

Development and Initial Validation of the Hangover Symptoms Scale: Prevalence and Correlates of Hangover Symptoms in College Students

Wendy S. Slutske, Thomas M. Piasecki, and Erin E. Hunt-Carter

Background: Despite its ubiquity, hangover has received remarkably little systematic attention in alcohol research. This may be due in part to the lack of a standard measure of hangover symptoms that cleanly taps the physiologic and subjective effects commonly experienced the morning after drinking. In the present study, we developed and evaluated a new scale, the Hangover Symptoms Scale (HSS), to potentially fill this void.

Methods: Participants were 1230 currently drinking college students (62% women, 91% Caucasian). They were administered a self-report inventory in which they reported the frequency of occurrence of 13 different hangover symptoms during the past 12 months. Participants also reported their history of alcohol involvement, alcohol-related problems, and family history of alcohol-related problems.

Results: On average, participants experienced 5 out of 13 different hangover symptoms in the past year; the three most common symptoms were feeling extremely thirsty/dehydrated, feeling more tired than usual, and headache. Higher scores on the HSS were significantly positively associated with the frequency of drinking and getting drunk and the typical quantity of alcohol consumed when drinking, a personal history of alcohol-related problems, and a family history of alcohol-related problems. After controlling for sex differences in alcohol involvement, women had higher scores on the HSS than men.

Conclusions: The HSS appears to capture a reasonably valid set of adjectives describing common hangover effects. It is hoped that the availability of a brief, valid hangover assessment such as the HSS will encourage further study of hangover's frequency, correlates, and consequences. Future research is needed to explore the performance of a re-worded HSS in laboratory settings, which may help bridge the gap between laboratory and survey investigations of hangover.

Key Words: Hangover, Symptoms, Prevalence, College Students, Family History of Alcohol Problems.

IT IS WELL-KNOWN that excessive alcohol ingestion can result in an aversive constellation of "morning after" effects, known collectively as alcohol "hangover." Hangover is common, and probably represents the most widely experienced negative consequence of alcohol use (Wechsler et al., 1994; Wiese et al., 2000).

Despite its ubiquity, hangover has received remarkably little systematic attention in alcohol research (Swift and Davidson, 1998). This is unfortunate because existing research suggests hangover has important consequences for both society and the individual drinker. Hangover results in substantial economic costs due to lost productivity (Cronton, 1987; Stockwell, 1998). Hangover may also produce

psychomotor performance decrements that could increase risk for accidental injury or death when operating a motor vehicle or engaging in other potentially dangerous activities (cf. Chait and Perry, 1994; Cherpitel et al., 1998; Finnigan et al., 1998; Lemon et al., 1993; Myrsten et al., 1980; Yesavage and Leirer, 1986). Hangover may also have prognostic significance. Recent research has found relations between hangover frequency and individual difference variables known to modify risk for the development of alcohol use disorders (McCauley et al., 1991; Newlin and Pretorius, 1990; Earleywine, 1993a; Span and Earleywine, 1999; Wall et al., 2000).

The lack of a standard measure of hangover symptoms may have stymied development of a systematic body of hangover research. In experimental studies, researchers have employed batteries of tests that include generic mood checklists, psychophysiological assessments, and psychomotor tasks to study hangover (e.g., Finnigan et al., 1998; Chait and Perry, 1994; Myrsten et al., 1980). In such studies, hangover is deemed present when measures deviate from those obtained under placebo or no-alcohol conditions the morning after a test dose of alcohol. Studies in this tradition benefit from tight experimental controls and have

From the Department of Psychological Sciences and the Missouri Alcoholism Research Center, University of Missouri-Columbia, Columbia, Missouri.

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Reprint requests: Wendy S. Slutske, PhD, 210 McAlester Hall, University of Missouri-Columbia, Columbia, MO 65211; Fax: 573-882-7710; E-mail: wendy@martha.psyc.missouri.edu.

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provided very important descriptive data. However, the specific batteries used have varied across studies, making integration of existing findings somewhat difficult (Wiese et al., 2000). Additionally, many of the battery components (e.g., performance measures) would be unduly cumbersome to use in survey or epidemiologic studies. Laboratory studies have typically used fairly generic mood checklists to probe subjective effects of hangover. Because these subjective measures are not hangover-specific, they may also be difficult to adapt to survey research designs.

