# Nightmare Frequency as a Function of Age, Gender, and September 11, 2001: Findings From an Internet Questionnaire

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*Retrospective estimates of nightmare frequency for a sample of 23,990 respondents to an Internet questionnaire (female: N = 19,367, mean age = 24.9 ± 10.14 years; male: N = 4,623; mean age = 25.5 ± 10.81) were evaluated as a function of age, gender, and pre- versus post-September 11, 2001. Female respondents reported more frequent monthly nightmares (4.44 ± 6.71) than did male respondents (3.39 ± 6.07), and this result was seen for all age strata younger than 60. Also, for female respondents, nightmare frequency increased from ages 10–19 to 20–39 then decreased monotonically to ages 50–59. For male respondents, nightmare frequency was stable from ages 10–19 to 30–39 then decreased to ages 50–59. An increase in nightmare frequency was observed post-September 11 only for male respondents—particularly for 10- to 29-year-olds. This increase was sustained 2 years later. These effects were maintained when dream recall was held constant. Results replicate, in a single sample, previously published gender and age effects and provide new evidence that the nightmares of males may be differentially sensitive to traumatic events for which victims and/or perpetrators are primarily male.*

**KEY WORDS:** parasomnias, nightmares, age, gender, September 11, 2001

Nightmares are the most common parasomnia, with 2–6% of respondents from community-based surveys reporting at least weekly episodes (Belicki &

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Belicki, 1982; Bixler, Kales, Soldatos, Kales, & Healy, 1979; Haynes & Mooney, 1975; Levin, 1994; Ohayon, Morselli, & Guilleminault, 1997). Weekly nightmares are considered in the *International Classification of Sleep Disorders, Revised: Diagnostic and Coding Manual* (American Sleep Disorders Association, 1997) to reflect at least moderately severe pathology. Nightmares are more frequent in children, females, and psychiatric patients, less frequent in older individuals, and comparable in frequency across many cultures.

Frequent nightmares are a correlate of psychopathology, although perhaps not as sensitive an indicator as the degree of subjective suffering that nightmares produce (Levin & Fireman, 2002). Frequent nightmares are also a typical, if not a defining, feature of posttraumatic stress disorder (PTSD). Thus, nightmare frequency in the general population might be expected to increase in step with other psychiatric symptoms after terror attacks such as those of September 11, 2001 (Galea et al., 2002). The far-reaching impact of the September 11 attacks was, in fact, detected in the content of dreams from nontraumatized persons (Hartmann & Basile, 2003). A generalized change in dreams has also been demonstrated after other disasters, such as Hurricane Iniki in 1992 (Pagel, Vann, & Altomare, 1995).

Apart from findings such as these, large-scale studies of posttraumatic nightmares that also take into account gender and age differences are rare. The goals of the present study were thus to assess nightmare frequency as a function of age and gender among respondents to an Internet questionnaire that was available to the general public beginning in January 1997 and to determine whether the events of September 11, 2001, were associated with changes in the self-reported nightmare frequencies of male and female respondents of different age strata.

## METHOD

Responses were taken from replies to a questionnaire that was available on the Montreal Dream & Nightmare Laboratory Web site between January 28, 1997, and January 14, 2004. A text version of this questionnaire has been published (Nielsen et al., 2003), and a modified online version is available (http://www.jtkresearch.com/dreamlab/). Characteristics of the questionnaire administered to a cohort of students at three major Canadian universities have also been published (Nielsen et al., 2003).

Among other items, the questionnaire requested age, gender, mother tongue, and estimates about the numbers of dreams and nightmares recalled in a typical month (i.e., "How many dreams do you recall in a typical month? ____ And how many nightmares? ____"). The time and date that each questionnaire was submitted was logged by the local server. Several other questions were posed concerning demographics and the prevalence of 55 typical dream themes, but only results concerning age, gender, and nightmare frequency are reported here. Participants were informed on the Web site that results from the study would be used in research and published in group form at a later date.

