.06, 0.69]. r <sup>2</sup> = 0.18	r = 0.44, p = 0.02 [CI: 0.08, 0.70]. r <sup>2</sup> = 0.19
Depression <sup>d</sup>	r = 0.63, p < 0.001 [CI: 0.34, 0.81]. r <sup>2</sup> = 0.40	r = 0.26, p = 0.19 [CI: -0.13, 0.58]. r <sup>2</sup> = 0.02	r = 0.32, p = 0.09 [CI: -0.06, 0.62]. r <sup>2</sup> = 0.25	r = 0.50, p = 0.006 [CI: 0.16, 0.74]. r <sup>2</sup> = 0.25
Trait-anxiety <sup>e</sup>	r = 0.57, p = 0.001 [CI: 0.25, 0.78]. r <sup>2</sup> = 0.33	r = 0.19, p = 0.32 [CI: -0.19, 0.53]. r <sup>2</sup> = 0.01	r = 0.39, p = 0.04 [CI: 0.02, 0.67]. r <sup>2</sup> = 0.15	r = 0.47, p = 0.01 [CI: 0.12, 0.72]. r <sup>2</sup> = 0.22
Negative alcohol-related consequences <sup>f</sup>	r = 0.26, p = 0.18 [CI: -0.12, 0.60]. r <sup>2</sup> = 0.08	r = 0.38, p = 0.05 [CI: 0.01, 0.66]. r <sup>2</sup> = 0.14	r = -0.25, p = 0.21 [CI: -0.57, 0.14]. r <sup>2</sup> = 0.05	r = -0.10, p = 0.61 [CI: -0.46, 0.28]. r <sup>2</sup> = 0.01
Suicidal risk <sup>g</sup>	r = 0.58, p = 0.001 [CI: 0.27, 0.79]. r <sup>2</sup> = 0.34	r = 0.26, p = 0.18 [CI: -0.13, 0.58]. r <sup>2</sup> = 0.08	r = 0.42, p = 0.03 [CI: 0.06, 0.69]. r <sup>2</sup> = 0.18	r = 0.57, p = 0.002 [CI: 0.24, 0.78]. r <sup>2</sup> = 0.32

Notes: r = Pearson correlation coefficient; CI = 95% confidence interval; r<sup>2</sup> = coefficient of determination.

- <sup>a</sup> Impulsivity-related traits as measured by the Short Spanish version of the UPPS-P Impulsive Behavior Scale (Verdejo García et al., 2010; Whiteside and Lynam, 2001).
- <sup>b</sup> Self-perceived health as measured by the General Health Questionnaire (Goldberg et al., 1997; Goldberg and Williams, 1991).
- <sup>c</sup> Psychological distress as measured by the Kessler Psychological Distress Scale (Kessler and Mroczek, 1994).
- <sup>d</sup> Depression as measured by the Beck Depression Inventory (Beck et al., 1996).
- <sup>e</sup> Trait-anxiety as measured by the State-Trait Anxiety Inventory (Spielberger et al., 1983).
- <sup>f</sup> Negative alcohol-related consequences as measured by the Brief Young Adult Alcohol Consequences Questionnaire (Kahler et al., 2005).
- <sup>g</sup> Suicidal risk as measured by the Inventory of Suicide Orientation (King and Kowalchuk, 1994).

2005) and our findings are in line with this assertion. Likewise, there is evidence suggesting that women score higher than men do in negative urgency (Costa et al., 2001; D'Acremont and Van der Linden, 2005). Our findings support that women score higher in negative urgency, and add evidence indicating that women score higher than men do in (lack of) premeditation, which to the best of our knowledge has not previously been described in the literature. All in all, results regarding whether or not sex differences exist in impulsivity-related traits are variable across studies (Cyders, 2013; D'Acremont and Van der Linden, 2005; Pompeia et al., 2018) and when such differences are reported they are, usually, a function of additional disorders, e.g., marijuana use (VanderVeen et al., 2016), sexual behaviors (Dir et al., 2014), among others.