Epidemiologic and survey research on hangover also suffers from potential measurement problems. Hangover is probably most often assessed in survey research by simply asking respondents a single question (i.e., "How frequently have you had a hangover in the past year?") as part of a longer list of drinking consequences (CORE Institute, 2001; Kauhanen et al., 1997; Wechsler and Wuethrich, 2002). More rarely, investigators have constructed multiple-item scales designed to tap a variety of typical hangover symptoms (e.g., Harburg et al., 1993; Smith and Barnes, 1983). A potential problem common to all of these assessments is that they have relied on the respondent's subjective definition of critical constructs. That is, these assessments typically require respondents to use their own understanding of the term "hangover" to generate their responses to the assessment items. This strategy may yield measures that contain considerable error if drinkers differ in their subjective definitions of "hangover" (e.g., Baker and Brandon, 1990; Monroe and Simons, 1991).

Newlin and Pretorius (1990) redressed some of these problems by introducing a multi-item Hangover Questionnaire (HQ) that can be used to survey drinkers' recent experiences with 13 distinct hangover symptoms. Notably, the HQ asks respondents to rate the frequency of experiencing each symptom with the phrase "Within the past year, when I drank alcohol..." and thus mitigates some of the potential respondent bias in the determination of hangover frequency. Variants of the HQ have been used in several studies (Newlin and Pretorius, 1990; Earleywine, 1993a, 1993b; Span and Earleywine, 1999; Wall et al., 2000), and numerous HQ items have been shown to be related to markers of risk for alcohol use disorders (e.g., family history of alcoholism, aldehyde dehydrogenase genotype). However, interpretation of these findings is complicated because the HQ does not focus specifically on the morning-after effects of alcohol, but rather contains a variety of items related to experiences and behaviors occurring during the drinking episode (e.g., "I got a headache while drinking," "I did some things I normally wouldn't do while drinking"), subjective evaluations of the drinking episode ("I regretted my behavior while drinking", "I regretted having drunk too much"), blackouts ("I forgot some things that happened while I was drinking"), and classic "morning after" effects ("I got a headache the morning after drinking"). Thus, the definition of "hangover" implicit

in the HQ item set is likely much broader than the way many researchers and laypersons understand the construct. It is unclear to what extent the relations between problem drinking variables and hangover frequency are attributable to hangover per se or depend on the inclusion of a broader set of items indexing other behaviors and experiences, such as memory loss or disinhibition under the acute influence of alcohol.

Progress in hangover research may require the development of a hangover measure that more cleanly taps the physiologic and subjective effects commonly experienced the morning after drinking. Ideally, a standard hangover measure would thoroughly sample the domain of known hangover symptoms, be easily adapted for either survey research or experimental studies, and not rely on respondents' subjective definitions of the hangover construct. In the present research, we sought to develop such a measure and test its validity in a survey research format. We created a new 13-item measure of hangover symptoms, the Hangover Symptoms Scale (HSS) that sampled from each of the eight domains (e.g., pain, gastrointestinal, cognitive, and mood symptoms) described by Swift and Davidson (1998) in their recent review of hangover effects. With minor modifications, these 13 symptom items are amenable for use in both laboratory and survey research. In its survey format (tested here), the HSS asks subjects to report the percentage of drinking occasions after which they experienced each symptom, and thus, like the HQ, may sidestep respondent bias associated with idiosyncratic subjective definitions of the hangover construct.

In the present study, 2 versions of the HSS, one assessing frequency of symptoms in the past year and one assessing the frequency of symptoms at the start of the drinking career, were administered to a large sample of currently drinking college undergraduates. These data permitted evaluation of the internal consistency of the HSS items. Additional measures of alcohol use quantity-frequency and family history of alcoholism permitted evaluation of the construct validity of the new scale. Presumably, if the HSS is a valid measure of hangover, then it should be robustly related to drinking heaviness. Based on prior research (Newlin and Pretorius, 1990; Span and Earleywine, 1999; McCaul et al., 1991) we also predicted that persons with a family history of alcoholism would report more frequent hangover.

While the present study was conducted primarily for the purpose of scale development and evaluation, the collected data also permitted us to characterize the prevalence of hangover symptoms among active college drinkers. Drinking on college campuses and its negative consequences have received increased attention in recent years (e.g., Wechsler and Wuethrich, 2002; O'Neill et al., 2001). College students who drink heavily attain lower grades and have more academic problems than students who drink moderately or not at all (e.g., Wood et al., 2000; Wood et

Table 1. Prevalence of Hangover Symptoms in the Past Year, Expressed as a Percentage of Drinking Occasions After Which the Symptom Occurred, Among College Students ($n = 1213-1217$)

