Abstract. Objective: To examine the prevalence of risk for sleep disorders among college students by gender and age, and their asso– ciations with grade point average (GPA). Participants: Participants were 1,845 college students at a large, southeastern public univer– sity. Methods: A validated sleep disorder questionnaire surveyed sleep data during the 2007–2008 academic year. Students' GPAs were obtained from the office of the registrar. Results: Twenty– seven percent of students were at risk for at least one sleep disorder. African American and Asian students reported less risk for insom– nia and fewer poor sleep practices relative to white and Latino students. Students reported insufficient sleep and a discrepancy be– tween weekday and weekend amount of sleep. Students at risk for sleep disorders were overrepresented among students in academic jeopardy (GPA2.0). Conclusions: Many college students are at risk for sleep disorders, and those at risk may also be at risk for academic failure. Keywords: academic performance, college students, gender, GPA, sleep disorders, sleep hygiene

College students experience a number of sleep prob– lems, which may impact academic performance, 1 health, and mood. A common sleep problem among college students is sleep deprivation and resulting excessive daytime sleepiness (EDS). Both biological and social factors contribute to deprivation. Many college students are older adolescents and are still dealing with adolescent physiology such as a biologically driven delayed sleep phase.2 Accord– ing to the National Sleep Foundation,3 59% of adults 18 to 29 years of age describe themselves as night–owls. Unable to fall asleep earlier in the evening, they cannot get enough sleep if they must get up early. In addition, sleep may be voluntar– ily sacrificed due to social factors or involuntarily curtailed because of living in a noisy residence hall or apartment. A typical coping technique for dealing with sleep deprivation

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is to attempt to make up for lost sleep by increasing sleep on the weekends, a practice that actually worsens the problem.4 Another potential source of EDS that has been less thor– oughly examined in this population, however, is untreated sleep disorders, which may be underdiagnosed among col– lege students. The International Classification of Sleep Dis– orders5 categorizes 3 types of sleep disorders: dyssomnias (which may produce EDS), parasomnias (which usually are not associated with EDS), and medical/psychological disor– ders. The first 2 categories are primary disorders of sleep, whereas the third category includes conditions that are often associated with disrupted sleep. The consequences of sleep problems—whether due to in– sufficient sleep or an untreated sleep disorder—can be se– rious. Sleep problems have been associated with deficits in attention and academic performance,6 drowsy driving,7 risk–taking behavior and depression,8 impaired social rela– tionships,9 and poorer health.10 Wolfson and Carskadon4 reported that reduced sleep time, later bedtime and awak– ening, irregular sleep/wake patterns, and poor sleep quality negatively impacted adolescents' school performance. The National Sleep Foundation3 found that high school students who reported insufficient sleep or daytime sleepiness also reported depressed mood and lower grades, whereas 80% of students who reported getting enough sleep made As and Bs in school. Among college students who carried a full aca– demic load, those who reported poorer sleep quality were likely to perform worse on academic tests.11 The impact of sleep loss on academic performance might be subtle. Fifty college students, deprived of sleep for 1 night, were then asked to solve math addition

problems.12 Partici– pants selected the difficulty level of the problems. After sleep loss, participants were more likely to choose easier problems to solve. Extrapolating from these data, students who are chronically sleepy may limit their future options by choos– ing easier courses while in college. The prevalence of sleep disorders in college students has not been established. It is not known whether reported sleepiness among college students is simply due to insuf– ficient sleep or whether it might be secondary to an undi– agnosed sleep disorder. Although reported sleep disorders in adults tend to increase with age,13 they may also occur among college students frequently enough to warrant screening this population. In addition, sleep patterns or disorders among college students may vary by gender or race/cultural affili– ation.14 The purpose of the present study was to determine the prevalence of sleep disorders among college students, to examine whether race or gender associated with different pat– terns of sleep disorders, and to determine whether students at risk for sleep disorders were also at risk for poor academic performance. METHODS Participants included 1,845 students enrolled in Introduc– tory Psychology labs at a large state university in southeastern United States. The students received extra credit for partic– ipating in research; alternative assignments were available. This project was approved by the local institutional review board. Twenty–nine percent of the sample was male.