There is a consensus asserting that anxiety and mood disorders are prevalent among women (Cía et al., 2018; Seedat et al., 2009; Van Droogenbroeck et al., 2018) and substance-related disorders are prevalent among men (Cía et al., 2018; Seedat et al., 2009). As for mental health status, our results showed that compared to men, women have worse self-perceived health and higher scores in psychological distress, depression, anxiety-trait, and suicidal risk. Strikingly, we have not found sex differences in negative alcohol-related consequences, which could be reflecting idiosyncratic features. These findings are somewhat surprising given the fact that other studies show sex differences in alcohol-related consequences (O'Brien et al., 2008; McCabe, 2002; Ray et al., 2012). However, most of the studies supporting such results have been conducted in developed countries. In this regard, it is important to bear in mind that we have previously discussed on dissimilar patterns existing in mental health-related problems between populations from developed and developing countries (López Steinmetz, 2015, 2017b; López Steinmetz et al., 2019). For instance, we have demonstrated that there are no sex differences in suicide attempters from the north westernmost of Argentina (López Steinmetz, 2017a).

To the best of our knowledge, adolescents' impulsivity-related traits and mental health by distinct altitude-latitude regions have not been analyzed until now. Relative to altitude-latitude regions, we have found differences in two of five impulsivity-related traits. Adolescents residing in the high-north region scored significantly higher in the tendency to act impulsively when experiencing positive affect (i.e., positive urgency) than those residing in the middle-center. Likewise, adolescents residing in the high-north region scored significantly higher in the tendency to seek new and exciting experiences and sensations (i.e., sensation seeking) than those residing in the middle-center and in the south-end. Conversely, the adolescents residing in these three altitude-latitude regions did not differ in the remaining impulsivity-related traits. Furthermore, the three adolescents' groups have similar mean scores in all GMHS and SMHS indicators, which reveals an opposite tendency relative to what the literature reports on mental health impairments depending on altitude (e.g., Bahrke and Shukitt-Hale, 1993; Brenner et al., 2011; Ha and Tu, 2018; Huber et al., 2018; Kious et al., 2019; Reno et al., 2018; Roth et al., 2002) or latitude (Zaki et al., 2018); however, none of previous studies have focused primarily on adolescents. Deepening these analyses could shed light on risk factors differences and similarities between distinct altitude-latitude regions, which could ultimately lead to more specific and effective treatment and prevention strategies or, alternatively, justify common treatment and prevention strategies along distinct regions, respectively. For instance, based on these current findings, strategies aimed at to prevent (or to treat) depression should be transversal in this country, since in the three regions analyzed mean scores were near to (high-north) or above (middle-center and south-end) 20, which in a non-clinical population indicates depression (Kendall et al., 1987).

The second aim of this research was to analyze relationships between impulsivity-related traits and indicators of GMHS and SMHS, both in the entire sample and in each of the three altitude-latitude regions, in order to weigh the importance of trait-impulsivity in these forms of mental disorders. In the entire sample, several positive bivariate relationships were found between all impulsivity-related traits with the indicators of

**Table 5.** Summary of the linear regression models better fitting<sup>a</sup> each specific mental health state (SMHS) indicator (N = 448).

SMHS indicator	Predictors	Estimate	Std. Error	t value	p-value <sup>b</sup>	95% CI	
						2.5%	97.5%
Depression	Intercept	-5.85	2.68	-2.19	0.03	-11.11	-0.60
	Negative urgency	1.87	0.17	10.71	<0.001	1.52	2.21
	Positive urgency	0.33	0.20	1.68	0.09	-0.06	0.72
	(Lack of) Perseverance	0.62	0.22	2.80	0.005	0.19	1.06
	(Lack of) Premeditation	0.57	0.22	2.53	0.01	0.13	1.01
	Sensation seeking	-0.36	0.16	-2.32	0.02	-0.67	-0.05
Anxiety	Intercept	6.67	2.56	2.60	0.01	1.63	11.71
	Negative urgency	2.06	0.17	12.37	<0.001	1.74	2.39
	Positive urgency	0.30	0.19	1.61	0.11	-0.07	0.68
	(Lack of) Perseverance	0.56	0.21	2.62	0.01	0.14	0.98
	(Lack of) Premeditation	0.45	0.22	2.10	0.04	0.03	0.88
	Sensation seeking	-0.66	0.15	-4.41	<0.001	-0.95	-0.37
Negative alcohol-related consequences	Intercept	-1.77	0.83	-2.13	0.03	-3.40	-0.14
	Negative urgency	0.28	0.07	3.87	<0.001	0.14	0.43
	Positive urgency	0.20	0.08	2.52	0.01	0.04	0.36
	(Lack of) Premeditation	0.22	0.08	2.58	0.01	0.05	0.38
Suicidal risk	Intercept	-5.57	3.80	-1.47	0.14	-13.04	1.89
	Negative urgency	2.53	0.25	10.21	<0.001	2.04	3.01
	Positive urgency	0.68	0.28	2.42	0.02	0.13	1.23
	(Lack of) Perseverance	1.01	0.32	3.20	0.001	0.39	1.63
	(Lack of) Premeditation	1.09	0.32	3.41	0.001	0.46	1.72
	Sensation seeking	-0.48	0.22	-2.17	0.03	-0.91	-0.04

Note: Std. Error = Standard error; 95% CI = 95% Confidence Interval.