Symptom	Never (%)	Occasionally (%)	About half the time (%)	Most of the time (%)	Every time (%)
Felt extremely thirsty or dehydrated	28	27	16	18	12
Felt more tired than usual	32	35	16	15	3
Experienced a headache	38	41	14	6	2
Felt very nauseous	51	36	9	3	1
Vomited	54	37	5	3	0
Felt very nauseous	54	32	9	5	1
Had difficulty concentrating	58	30	7	4	1
More sensitive to light and sound than usual	59	26	9	5	1
Sweated more than usual	73	16	7	4	1
Had a lot of trouble sleeping	81	11	4	3	1
Was anxious	81	14	4	1	0
Felt depressed	83	12	2	2	1
Experienced trembling or shaking	87	10	2	1	0

al., 1997). Findings such as these probably reflect, at least partially, the interference of hangover effects with important scholastic tasks such as studying and attending classes. Available survey data suggest that between 60 and 75% of college students report experiencing at least one hangover each year (CORE Institute, 2001; Prendergast, 1994). However, little is known about the prevalence and frequencies of specific hangover effects in college students. To better characterize hangover experiences among college students, we present descriptive data for each hangover symptom.

METHODS

Participants

Participants were selected from 1474 college undergraduates enrolled in Introduction to Psychology courses at the University of Missouri-Columbia (a large state University with approximately 20,000 undergraduates in attendance) during the Fall 2001 semester. The students completed a 14-page mass-pretesting questionnaire to qualify for required exposure to psychological research by participating as research subjects. (Students could also satisfy this requirement by completing either a short paper or taking a short exam based on supplementary readings. The majority of students enrolled in Introduction to Psychology, about 90%, opted to satisfy this requirement by participating in research.) Of these 1474 participants, 1234 (84%) reported drinking any alcohol in the past year; the majority of the participants who did not drink in the past year were lifetime alcohol abstainers (68%). After excluding 4 participants who did not provide usable data on the hangover assessment, there were 1230 currently drinking college students who were the focus of this investigation; 758 (62%) of the participants were women, 1114 (91%) were Caucasian, 40 (3%) were African-American, 33 (3%) were Asian, and 11 (1%) were Hispanic. The participants ranged in age from 18 to 51 years old (mean age = 18.8 years, SD = 1.7); 99% of the participants were between 18 and 22 years of age (of the 16 participants older than 22, 13 were between the ages of 23–32, 1 was 39, 1 was 44, and 1 was 51 years old) and only a small minority of the participants, 5%, were of legal drinking age (i.e., 21 years of age or older).

Measures

The assessment of hangover symptoms contained 13 items that sampled from each of the eight domains (constitutional, pain, gastrointestinal, sleep and biological rhythms, sensory, cognitive, mood, and sympathetic hyperactivity symptoms) described by Swift and Davidson (1998) (see

Table 1 for a list of the hangover symptoms assessed). For each of the 13 hangover symptoms, the participants indicated the percentage of drinking occasions, on a 5-point scale ranging from never (0% of the time) to every time (100% of the time), that were followed the next morning by the symptom (one of the symptoms, vomiting, could have occurred either during the night or the next morning). This response format was similar to that used in the HQ (Newlin and Pretorius, 1990). Assessing the percentage of drinking occasions after which hangover symptoms occur partially controls for differences in the frequency of drinking and allows the HSS item scores to be interpreted as hangover susceptibility or proneness. The 13 hangover symptoms were assessed with reference to the first few times that participants ever drank alcohol, and then repeated with reference to drinking occasions that occurred in the past 12 months.

Because HSS items were keyed in terms of the percentage of drinking occasions after which each symptom was experienced, they could indicate whether or not a given subject experienced each symptom in the past year, but could not provide information on the total number of times a hangover was experienced. To obtain this information directly, we administered another item that asked participants to indicate the number of times that they experienced at least one of the 13 symptoms in the past year, with response options on a 5-point scale of never, 2 times or less (once or twice per year), 3–11 times (more than once or twice, but less than once per month), 12–51 times (more than once a month, but not every week), and 52 times or more (once per week or more frequently). We refer to this item as the “hangover count item” below to distinguish responses to it from HSS responses.

Participants also reported about their early drinking experiences (the age when they first had a full drink, how many drinks they consumed the first time that they drank, and how well they remembered their first drinking experience), their alcohol use in the past year (frequency of drinking, frequency of getting drunk [defined as “your speech was slurred or it was difficult to keep your balance”], and the typical quantity consumed when drinking), and possible alcohol-related problems in themselves, their biological father, and their biological mother. A drink of alcohol was defined for the participants as a standard-size can or bottle of beer, one glass of wine, or a shot of liquor. The alcohol-related problems assessment consisted of a single item “Have you ever had any of the following experiences related to your use of alcohol: Problems fulfilling obligations at school or work, physical health or emotional problems, problems with family or friends, legal problems (e.g., DUI, DWI).” The family history of alcohol-related problems assessment consisted of the same single item changed to “To your knowledge, have your biological parents . . .” with the response options of neither parent, biological father, biological mother, or both of their biological parents. Although it would have been preferable to include a more comprehensive assessment of parental alcohol-related problems, such single-item assessments have been shown to have good inter-rater reliability (Slutske et al., 1996).