Seventy percent of the participants were white, 17% African Amer– ican, 5% selected a designation of "other," 4% were Asian, and 4% were Latino students. The participants had an av– erage age of 20.38 years (SD = 4.63, range = 18–71), and an average grade point average of 2.77 (SD = .92, range = 0.00–4.00). Forty–six percent were first year students, 26% were sophomores, 16% juniors, and 10% seniors. The ma– jority of the students (76%) considered themselves to be "evening" people. The survey used, the SLEEP–50 by Spoormaker et al,15 has been validated for college students. It consists of 50 items that tap a variety of sleep characteristics. The valida– tion sample included 377 college students, 342 patients with sleep disorders, 32 individuals who experienced nightmares, and 44 healthy controls. The results indicated good internal consistency (Chronbach's alpha = .85), and test–retest re– liability ranged from .65 to .89. Scales and cut–off scores for several sleep disorders were developed, and sensitivity and specificity values identified for each scale. To each item (eg, "I am told I snore.") the student indicated that it was "not at all" (1), "somewhat" (2), "rather much" (3), or "very much" (4) true. Additional items were added to the survey to obtain demographic information as well as additional de– tails about sleep (eg, typical amount of sleep when there is work/school the next day, typical amount of sleep when there is no work/school the next day). The SLEEP–50 provides scores for Obstructive Sleep Ap– nea (OSA), Periodic Limb Movement Disorder/Restless Leg Syndrome (PLMD/RLS), Insomnia, Narcolepsy, Circadian Rhythm Disorders (CRDs), Sleepwalking, Nightmares, Af– fective Disorder, Hypersomnia, Sleep State Misperception (SSM), Sleep Hygiene (behaviors and environmental condi– tions that influence sleep), and Impact on Daily Functioning (IDF; disruptions to the ability to function well during the day). Cut–points were identified to determine which students were at risk for the various disorders. In order to be identified as "at risk" for each disorder, the participant's scores on both the disorder's scale and the IDF scale had to meet or exceed a specified threshold. Data were collected online during the 2007–2008 aca– demic year. Current grade point average (GPA; as of the end of the semester when the sleep survey was completed) was provided as de–identified data by the registrar's

office. Descriptive information about sleep scales, sleep habits, and student characteristics are presented. Continuous vari– ables were analyzed by analyses of variance (ANOVA), t tests, and Fisher's least significant difference (LSD), and counts were compared by means of χ^2 analyses. RESULTS Table 1 presents descriptive information about the sleep disorder scales and prevalence of risk for sleep disorders. Over 500 students out of 1,845 (27%) were at risk for at least one sleep disorder. The most commonly reported disorders were narcolepsy and insomnia, followed by RLS/PLMD, CRDs, affective disorder, OSA, and hypersomnia. Prevalence rates for sleepwalking, nightmares, and SSM were low. The rate of narcolepsy indicated by this scale is extremely high relative to the general population. Due to questions about the accuracy of this scale, analyses involving participants identified as at risk for narcolepsy should be considered un– interpretable at this time, and are not reported here. A breakdown of specific sleep hygiene practices/ characteristics indicated fairly even rates (3% to 6%) of keeping the bedroom too light, too noisy, nighttime alcohol consumption, smoking, use of other substances that could interfere with sleep, and feeling sad or feeling no pleasure. On a scale of 1 (do not get nearly enough sleep) to 10 (get an ideal amount of sleep), students averaged 6.50. They reported sleeping an average of 6.79 hours (SD = 1.41) on a typical school/work night, and 9.30 hours (SD = 1.87) when they did not have school/work the next day, producing a day– of–the–week sleep discrepancy of 2.49 hours (SD = 1.84). Nineteen percent reported that they worried rather much or very much about whether they got enough sleep (42% re– ported no worry), and 13% reported that they generally slept badly (56% reported they never slept badly). Seventy–six per– cent described themselves as rather or very much an evening person. Because of relatively small sample sizes (when compared to the overall sample size) for students identifying as Asian, Latino, or other, analyses of race/ethnicity effects included just African American and Caucasian students. Chi–square analyses indicated no significant race differences in risk for sleep disorders, although 2 approached significance. A higher percentage of Caucasian students were at risk for RLS/PLMD (9%6%; $\chi^2(1)$ = 2.67, p = .10) and insomnia (12%9%; $\chi^2(1)$ = 3.05, p = .08). A Gender × Race ANOVA examining the number of poor sleep hygiene practices (the Factors Affecting Sleep scale) produced a significant main effect of race/ethnicity, $F(4, 1585)$ = 31.39, p.01, ηp^2 = .02. African Americans students (M = 8.45, SD = 1.69) had fewer poor sleep hygiene practices than did white students (M = 9.31, SD = 2.10). There were no gender differences in the percentages at risk for OSA, CRDs, or hypersomnia (Table 2). Females were at greater risk for RLS/PLMD, insomnia, affective disorder, nightmares, and having at least one sleep disorder. An ANOVA examined whether having any sleep disorder (no disorders versus at least one sleep disorder) was associ– ated with GPA. Those who reported no sleep disorder had a higher GPA (M = 2.82, SD = .88) than did those who re– ported at least one sleep disorder (M = 2.65, SD = .99), $F(1, 1842)$ = 15.17, p.01, ηp^2 = .01. Self–identified morn– ing people had a higher GPA (M = 2.90, SD = .84) than did evening people (M = 2.72, SD = .93), $t(1842)$ = 3.56, p.01. In response to a statement "I generally sleep badly," those who indicated this described them "very much" had a significantly lower GPA (M = 2.35, SD = 1.10) than those who indicated it was "rather much" (M = 2.71, SD = .79), "somewhat" (M = 2.75, SD = .97), or "not at all" (M = 2.82, SD = .88) true of themselves, $F(3, 1836)$ = 7.32, p.01. Grade point average was significantly but weakly corre– lated with amount of sleep prior to school/work (r = .12, p.01), and with the difference score (r = −.06, p.05), indi–