<sup>a</sup> Best fitted model according to multiple linear regressions: stepwise selection (direction: both) by using exact Akaike's Information Criteria (AIC) to compare additive fitted models.

<sup>b</sup> Exact p-values are informed, except for p-values under 0.001, which are informed as < 0.001.

GMHS and SMHS, but the main ones – taking  $r^2$  values as criterion – were between the tendency to act impulsively when experiencing negative affect (i.e., negative urgency) with psychological distress, trait-anxiety, depression, and suicidal risk. All these relationships were also found when analyzing each distinct altitude-latitude region, although with small varying values of  $r^2$  (see Tables 2, 3, and 4). Furthermore, in adolescents residing in high-north, additional main relationships were found between the tendency to act without reflection on the

consequences of an action (i.e., [lack of] premeditation) with suicidal risk, and depression. Likewise, in adolescents residing in the south-end, the main relationships also included those between negative urgency and self-perceived health, as well as between (lack of) premeditation with suicidal risk, depression, and trait-anxiety. In the entire sample, bivariate relationships were found between negative alcohol-related consequences with almost all the impulsivity-related traits – except (lack) of perseverance –; however, the majority of these relationships had

**Table 6.** Summary of Cohen's effect size for models better fitting each specific mental health state (SMHS) indicator (N = 448).

SMHS indicator	Predictors	F	90% CI	
Depression	Negative urgency	0.64	0.55	0.72
	Positive urgency	0.04	0.00	0.12
	(Lack of) Perseverance	0.23	0.15	0.31
	(Lack of) Premeditation	0.12	0.04	0.20
	Sensation seeking	0.11	0.03	0.19
	Anxiety	Negative urgency	0.71	0.62
Positive urgency		0.009	0.00	0.07
(Lack of) Perseverance		0.21	0.14	0.29
(Lack of) Premeditation		0.09	0.00	0.17
Sensation seeking		0.21	0.13	0.29
Negative alcohol-related consequences		Negative urgency	0.30	0.22
	Positive urgency	0.13	0.05	0.20
	(Lack of) Premeditation	0.12	0.04	0.20
Suicidal risk	Negative urgency	0.64	0.56	0.73
	Positive urgency	0.08	0.00	0.16
	(Lack of) Perseverance	0.27	0.19	0.35
	(Lack of) Premeditation	0.16	0.08	0.24
	Sensation seeking	0.10	0.02	0.18

Note: f = Cohen's f (partial); 90% CI = 90% Confidence Interval.

**Table 7.** Bivariate correlations between depression<sup>a</sup>, trait-anxiety<sup>b</sup>, negative alcohol-related consequences<sup>c</sup>, and suicidal risk<sup>d</sup> in each of the three altitude-latitude regions.