The database of raw responses was reduced in several ways (see Table 1). First, a research assistant manually checked each subject record and deleted all duplicates, errors, and estimates of extreme dream recall (>124/month or 4/day) or nightmare recall (>93/month or 3/day). Of the 30,743 original records, 7.3% (2,240) were deleted due to such factors; the majority of these were duplicate submissions

**Table 1.** Exclusion Criteria Applied to Prepare Internet Sample for Statistical Analysis

| Exclusion criterion | No. cases excluded | % cases excluded | No. cases retained |
|---|---|---|---|
| Original records (January 1997 to January 2004) | | | 30,743 |
| 1. Duplicate submissions, erroneous values, reported >93 nightmares or >124 dreams per month | 2,240 | 7.29 | 28,503 |
| 2. Failed to estimate dream and/or nightmare recall | 2,973 | 9.67 | 25,530 |
| 3. Age and/or sex not specified | 1,527 | 4.97 | 24,003 |
| 4. Age <10 or >99 years | 13 | 0.04 | 23,990 |
| Cases for statistical analysis | 6,753 | 22.0 | 23,990 |

caused by a technical oversight (respondents double- rather than single-clicking the submit button). Second, respondents were excluded who failed to estimate their dream and/or nightmare recall (2,973). Third, respondents were excluded who did not specify their age and/or gender (1,527). Fourth, respondents were excluded who indicated that they were younger than 10 years (8) or older than 99 years (5). A total of 23,990 records, or 78% of the original data set, was retained for analysis.

Raw nightmare frequencies for the 23,990 respondents were initially examined with standard descriptive statistics. Because of skewness in the distribution of the nightmare frequency scores, these were log-transformed (log frequency + 1) to produce a more normalized measure (logNM) that was used in multivariate comparisons. LogNM was assessed as a function of gender, 9/11 status and age using, initially, a 2 × 2 × 6 ANOVA with gender (male or female), 9/11 status (pre-9/11 or post-9/11), and age (10–19, 20–29, 30–39, 40–49, 50–59, and 60–99) as independent variables. However, because large sample size inequalities between the six age strata (*N*s = 9,316, 8,381, 3,641, 1,897, 604, and 151, respectively) produced large heterogeneity of variance for this variable and because no interactions with age were obtained for this analysis, main effects and interactions for gender and 9/11 status were evaluated separately with a 2 (male, female) × 2 (pre-9/11, post-9/11) ANOVA. Effects were further evaluated with a priori polynomial trends (for age) and post hoc Student *t* tests (for age, gender, and 9/11 status).

Raw age scores were also assessed with a 2 (male, female) × 2 (pre-9/11, post-9/11) ANOVA and *t* tests to assess differences between groups on this factor. To determine whether the effects for nightmare recall were independent of effects for dream recall in general, main effects for logNM were reassessed in relation to a log-transformed (log frequency + 1) measure of dream recall (logD).

## RESULTS

Of the total sample, 19,367 respondents were female and 4623 male; females were, on average, 6 months younger (24.9 ± 10.14 years) than males [25.5 ± 10.81 years; $F(1, 23{,}986) = 7.742$, $p = .005$]. The only 10-year stratum for which this gender difference was significant was ages 10–19, in which females were about 2.5 months younger (16.4 ± 1.87 years) than males [16.6 ± 1.84 years; $t(9{,}314) = 3.515$, $p = .0004$]. Thirteen percent of the sample (3,125) fell into the pre-9/11 group and 87% (20,865) into the post-9/11 group (see Table 2). Post-9/11 participants were on

**Table 2.** Study Sample by Gender and 9/11 Status

| | No. cases | % cases |
|---|---|---|
| Pre-9/11 | | |
| Males | 674 | 2.81 |
| Females | 2,451 | 10.22 |
| Post-9/11 | | |
| Males | 3,949 | 16.46 |
| Females | 16,916 | 70.51 |
| Total | 23,990 | 100.00 |

average almost 3 years younger (24.7 ± 10.11 years) than pre-9/11 participants [27.6 ± 11.96 years; $F(1, 23{,}986) = 153.102$, $p < .01 \times 10^{-10}$]. Age was thus used as a covariate in subsequent comparisons of 9/11 status. The principal spoken languages of the sample were English (88.6%) and French (8.3%), with a small percentage of Spanish (1.0%) and other languages such as Russian, German, Italian, and Dutch (2.2%).