cating that students who got more sleep before school/work and those who reported more consistent sleep schedules had higher grades. Although significant, these correlations are still small, and should be interpreted cautiously. Another way to characterize the "real-world" associations between potential sleep disorders and GPA is to examine numbers of students at risk for a sleep disorder who are also at risk academically. At this institution, students must maintain a 2.0 GPA. If they fall below that they are put on academic probation and, unless the GPA improves over the next semester, expelled. A significant number of students at risk for OSA, insomnia, or CRDs were also in academic peril (Table 3). Individuals at risk for at least one disorder were significantly overrepresented in the group with a GPA2.0. This disparity was most apparent among female stu- dents. African American and white students at risk for a sleep disorder were at equal risk academically. COMMENT Seventy million Americans (≈23%) are reported to have some type of sleep disorder.16 The 27% reported by this sam- ple is in line with that estimate. Prevalence for each sleep dis- order in this sample was consistent with those reported in the literature, with one glaring exception. Narcolepsy likely af- fects There was no reason to assume that this sample was at any greater risk than similar ones, although this possibility cannot be ruled out. The anomaly could be due to some characteristic of the Narcolepsy scale on this questionnaire. Spoormaker et al15 noted that the Nar- colepsy scale was the most problematic, with one of its items loading on the IDF scale, and another loading on both Nar- colepsy and Nightmares scales. The Narcolepsy scale for this sample may be conflated with other sleep disorders. This ar- gument is strengthened by the fact that all 89% of students who were at risk for narcolepsy were also at risk for at least one other disorder. Arguing against overinclusion, however, is the finding in the validation study of a specificity score of .86, but a sensitivity score of just .67 for the Narcolepsy scale, suggesting that the scale did a good job of excluding those who did not have narcolepsy, but did less well at identi- fying those who did have narcolepsy. If anything, narcolepsy should have been underestimated. Students at risk for OSA were overrepresented within stu- dents with a GPA2.0, as were those at risk for insomnia, CRDs, or at least one sleep disorder. Why female, African American, and white students had the greatest connection be- tween risk for a sleep disorder and lowered GPA is not clear. Future research will need to examine group differences in severity of sleep disorders and comorbid risk factors. A number of mechanisms may explain the relation be- tween sleep disorders and academic performance. An ob- vious one is daytime sleepiness, with lowered levels of at- tention,18 and impaired memory and decision making. 19 If daytime sleepiness was the only culprit, however, it is not clear why the same relation with academic performance was not found for PLMD/RLS or hypersomnia. It is possible that students with these disorders were less sleepy than other groups; however, in the absence of a measure of sleepiness, we cannot speculate on relative degrees of daytime sleepiness associated with risk for these disorders. Adequate, uninterrupted sleep may optimize learning and cognitive functioning. Sleep appears to play an important, al- though not well-understood, role in memory consolidation.20 Sleep after study promotes integration of newly acquired material with existing memories. Untreated sleep disorders, therefore, may hamper a student's ability to learn new ma- terial well. Obstructive sleep apnea has been associated with cognitive deficits,21 and treatment of OSA may21 or may not22 improve cognition. Less directly, poor sleep might im- pact learning by means of reduced motivation, compromised health, or depressed