Table 2. Characteristics of Alcohol Involvement Among College Students

Variable	All participants (n = 1211–1225) (%)	Men (n = 465–470) (%)	Women (n = 746–755) (%)
Lifetime drinking occasions			
1–10	13	8	16
11–100	36	28	41
101–1000	38	43	36
>1000	12	21	7
Age first drank (years)			
<11	4	5	3
11–14	30	35	27
15–16	45	36	50
17–18	21	21	20
>18	2	2	1
Past-year frequency of drinking			
<1 day a month	23	16	28
1–3 days a month	34	30	37
1–2 days a week	31	38	27
≥3 days a week	11	17	8
Past-year frequency of getting drunk			
Never	16	12	19
<1 day a month	37	32	41
1–3 days a month	30	32	29
1–2 days a week	15	21	11
≥3 days a week	2	4	1
Past-year typical quantity drank			
1 drink	10	7	12
2–3 drinks	24	13	31
4–5 drinks	33	25	39
6–7 drinks	19	26	15
>7 drinks	14	30	4
Lifetime alcohol-related problems	32	35	30
Parental alcohol-related problems	23	23	23

RESULTS

For both sets of hangover symptoms items – those based on the first few lifetime drinking occasions and those based on the past year drinking occasions – we examined the prevalence of each of the 13 individual hangover symptoms, conducted a principal components analysis of the hangover symptom items, assessed the psychometric characteristics of full and short-form versions of the HSS, and evaluated the relations of the HSS with alcohol use, alcohol-related problems, parental alcohol-related problems, and sex. Both sets of items yielded very similar results. The correlation between the hangover scales indexing the two different drinking epochs was 0.79, indicating a high degree of stability of hangover symptoms and suggesting that there was little unique information captured by our assessments of hangover at the initiation of the drinking career versus in the past year. Therefore, for all subsequent analyses, we only present the results of those based on hangover symptoms that occurred in the past year.

Prevalence of Hangover Symptoms in the Past Year

Descriptive data concerning alcohol involvement in this sample are presented in Table 2. Most of the participants reported that they had consumed alcohol on between 101 and 1000 occasions over their lifetime. The modal age of onset of drinking in these mostly college-age young adults was 15–16 years, indicating that the majority of participants had been drinking for about 2–3 years.

Table 3. Number of Times Experienced at Least One Hangover Symptom in the Past Year Among College Students

Response	All participants (n = 1216) (%)	Men (n = 466) (%)	Women (n = 749) (%)
0 times	13	11	14
1–2 times	27	25	28
3–11 times	34	33	35
12–51 times	21	23	20
≥52 times	5	7	4

The past-year prevalences of hangover symptoms, based on responses to HSS items, are presented in Table 1. The most common hangover symptom was feeling extremely thirsty or dehydrated (72%) and the least common symptom was experiencing trembling or shaking (13%). In response to the hangover count item, 87% of the participants reported experiencing at least one hangover symptom in the past year; Table 3 summarizes the responses to the hangover count item for the total sample and for men and women separately.

We tested for potential sex differences in individual hangover symptoms using responses to the HSS items. For these analyses, each HSS item was dichotomized to reflect the presence or absence of the symptom. Men and women were equally likely to experience at least one of the hangover symptoms in the past year (men: 89%; women: 87%; $\chi^2 = 1.2$, df = 1, N = 1215, $p = 0.282$). Using a liberal criterion for statistical significance ($p < 0.05$), there were no symptoms that women experienced more often than

men and there were only two symptoms that men experienced more often than women: vomiting (men: 50%; women: 44%; $\chi^2 = 4.7$, df = 1, N = 1215, $p = 0.031$) and sweating more than usual (men: 34%; women: 23%; $\chi^2 = 18.9$, df = 1, N = 1214, $p < 0.001$). After applying a Bonferroni correction, only the latter difference remained statistically significant; after controlling for the frequency of drinking and getting drunk and the typical quantity of alcohol consumed when drinking in the past year, neither sex difference remained.

Men reported drinking more frequently ($\chi^2 = 53.7$, df = 3, N = 1211, $p < 0.001$), getting drunk more frequently ($\chi^2 = 42.9$, df = 4, N = 1209, $p < 0.001$), and typically consuming much more alcohol per drinking occasion ($\chi^2 = 228.5$, df = 4, N = 1214, $p < 0.001$) in the past year than did women (see Table 2). Controlling for the frequency of drinking and getting drunk and for the typical quantity of alcohol consumed when drinking uncovered a number of differences between men and women not evident in the previous set of analyses. After controlling for the frequency of drinking and getting drunk and for the typical quantity of alcohol consumed when drinking, women were significantly more likely than men to experience at least one of the hangover symptoms ($\chi^2 = 5.0$, df = 1, N = 1216, $p = 0.026$), and were also significantly more likely to experience 9 of the 13 individual hangover symptoms (thirsty/dehydrated, more tired than usual, headache, nauseous, weak, difficulty concentrating, more sensitive to light and sound, anxious, and trembling or shaking). Of these, 5 differences remained significant even after applying a Bonferroni correction (thirsty/dehydrated, more tired than usual, headache, nauseous, weak).