The overall mean frequency of raw nightmare recall was 4.24 ± 6.07 nightmares/month or slightly less than 1 nightmare/week (see Table 3). This value was higher for females (4.44 ± 6.71) than for males [3.39 ± 6.07; $F(1, 23{,}988) = 94.375$, $p < .03 \times 10^{-20}$]—an odds ratio of 1.31 to 1. The value also varied with age [$F(1, 23{,}978) = 5.990$, $p < .0002$], with the lowest frequency (2.33 ± 5.12) occurring for the 60–99 group and the highest frequency (4.51 ± 6.48) for the 20–29 group. The number of respondents reporting at least 4.5 nightmares/month (1 nightmare/week) was 28.8%, a value that was higher for females (30.4%) than for males (22.2%; $\chi^2$ [1] = 122.74, $p < .01 \times 10^{-25}$). The number reporting at least 9 nightmares/month (2 nightmares/week) was 14.8%, a value also higher for females (15.8%) than for males (10.7%; $\chi^2$ [1] = 76.29, $p < .01 \times 10^{-16}$). The overall median of 2 and mode of 1 reflect the negative skew of the distribution of raw scores and need for log transformation.

ANOVA main effects for the logNM variable were observed for gender, 9/11 status and age (all $p < .00000001$). For gender [$F(1, 23{,}966) = 43.625$], females reported more frequent nightmares (0.542 ± 0.388) than males overall (0.436 ± 0.385) and at every age stratum except 60–99 ($p = .235$; see Figure 1). A year-by-year assessment of the 10–19 age stratum indicated that the gender difference first appeared as a trend at age 14 [$t(742) = 1.887$, $p = .060$] and then significantly differentiated groups for all ages thereafter (all $p < .01$).

For age, changes in logNM with increasing age [$F(5, 23{,}766) = 16.205$] were best described by a linear trend ($p = .000000002$) and secondarily by a cubic trend ($p = .006$). Contrasts between adjacent age strata indicated that logNM increased

**Table 3.** Descriptive Statistics for Raw Nightmare Frequency (per Month)

| Descriptive statistic | Females | Males | Total |
|---|---|---|---|
| *N* | 19,367 | 4,623 | 23990 |
| Mean | 4.44 | 3.39 | 4.24 |
| *SD* | 6.71 | 6.07 | 6.07 |
| Mode | 1 | 0 | 1 |
| Median | 2 | 1 | 2 |
| % reporting ≥4.5 nightmares/month (~1 nightmare/week) | 30.3 | 22.2 | 28.8 |
| % reporting ≥9 nightmares/month (~2 nightmares/week) | 15.2 | 10.3 | 14.3 |

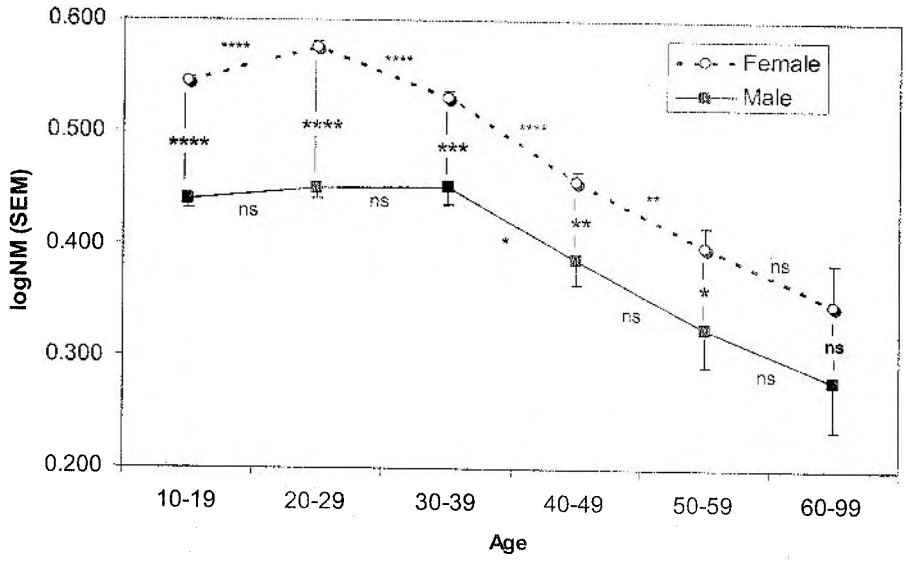


**Figure 1.** Log frequency of nightmare recall by gender and age for 23,990 respondents. ns = not significant. $^{*}p < .05$; $^{**}p < .01$; $^{***}p < .001$; $^{****}p < .00001$.

from ages 10–19 (0.525 ± 0.383) to 20–29 [0.551 ± 0.388; $t(17{,}448) = 4.397$, $p < .00001$], then decreased monotonically to 30–39 [0.517 ± 0.397; $t(12{,}020) = -4.549$, $p < .000005$], 40–49 [0.443 ± 0.391; $t(5{,}536) = -6.500$, $p < .0000001$], and 50–59 [0.380 ± 0.386; $t(2{,}499) = -3.477$, $p < .001$] but only marginally to 60–99 [0.325 ± 0.351; $t(249) = -1.676$, $p = .095$].