mood. In the current sample, race/ethnicity did not produce sig‑ nificant differences in risk for sleep disorders. Although some studies have found Caucasians to be at greater risk for RLS/PLMD, others have found no race differences.23 African Americans have been reported to be at greater risk for OSA.24 It may be that race/ethnic differences in sleep dis‑ orders were not found in the present study because college students are not representative of adults in general. For exam‑ ple, they may have more ready access to health care. Because of the lack of consensus in the literature about race/ethnic dif‑ ferences in prevalence of sleep disorders, the nonsignificant trends reported here, and the potential benefits of identifying those most at risk for specific sleep disorders, future research should further explore any race‑ or ethnicity‑related differ‑ ences in sleep disorders. Females were at greater risk for RLS/PLMD, insomnia, affective disorder, nightmares, and more likely to be at risk for at least one sleep disorder. Other studies have found fe‑ males to be at greater risk for RLS.25 There could be several reasons for this, such as pregnancy, low iron levels (iron is an essential cofactor for the metabolism of dopamine),26 or ge‑ netics.27 Insomnia, affective disorders, and nightmares may represent co‑occurring sleep and mood problems that are closely intertwined and likely transactional. Nightmares and short sleep duration are associated with suicidal behavior.28 Distress associated with nightmares predicts greater levels of psychological disturbance.29 Women are more likely to report depression, anxiety, and nightmares, which are asso‑ ciated with stress and psychopathology.30 Therefore, insom‑ nia and nightmares might be related to depressive symptoms among women in this sample. This will need to be tested by future research. Most students in this sample considered themselves to be evening people and reported insufficient sleep during the week, which they tried to make up on the weekends, result‑ ing in a day‑of‑week discrepancy of almost 2.5 hours. These self‑reported amounts of sleep need to be verified by objec‑ tive measures such as actigraphy. Being an evening person, sleeping "badly," getting less sleep, and having inconsistent bedtimes predict a lowered GPA. These behaviors may be modifiable (given sufficient motivation), and education about sleep hygiene may be useful, perhaps as part of an interven‑ tion package for students who are struggling academically. Assuming an average basal sleep need of 8 hours per night,3 the students in this sample, who reported a mean of 6.79 hours of sleep during their school/work week, lost 6.05 hours of sleep over 5 days. Even though they compensated by getting extra sleep on the weekends, this extra sleep (2.6 hours over a 2‑day period) was not enough to compensate for the lost sleep during the week, resulting in a mounting sleep debt. Although there are individual differences in amount of sleep needed, the fact that 86% of the participants reported that waking up tired was somewhat, rather much, or very much true of them indicates that the majority of students were not getting adequate rest. Identification and treatment of students with sleep disor‑ ders may produce benefits such as improved academic per‑ formance and better quality of life. If the findings reported here are representative, then sleep screening and treatment among college students may be of great benefit, particularly among individuals at risk for academic failure. Diagnosis and treatment of sleep disorders could lead to increased or more consolidated sleep in young adults, and may improve cognition and mood. When 15 college students were asked to sleep as much as possible at night during the sleep‑extension phase of one study,30 daytime sleepiness decreased, and reaction time, mood, and fatigue improved, despite the fact that participants had