Development of the Hangover Symptoms Scale

A principal components analysis of the 13 hangover symptom items was conducted. There were two principal components with eigenvalues greater than one (eigenvalues of 5.1 and 1.2) that accounted for 39% and 9% of the variance in the symptoms, respectively. A one-factor model was judged to be preferable to a two-factor model of hangover symptoms because: a) the items were all significantly intercorrelated ($r_s = 0.18\text{--}0.56$, all $p < 0.001$); b) the factor loadings were uniformly high in the one-factor model (i.e., the mean factor loading was 0.62 and all of the loadings were greater than 0.42; see Table 4); c) the components in the two-factor model were strongly correlated with each other ($r = 0.61$); d) the second component did not account for a large portion of variance; and, e) the five items that had modest loadings on the first component and substantial loadings on the second component were also the five items with the lowest prevalences (sweating, trouble sleeping, anxious, depressed, and trembling or shaking; see Table 1) suggesting that these two components were not identifying meaningful clusters of hangover symptoms but were instead reflecting psychometric properties of the

Table 4. Factor Loadings From Principal Components Analyses of Past-Year Hangover Symptoms

Symptom	All participants (n = 1205)	Men (n = 454)	Women (n = 725)
Felt extremely thirsty or dehydrated	0.62	0.64	0.61
Felt more tired than usual	0.73	0.68	0.75
Experienced a headache	0.68	0.65	0.70
Felt very nauseous	0.68	0.65	0.71
Vomited	0.52	0.46	0.55
Felt very weak	0.76	0.73	0.79
Had difficulty concentrating	0.72	0.74	0.70
More sensitive to light and sound than usual	0.63	0.66	0.60
Sweated more than usual	0.62	0.68	0.59
Had a lot of trouble sleeping	0.43	0.48	0.42
Was anxious	0.55	0.63	0.49
Felt depressed	0.53	0.51	0.53
Experienced trembling or shaking	0.55	0.59	0.53
Eigenvalue	5.1	5.1	5.0
% Variance	39	40	39

items. Experts have convincingly demonstrated in Monte Carlo studies that the popular rule-of-thumb of retaining the number of factors corresponding to the number of eigenvalues greater than one is not an effective strategy for identifying the correct number of factors, and that it often leads to retaining too many factors (Cliff, 1988; Fabrigar et al., 1999), therefore we did not rely on the eigenvalues-greater-than-one rule in selecting the proper model. The factor loadings from the one-factor model are shown in Table 4. The results of the principal components analyses justified combining the 13 hangover symptoms into a single scale.

Table 4 also presents the results of conducting principal components analyses separately for the men and the women in the sample. The results of the analyses stratified by sex led to the same conclusion as the analysis of the full sample, and the results for men and women were very similar (the factor loadings presented in Table 4 for men and women correlated 0.76).

We examined two different approaches to combining the hangover symptom items. In the first approach (which we will call the "dichotomous" approach), each 5-level item was dichotomized according to whether the symptom never occurred or ever occurred, and these 13 dichotomous items were summed to form a scale with a possible range of 0–13. This approach to combining items yields a scale that emphasizes the diversity of hangover symptoms occurring within the past year; the internal consistency reliability (coefficient alpha) for the scale formed using this approach was 0.84 and the item-scale correlations ranged from 0.32–0.62. In the second approach (which we will call the "polytomous" approach), the original 5-level items were summed to form a scale with a possible range of 0–52. This approach to combining items emphasizes the pervasiveness as well as the diversity of hangover symptoms occurring within the past year; the internal consistency reliability (coefficient alpha) for the scale formed using this approach was 0.86 and the item-scale correlations ranged from 0.35–0.68. All of the items appeared to be adequate indicators of

hangover. The single best indicator (across approaches to combining items) was feeling very weak and the worst indicator was having a lot of trouble sleeping.