However, different age-related profiles were observed for females and males. For females, the changes with age were very pronounced, with a significant increase from ages 10–19 (0.545 ± 0.383) to 20–29 [0.576 ± 0.386; $t(14{,}306) = 4.824$, $p < .000002$], followed by a decrease to 30–39 [0.530 ± 0.392; $t(9{,}684) = -5.341$, $p < .0000001$], 40–49 [0.456 ± 0.385; $t(4{,}506) = -6.078$, $p < .000000002$], and 50–59 [0.398 ± 0.376; $t(1{,}990) = -2.796$, $p < .006$] but no further decrease to 60–99 [0.348 ± 0.370; $t(549) = -1.230$, $p = .219$; see Figure 1]. A more detailed analysis revealed that the downturn in logNM first occurred comparing ages 25–29 (0.580 ± 0.383) to 30–35 [0.544 ± 0.393; $t(4{,}387) = -3.028$, $p < .003$]. In fact, the only significant drop between adjacent years in these strata was from age 28 (0.610 ± 0.372) to 29 [0.548 ± 0.381; $t(889) = -2.474$, $p < .015$].

For males, no increase was apparent for ages 10–19 to 20–29 (0.440 ± 0.371 vs. 0.450 ± 0.380) nor was there a decrease from 20–29 to 30–39 (0.450 ± 0.380 vs. 0.452 ± 0.410). However, there was a decrease from 30–39 to 40–49 [0.452 ± 0.410 vs. 0.388 ± 0.409; $t(1{,}028) = -2.393$, $p < .017$] and a further marginal decrease from 40–49 to 50–59 [0.388 ± 0.409 vs. 0.325 ± 0.411; $t(507) = -1.577$, $p < .116$] but not to 60–99 [0.325 ± 0.411 vs. 0.279 ± 0.309; $t(109) = -0.835$, $p < .471$]. A more detailed assessment revealed the downturn in logNM for male respondents began between 30 and 34 (0.486 ± 0.418) and 35–39 [0.398 ± 0.392; $t(673) = -2.730$, $p < .007$]. Although the sample size for males was too small to conduct year-by-year comparisons, tests of adjacent 2-year strata revealed a single significant decrease from ages 30–31 (0.528 ± 0.441) to 32–33 [0.431 ± 0.373; $t(349) = -2.247$, $p < .026$].

For 9/11 status, logNM was higher for post-9/11 (0.525 ± 0.389) than for pre-9/11 (0.497 ± 0.393) participants [$F(1, 23{,}986) = 21.440$, $p < .000004$], even when age was controlled as a covariate [$F(1, 23{,}985) = 13.474$, $p < .0003$]. Further, a Gender × 9/11 Status interaction [$F(1, 23{,}986) = 10.437$, $p < .002$; Figure 2] indicated that the pre- versus post-9/11 difference was obtained for males [0.375 ± 0.364 vs. 0.446 ± 0.387; $F(1, 4{,}621) = 19.893$, $p < .000009$], even with age covaried [$F(1, 4{,}620) = 15.976$, $p < .00007$], but was not obtained for females [0.531 ± 0.394 vs. 0.543 ± 0.387; $F(1, 19{,}365) = 2.303$, $p = .129$; $F(1, 19{,}364) = 0.229$, $p = .633$ age covaried]. By age strata (see Figure 3), the 9/11 status effect was robust for males ages 10–19 ($p = .005$) and 20–29 ($p = .019$), absent for males ages 30–49 and 60–99, and marginal for males ages 50–59 ($p = .053$). For females, the 9/11 status effect was not apparent at any age.

Analysis of the pre- versus post-9/11 effect by 3-month averages for males revealed that, relative to the third (pre-9/11) quarter of 2001, logNM (0.349 ± 0.373) was significantly higher in the fourth quarter of 2001 [0.459 ± 0.394; $t(531) = 2.772$, $p < .007$), whereas Duncan's multiple-range test indicated that the third quarter of 2001 formed a subset distinct from all subsequent quarters ($p < .05$). Further, Dunnett $t$ tests comparing all subsequent quarters to the third quarter revealed that logNM for the latter was lower than logNM for 7 of 10 of the post-9/11 quarters ($p < .05$; Figure 4) and marginal for the other 3 ($p < .15$).