Mental health state factors	High-north (n = 251)			
	r	p-value	CI	r <sup>2</sup>
Depression and Trait-anxiety	0.81	<0.001	0.76, 0.85	0.66
Depression and Negative alcohol-related consequences	0.38	<0.001	0.27, 0.48	0.15
Depression and Suicidal risk	0.81	<0.001	0.76, 0.85	0.65
Trait-anxiety and Negative alcohol-related consequences	0.30	<0.001	0.19, 0.41	0.09
Trait-anxiety and Suicidal risk	0.80	<0.001	0.75, 0.84	0.64
Negative alcohol-related consequences and Suicidal risk	0.32	<0.001	0.20, 0.42	0.10
Mental health state factors	Middle-center (n = 169)			
	r	p-value	CI	r <sup>2</sup>
Depression and Trait-anxiety	0.81	<0.001	0.75, 0.86	0.66
Depression and Negative alcohol-related consequences	0.15	0.05	0.002, 0.30	0.02
Depression and Suicidal risk	0.78	<0.001	0.71, 0.83	0.60
Trait-anxiety and Negative alcohol-related consequences	0.11	0.15	-0.04, 0.26	-
Trait-anxiety and Suicidal risk	0.82	<0.001	0.77, 0.87	0.68
Negative alcohol-related consequences and Suicidal risk	0.03	0.70	-0.12, 0.18	-
Mental health state factors	Low-south (n = 28)			
	r	p-value	CI	r <sup>2</sup>
Depression and Trait-anxiety	0.92	<0.001	0.82, 0.96	0.84
Depression and Negative alcohol-related consequences	0.13	0.51	-0.26, 0.48	-
Depression and Suicidal risk	0.88	<0.001	0.75, 0.94	0.77
Trait-anxiety and Negative alcohol-related consequences	-0.03	0.88	-0.40, 0.35	-
Trait-anxiety and Suicidal risk	0.78	<0.001	0.57, 0.89	0.61
Negative alcohol-related consequences and Suicidal risk	0.10	0.46	-0.28, 0.46	-

Notes: r = Pearson correlation coefficient; CI = 95% confidence interval; r<sup>2</sup> = coefficient of determination.

<sup>a</sup> Depression as measured by the Beck Depression Inventory (Beck et al., 1996).

<sup>b</sup> Trait-anxiety as measured by the State-Trait Anxiety Inventory (Spielberger et al., 1983).

<sup>c</sup> Negative alcohol-related consequences as measured by the Brief Young Adult Alcohol Consequences Questionnaire (Kahler et al., 2005).

<sup>d</sup> Suicidal risk as measured by the Inventory of Suicide Orientation (King and Kowalchuk, 1994).

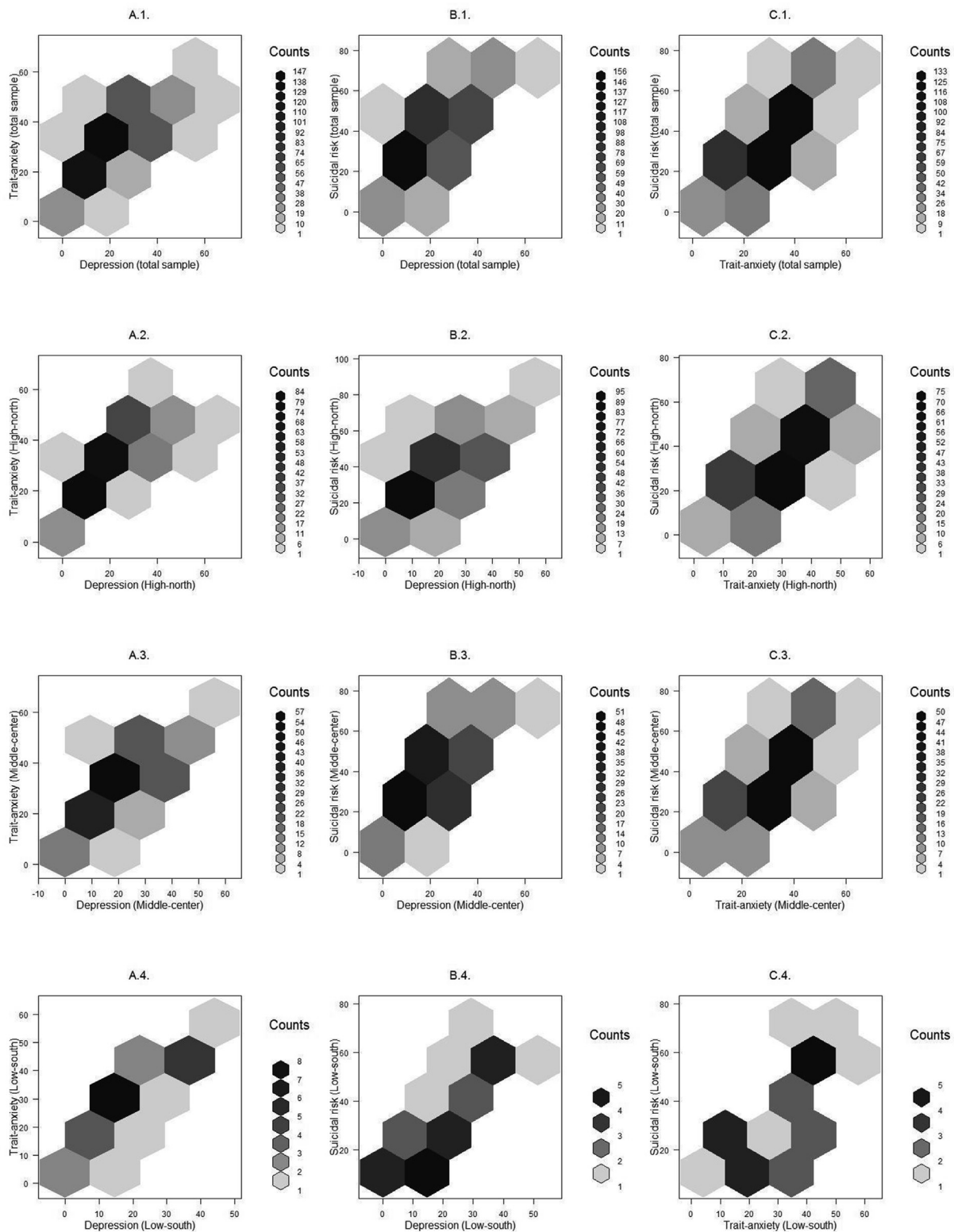
small effect sizes and were smaller than those reported in the literature (Coskunpinar et al., 2013). In the entire sample, in the high-north region, and in the middle-center region, the main bivariate relationship for negative alcohol-related consequences was with negative urgency, which had effect sizes close to medium ( $r = 0.28$  to  $0.29$ ). In the low-south region, the main bivariate relationships were with positive urgency and with sensation seeking, both having medium effect sizes ( $r = 0.38$ ). Although these effect sizes were not large, our results were consistent with previous studies reporting relationships between negative alcohol-related consequences with both positive and negative urgency (Pilatti et al., 2016).