reported little daytime sleepiness prior to the extension phase. Additional research is needed to determine whether treating sleep disorders trans– lates into improved academic performance and/or quality of life. A few universities have tried interventions intended to im– prove sleep. Although several studies emphasize a need to educate college students about good sleep hygiene, it is not established that this will change sleep behavior or daytime outcomes. Tsai and Li[31] evaluated the effectiveness of a 2– credit course on sleep management. Lectures, group discus– sion, and self–evaluation were used to educate 241 college students about sleep hygiene, resulting in improved sleep quality, but not sleep patterns. The authors concluded that the course had only a mild impact on sleep behaviors. Other evidence, however, suggests that knowledge of sleep hygiene does impact sleep–related behavior, with increased knowl– edge of sleep hygiene resulting in better sleep practices, which, in turn, was associated with better sleep quality.[32] One reason for this discrepancy may be undetected and untreated sleep disorders. Education can highlight poor sleep practices, but cannot overcome a physiologically based sleep disorder. Future research can test the effectiveness of sleep education among those with no apparent risk for a sleep disorder. In a best–case scenario, successful treatment of sleep dis– orders or improved sleep practices might increase GPAs, improving students' chances of staying in school and ulti– mately graduating. Although it is reasonable to expect that a successfully treated sleep disorder will contribute to aca– demic success, a cause–and–effect relationship has not been established. Given the potential prevalence of sleep disorders, careful study is needed. Extrapolating from the percentages obtained from this sample, 6,575 students in this institu– tion might be at risk for a sleep disorder, with 1,446 of the 6,575 already in academic trouble. Obviously, there are many other factors that could influence grades, retention, and grad– uation rates that are unrelated to sleep. However, it seems reasonable for colleges to consider adding sleep screening and intervention early in students' academic experience in an effort to improve student health as well as retention and graduation rates. Sleep screening is low–cost and easy to im– plement. Follow–up plans to direct at–risk students to sleep labs accredited by the American Academy of Sleep Medicine would need to be developed. Large–scale screening and re– ferral of entering college students, and any related outcomes, need to be examined in a prospective study. Few large–scale studies have examined patterns of risk for sleep disorders among college students in light of gender, race, and academic success. One strength of the current study is the use of a survey that was validated for this population. GPA was actual rather than self–reported and was current as of the end of the semester in which the survey was taken. No survey, however, can take the place of diagnosis by a sleep physician. Although the survey results could identify participants at risk for a sleep disorder, it was not known whether they had a diagnosable disorder. In addition, factors unrelated to sleep almost certainly influenced GPA. Another limitation of the study was the inflated Narcolepsy scale. Further validation of this scale is needed. This report is an initial look at an understudied population. It raises issues that require additional study, especially with regard to the actual prevalence of sleep disorders among college students as a group as well as among subgroups; effective approaches to screening for sleep disorders; the academic, social, and health outcomes of identifying and treating sleep disorders; and effective means of promoting sleep awareness and good sleep practices among college stu– dents. Given cultural differences in beliefs about and

patterns of sleep,33 interventions for sleep practices may need to be culture specific. Online surveys offer a practical approach to screening large numbers of students, but plans must be in place to notify students who are at risk for a sleep disorder and to direct them to an appropriate physician. Information about good sleep practices could be integrated into freshmen seminars or introductory meetings. Producing a fundamen- tal change in sleep-related behavior and attitudes, however, is a much more daunting task. The length and content of effective interventions will need to be established. Identify- ing and treating sleep disorders will likely be simpler than convincing a student to practice good sleep hygiene. In summary, these data indicate a substantial number of college students may be at risk for sleep disorders or poor sleep hygiene, and that sleep may impact academic success. Institutions of higher learning are concerned about student retention and graduation rates.34 Twenty-seven percent of the present sample were at risk for at least one sleep dis- order. Risk for a sleep disorder predicted GPA, which, in turn, predicts students' persistence in college.35 Identifica- tion and successful resolution of sleep problems, therefore, might increase retention and graduation rates. Czeisler,36 re- ferring to businesses, stated that "[p]aying attention to sleep is the low-hanging fruit that could dramatically raise produc- tivity." Perhaps the same will be true for academic produc- tivity, although further study is needed to see the impact of treatments. It is worth the effort to identify and treat sleep disorders among college students in hopes of improving their overall health as well as their academic success.