The previous effects for logNM were further examined in relation to the log-transformed dream recall estimate (logD). The two measures were found to be positively correlated [$r(23990) = .397$, $p < .001$). Using a similar 2 (male, female) × 2 (pre-9/11, post-9/11) design with logD as dependent measure, significant effects were found for gender [$F(1, 23986) = 128.483$, $p < .00000001$), 9/11-status [$F(1, 23986) = 4.634$, $p < .031$) and the gender × 9/11-status interaction [$F(1, 23986) = 6.288$, $p < .012$). In this case, logD was higher for females (1.042 ± 0.355) than for males (0.962 ± 0.385) and was higher pre-9/11 (1.051 ± 0.365) than post-9/11 (1.023 ± 0.362). Further, logD decreased pre- to post911 for females (1.076 ± 0.356 vs. 1.037 ± 0.353) while it did not for males (0.959 ± 0.382 vs. 0.962 ± 0.385). These effects were unchanged by covarying age. A one-way ANOVA with age as the independent variable also revealed a significant effect for age [$F(1, 23984) = 11.313$,

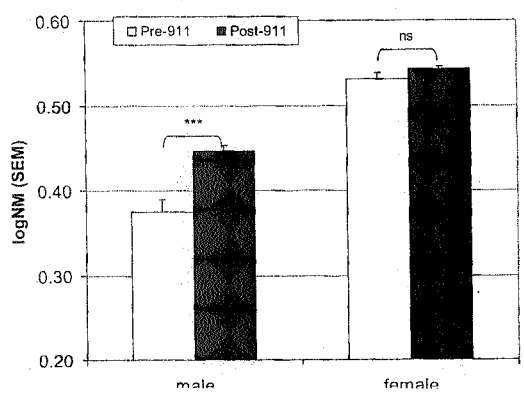


**Figure 2.** Log nightmare frequency for participants responding pre- and post-9/11. Post-9/11 frequency was larger than pre-9/11 frequency for male, but not female, respondents.