The mean score on the hangover scale in which the dichotomous approach to combining items was used was 5.2 ($SD = 3.4$, range = 0–13), indicating that, on average, participants reported experiencing about 5 out of 13 different hangover symptoms during the past year. The mean score on the hangover scale in which the polytomous approach to combining items was used was 8.3 ($SD = 6.9$, range = 0–49). The dichotomous approach to combining symptom items yielded a more normally distributed scale (skewness = 0.098, SE of skewness = 0.070, kurtosis = -0.923, SE of kurtosis = 0.140) than the polytomous approach to combining symptom items (skewness = 1.217, SE of skewness = 0.070, kurtosis = 2.276, SE of kurtosis = 0.141). Therefore, in the following section, we present the results of analyses that used the hangover symptom scale based on the dichotomous approach to combining symptoms. The approach used to combine the symptoms did not affect the results of the correlational analyses below.

There are many research contexts in which it may not be feasible to administer a full 13-item inventory of hangover symptoms. Thus, we also examined the reliability and validity of a 5-item short-form hangover symptoms scale. The 5 items were selected based on the relative magnitude of their factor loadings in the principal components analysis (see Table 4) and their item-scale correlations. The five best indicators of hangover retained in the 5-item short form were: more tired than usual, headache, nauseous, felt very weak, and had difficulty concentrating. The internal consistency reliability for the 5-item short-form scale formed using the dichotomous approach to combining items was 0.79 and the item-scale correlations ranged from 0.53–0.62. The correlates of the 5-item short form of the hangover symptoms scale were nearly identical to those of the full 13-item scale.

The psychometric properties of the full and short-form versions of the HSS were similar for men and women. The internal consistency reliability of the full version of the HSS was 0.83 among men and 0.84 among women and the same set of 5 items selected for the short form of the HSS had the largest item-scale correlations in both men and women. The internal consistency reliability of the short form of the HSS was 0.78 among men and 0.80 among women.

Correlates of the Hangover Symptoms Scale

The HSS was significantly positively associated with the frequency of drinking ($r = 0.44$, $p < 0.001$) and getting drunk ($r = 0.52$, $p < 0.001$) and with the typical quantity of alcohol consumed when drinking ($r = 0.40$, $p < 0.001$) in the past year. Thirty-two percent of the participants reported experiencing at least one of four alcohol-related problems in their lifetime. Those who reported an alcohol-related problem had significantly higher scores on the HSS

than those who did not (no alcohol-related problems: mean = 4.3, $SD = 3.3$; alcohol-related problems: mean = 7.0, $SD = 3.0$; $t = 13.64$, $df = 1225$, $p < 0.001$). Twenty-three percent of the participants reported that one or both of their biological parents had a history of at least one of four alcohol-related problems (18% fathers only, 3% mothers only, 2% both parents). Those who reported that one or both biological parents had a history of an alcohol-related problem had significantly higher scores on the HSS than those who did not (no parental alcohol-related problems: mean = 4.9, $SD = 3.4$; parental alcohol-related problems: mean = 5.9, $SD = 3.6$; $t = 4.03$, $df = 1225$, $p < 0.001$). Scores on the HSS did not differ for men and women (men: mean = 5.3, $SD = 3.4$; women: mean = 5.1, $SD = 3.4$; $t = 0.80$, $df = 1227$, $p = 0.423$).

Next, we examined the association of the HSS with alcohol-related problems after controlling for the frequency of drinking and getting drunk and the typical quantity of alcohol consumed when drinking in the past year. Similar analyses were also conducted examining the associations of the HSS with parental alcohol-related problems and with sex. Alcohol-related problems ($\beta = 0.196$, $t = 7.70$, $df = 1$, $p < 0.001$) and parental alcohol-related problems ($\beta = 0.087$, $t = 3.61$, $df = 1$, $p < 0.001$) remained significant correlates of the HSS, and a significant difference between men and women (with women now having higher scores) emerged ($\beta = 0.128$, $t = 4.89$, $df = 1$, $p < 0.001$) after controlling for the frequency of drinking and getting drunk and the typical quantity of alcohol consumed when drinking in the past year. Finally, all of the correlates of the HSS were entered into a single regression model in which the frequency of drinking and getting drunk and the typical quantity of alcohol consumed when drinking in the past year were controlled. All three of the previously-examined correlates continued to remain significantly associated with the HSS (alcohol-related problems: $\beta = 0.181$, $t = 7.11$, $df = 1$, $p < 0.001$; parental alcohol-related problems: $\beta = 0.066$, $t = 2.76$, $df = 1$, $p = 0.006$; female sex: $\beta = 0.120$, $t = 4.70$, $df = 1$, $p < 0.001$). The associations of the HSS with alcohol use, alcohol-related problems, and parental alcohol-related problems did not differ for men and women.