Literature on impulsivity-related traits is more prolific in what refers to the link with depression rather than anxiety, which may implicitly reflect the weight of one and another in its relationship to impulsivity. Notwithstanding, consistent with Moustafa et al. (2017), the positive relationship we have found between impulsivity-related traits (mainly, for negative urgency) and anxiety was higher than that for depression, although both were high. The strong relationships between impulsivity and both depression and anxiety are expected to decrease with age (Moustafa et al., 2017), probably due to developmental factors (Shulman et al., 2016). However, it was also reported that the relationship between impulsivity and depression persists even in remission (Saddichha and Schuetz, 2014). Concerning the link between impulsivity and SB, there are contradictory assertions across the literature. While according to meta-analytic results the relationship between trait-impulsivity and SB is small (Anestis et al., 2014), some authors assert that this relationship is well established (Gorlyn, 2005; Gvion and Apter, 2011). However, both viewpoints agree that some limitations in the understanding of this relationship are due to a lack of consensus about the definition of impulsivity (Gorlyn, 2005; Gvion and Apter, 2011), which led to difficulties in its measurement (Anestis et al., 2014; Gorlyn, 2005; Gvion and

Apter, 2011). Overall, impulsivity and SB remain as important factors of adolescents' mental health. As previously mentioned, several positive relationships were found in this study between impulsivity-related traits and suicidal risk, but the main ones corresponded to negative urgency, which is consistent with the literature (Klonsky & May, 2010; Lockwood et al., 2017), followed by (lack of) premeditation, in the entire sample and in each of the three altitude-latitude regions. Additionally, in the low-south region the link between (lack of) perseverance and suicidal risk was relevant. Since SB is strongly predicted by its past occurrence and the risk for recurrence appears to increase with each subsequent attempt (Liu, 2019), it is important to mention that, in the entire sample analyzed, 17.41% has attempted suicide one or more times during the past (data not shown). According to the literature, elevated impulsivity facilitates the transition from suicidal thoughts to SB and dissimilar impulsivity-related traits characterize attempters and ideators-only. Thus, while high scores on negative urgency characterize both attempters and ideators-only, solely the former exhibit high scores on (lack of) premeditation, and none exhibit high sensation seeking or (lack of) perseverance (Klonsky & May, 2010). Whether these statements adopted are true, our sample could be thought as an attempter's sample. Moreover, a remaining question is whether the link between (lack of) perseverance and suicidal risk, found solely in the low-south region, indicates an idiosyncratic feature. Further research is needed in order to weigh the importance of trait-impulsivity in mental disorders among adolescents.

When multiple regressions were carried out, the largest effect size of impulsivity related-traits corresponded to negative urgency for all the SMHS indicators analyzed. Overall, higher scores in negative urgency, in (lack of) perseverance, and in (lack of) premeditation predicted higher levels of depression, anxiety, and suicidal risk; while higher scores in sensation seeking were inversely correlated with such SMHS indicators. Nonetheless, having higher scores in negative urgency, in positive





**Figure 1.** Distributions of adolescents according to depression and trait-anxiety scores (panel A), depression and suicidal risk scores (panel B), and trait-anxiety and suicidal risk (panel C) scores in adolescents from: 1) the entire sample (N = 448), 2) high altitude and north westernmost latitude (n = 251), 3) middle altitude and center latitude (n = 169), and 4) low altitude and south end latitude (n = 28).

urgency, and in (lack of) premeditation – but not in (lack of) perseverance nor in sensation seeking – predicted worst negative alcohol-related consequences. Impulsivity, aggression, and risk-taking – among others – are endophenotypes reported as related to SB and substance use disorders in the literature; however, disentangling pathogenetic hypotheses is

difficult (Costanza et al., 2020) and more research is needed. In this regard, our findings on impulsivity-related traits in adolescents help shed light on which endophenotypes may be related to depression, anxiety, and suicidal risk, on the one hand, and which could be related to alcohol drinking, on the other.

The third and last aim of this research was to analyze bivariate relationships between depression, trait-anxiety, negative alcohol-related consequences, and suicidal risk, in the entire sample and in each of the three altitude-latitude regions, in order to test two-disorder comorbidities. In the entire sample, we found positive relationships in all analyses, but the main ones – in descending relevance, taking  $r^2$  values as criterion – were between depression and trait-anxiety, trait-anxiety and suicidal risk, and depression and suicidal risk. These relationships were also the main ones when analyzing each with altitude-latitude regions, although with small varying values of  $r^2$  (see Table 7). However, in both the middle-center and low-south regions the relationships between trait-anxiety and negative alcohol-related consequences, and between the latter and suicidal risk, were not significant. Likewise, in the low-south region, the link between depression and negative alcohol-related consequences was not significant. Our findings on the link between depression and trait-anxiety are in line with wide literature reporting this comorbidity as frequent (Cummings et al., 2014). Similarly, our results are in concordance with the myriad of literature establishing a link between depression and suicidal risk (Gili et al., 2019). On the other hand, controversy exists surrounding the relationship between anxiety disorders and whether they are independently associated (i.e., after adjusting for comorbid mental disorders) with suicidal risk. Indeed, while some studies assert that anxiety disorders are an independent risk factor for suicidality (Boden et al., 2007; Hawgood and De Leo, 2008; Sareen et al., 2005) others assert that they are not (Coryell et al., 2019; Laan et al., 2011), but the majority of these studies are not primarily based on an adolescent population. In this regard, our findings highlight that the link between trait-anxiety and SB is almost as relevant as for depression when analyzing the north-end region, or even more relevant when analyzing the entire sample and the middle-center region.

One limitation of this study was that we focused on adolescents who were college students. We recognize that this sample could differ from non-college adolescents (see, e.g., Heinrich et al., 2010). Furthermore, a limitation regarding analyses based on the altitude-latitude regions could be the relatively small size of the low-south group. In addition, our samples from the different altitude-latitude regions yielded a smaller sample in the low-south group. However, in this regard, it is important to keep in mind that this low-south region (i.e., Tierra del Fuego) has a smaller population – and thus an even smaller university population – than the high-north and the middle-center regions analyzed in this study (i.e., Jujuy and Córdoba, respectively). Finally, the proportion of men and women composing the sample may be an additional shortcoming of this research. Despite these limitations, the findings presented in this work remain valuable since they have clinical interest on the early detection of sub-groups of at-risk adolescent college students.

## Declarations

### Author contribution statement

L.C. López Steinmetz: Conceived and designed the experiments; Performed the experiments; Analyzed and interpreted the data; Contributed reagents, materials, analysis tools or data; Wrote the paper.

J. C. Godoy: Contributed reagents, materials, analysis tools or data; Wrote the paper.

S. B. Fong: Analyzed and interpreted the data; Contributed reagents, materials, analysis tools or data; Wrote the paper.

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### Competing interest statement

The authors declare no conflict of interest.

### Additional information

No additional information is available for this paper.

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