DISCUSSION

Alcohol hangover deserves more systematic research attention, and standardized, brief hangover assessments are needed to encourage hangover research. To be maximally useful, a hangover measure should assess multiple symptom domains, should not rely on respondents' idiosyncratic definitions of hangover, and should be written in such a way that it taps the "morning after" effects that jibe with classic notions of the hangover construct. In this research, we sought to develop and evaluate a measure with these properties. The Hangover Symptom Scale (HSS) was constructed to obtain reports of the frequency with which

drinkers experienced 13 symptoms the morning after drinking, and thus to tap multiple next-day effects while circumventing respondent's preconceived notions of hangover.

Findings from this study provide preliminary support for the use of the HSS. We found that the 13 items of the HSS can be reasonably interpreted as loading on a single common factor indicative of a global hangover syndrome. Reliability of the HSS is acceptable as indicated by coefficient alphas greater than 0.80 across alternate scoring algorithms and past-year versus early drinking career assessments. Estimates of hangover for the first few drinking occasions and the past year were highly stable ($r = 0.79$) which might be interpreted as indicating that hangover proneness is traitlike and that the HSS will show reasonable test-retest reliability. Accurate estimation of test-retest reliability, however, must await longitudinal studies that incorporate multiple administrations of the HSS; biases inherent in retrospective recall (e.g., Hammersley, 1994) might also account for the high correlation between HSS scores across time periods in this research.

Preliminary evidence for the construct validity of the HSS was also found. Because hangover is presumed to be at least partially related to the dose of alcohol consumed, we expected that a valid hangover measure should relate to alcohol use variables. In this study, HSS scores were positively related to the frequency of drinking and getting drunk, the typical quantity of alcohol consumed during a drinking episode, and to the presence of alcohol-related problems among drinkers.

Constitutional variables may also mediate hangover proneness, and we found evidence for such effects in this study. Consistent with prior research using the HQ (Newlin and Pretorius, 1990; Span and Earleywine, 1999), we found that respondents who had a family history of alcohol-related problems reported more hangover symptoms than those without a family history of alcohol-related problems.

Complex relations were found with regard to sex of the drinker. There were no differences between men and women on unadjusted HSS scores, but when analyses controlled for the frequency of drinking and getting drunk and the typical quantity of alcohol consumed when drinking, a different pattern emerged. In these covariate-adjusted analyses, women were predicted to have higher HSS total scores. These findings suggest that in their natural contexts, male and female students titrate their drinking to different typical doses (with females drinking less alcohol per occasion) but experience hangovers at comparable rates. Conversely, at a given dose of alcohol, females may be more susceptible to hangover and to experience more severe hangover symptoms than men. This finding makes pharmacologic sense; because women tend to weigh less and have lower percentages of total body water than do men, they should achieve higher degrees of intoxication and, presumably, more hangover per unit alcohol (Ely et al., 1999; Mumethaler et al., 1999). Unfortunately, we only obtained information about the frequency of hangover symptoms; it

would be worthwhile in future research to also obtain information about the severity of hangover symptoms that are experienced.

We explored the value of several different permutations of the HSS in this research. For instance, we assessed hangover frequency during the first few drinking occasions and during the past year. As noted above, estimates of hangover frequency were highly intercorrelated across these two forms of administration. This may suggest that hangover is relatively trait-like and that little is to be gained by asking respondents about early hangover experiences. However, owing to the nature of our sample, it may be premature to discard questions keyed to hangover experiences after early drinking episodes. Our sample of college students had, on average, only been drinking alcohol for 2–3 years. Samples of older adults may show larger discrepancies in hangover between the past-year and the early drinking career owing to slow-onset pharmacologic effects (e.g., tolerance) or preferential selection into or out of drinking by severe hangover sufferers. Future research should explore these questions while being mindful of the potential for biases in retrospective recall to potentially influence the obtained results. We also explored two distinct scoring algorithms for the HSS (i.e., the dichotomous versus polytomous approaches). Results of these analyses indicated that both approaches yielded similar relations with external variables. Because scores derived from the dichotomous approach were more normally distributed, we concentrated on results obtained using the dichotomous approach and recommend dichotomous scoring for most basic analyses involving linear models. However, the greater range and resolution of severe symptoms obtainable with polytomous scoring may be useful in some research applications (e.g., use of item response models; Embretson and Riese, 2000). Finally, we explored the feasibility of distilling a shorter parcel of items from the 13-item HSS for use in research contexts where brief assessments are needed. We found evidence that a 5-item scale (more tired than usual, headache, nauseous, felt very weak, and had difficulty concentrating) had good internal consistency (coefficient alphas >0.77) and showed a similar profile of correlates as did the entire HSS.

As noted earlier, an ideal hangover measure would foster comparability across both laboratory and survey investigations. In this research, we evaluated the HSS in a survey research framework. This approach was chosen because a survey design allowed us to collect data from a large sample, and many basic scale construction and validation tasks (e.g., principal components and correlational analyses) require or benefit from large subject-variable ratios. Formally, then, we cannot surmise from the present data whether the HSS would be sensitive to laboratory manipulations such as alcohol challenge. Clearly, the response format used here, which asks about the percentage of drinking occasions after which each symptom was experienced, is not directly portable to most typical laboratory

settings. However, the HSS may be of use in laboratory studies with minor wording modifications. For instance, it may be necessary to key these adjectives to immediate experience (e.g., "how do you feel right now") and to change the response format to a Likert-type scale indexing the intensity of current symptomatology. Future research is needed to explore the performance of a re-worded HSS in laboratory settings. The benefits that might accrue from better contact between laboratory and survey investigations of hangover, coupled with evidence from the present study suggesting that the HSS captures a reasonably valid set of adjectives describing common hangover effects, may justify the effort involved in conducting such studies.

While the major aim of this study was to evaluate the HSS, the collected data also allowed us to characterize hangover symptoms in some detail among a large sample of current college students. We limited our analyses to students who reported drinking any alcohol in the past year. Of the currently drinking students we surveyed, 87% reported at least one symptom of hangover in the past year. If the 240 survey respondents who reported not drinking alcohol in the past year are presumed to not have suffered from hangover, then the past-year prevalence among all students may be estimated at approximately 73%, a figure that is consistent with the 60–75% prevalence rates obtained in prior studies (CORE Institute, 2001; Prendergast, 1984).

With respect to the frequency of hangover, our data suggest that the modal number of hangover experiences (as judged by responses to the hangover count item; Table 3) is between 3 and 11 times in the past year. Thus, while hangover is a common phenomenon among college drinkers, for most of them it occurs rarely enough that is unlikely to have a major deleterious impact on academic performance. However, we also found that 26% of students reported at least one hangover symptom once per month or more frequently (Table 3; cf, Meilman et al., 1990). Further research is needed to characterize this subsample of students with frequent hangover. For instance, it would be instructive to determine whether these individuals are at especially high risk of academic failure and whether members of Greek organizations are over-represented among this group (e.g., Sher et al., 2001).

Only three hangover symptoms were experienced by more than half of college drinkers in the past year: felt extremely thirsty/dehydrated, felt more tired than usual, and experienced a headache. At present, it is not clear how to best interpret the differing frequencies of individual symptoms. One possibility is that thirst, fatigue, and headache represent especially low-threshold symptomatic responses to alcohol overindulgence, and that other hangover symptoms require higher alcohol doses to become manifest. That is, ranking symptoms by their prevalence in the population may reflect their severity, with more rare symptoms such as trembling and shaking marking cases of extreme alcohol abuse/dependence. Alternatively, there may

be constitutional differences in susceptibility to some hangover symptoms (e.g., Wall et al., 2000), and thus symptom prevalences may reflect the population distribution of these latent vulnerability factors. While they are speculative, these propositions highlight the potential value of future research designed to elucidate the meaning of low-prevalence hangover symptoms, and thus should encourage inclusion of these items in future studies where a 13-item scale is practicable.

Several limitations must be borne in mind when considering our findings. First, we were not able to administer alternative measures of hangover (such as the HQ) to this sample owing to institutional limits on the number of items that could be included in the mass-survey screening instrument. Thus, we were not able to examine questions of discriminant and convergent validity in this study. This will be an important task for future research appraising the value of the HSS. Similarly, given the nature of the screening survey, we were limited to a relatively brief set of self-report external validation criteria (e.g., family history of alcohol problems, frequency of alcohol use). Thus, different relations between the HSS and other variables might be obtained if objective criteria or more sophisticated self-report assessments such as time-line follow-back (Bardone et al., 2000) or ecological momentary assessment (Stone and Shiffman, 1994) were used. Studies relating the HSS to an array of external criteria are needed to more thoroughly establish its construct validity. While our sample was useful for characterizing hangover experiences among college students, it is important to point out that participants were culled from a single class on a single campus, and thus caution must be exercised when comparing these findings to those of other larger, multi-campus studies. Moreover, our sample of college students, *perforce*, contained a narrow age range and comprised relatively inexperienced drinkers. Future research in samples ranging more widely in age and drinking experience are needed to evaluate the HSS. Finally, we did not assess respondents' preferred alcoholic beverage type. Beverages with high concentrations of congeners (such as brandy and whiskey) may be more likely to produce hangover (e.g., Swift and Davidson, 1998; Wiese et al., 2000). Relating HSS scores to beverage type will be an important task for future research.

Notwithstanding these limitations, this study provided preliminary support for the reliability and validity of the HSS. It is hoped that the availability of a brief, valid hangover assessment such as the HSS will encourage further study of hangover's frequency, correlates, and consequences.

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