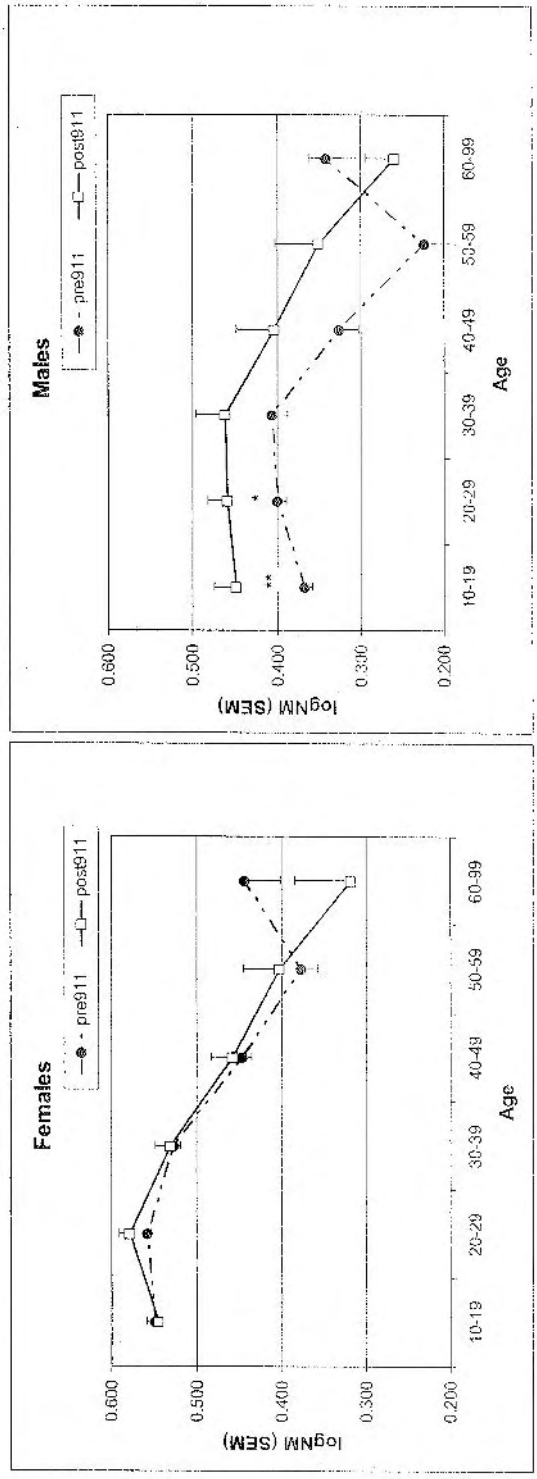


**Figure 3.** Log nightmare frequency for participants responding pre- and post-9/11 as a function of gender and age.
$^{*}p < .05$; $^{**}p < .01$.

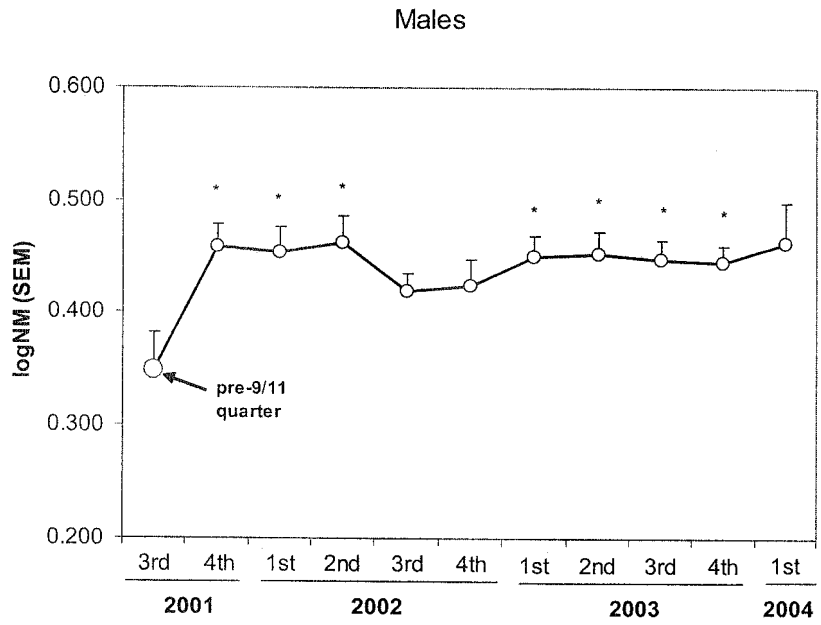


**Figure 4.** Log nightmare frequency for male participants pre- and post-9/11 by yearly quarters (*$p < .05$ relative to pre-9/11 quarter).

$p < .00000001$) which was best described by a cubic trend ($p < .001$), that is, recall increased from 10–19 (1.011 ± 0.351) to 20–29 (1.044 ± 0.355) and 30–39 (1.040 ± 0.373), decreased to 40–49 (1.010 ± 0.392) and 50–59 (0.977 ± 0.409) and increased again to 60–99 (1.013 ± 0.447).

To minimize the effects of dream recall on nightmare recall, both age and logD were entered as covariates in the previous 2 (male, female) × 2 (pre-9/11, post-9/11) and one-way (age) logNM designs. Significant results still obtained for all effects: gender [$F(1, 23984) = 101.583$, $p < .00000001$), 9/11-status [$F(1, 23984) = 24.248$, $p < .0000001$), gender × 9/11-status [$F(1, 23984) = 5.731$, $p < .017$), and age [$F(1, 23984) = 46.575$, $p < .00000001$).

## DISCUSSION

The findings reveal a very high frequency of nightmares in the study sample: 4.24 nightmares/month or just less than 1 nightmare/week (the corresponding frequency of dream recall was 13.7/month or about 3/week). In fact, 28.8% of the sample reported at least 1 nightmare/week, whereas 14.3% reported at least 2 nightmares/week. This estimate is higher than others reported in the literature and twice as high as an estimate for 936 university students (1.97 ± 3.40 nightmares/month) obtained using the same questionnaire (Nielsen et al., 2003). In general, weekly nightmares are reported by 2–6% of samples (see Levin & Nielsen, in press) and correspond to the *International Classification of Sleep Disorders, Revised* definition of a moderately severe nightmare disorder. One explanation for the high frequency of nightmares in our sample is that individuals seeking out our Web site

tended to suffer from more frequent disturbed sleep or dreaming. Because our site was meta-tagged with terms such as dreaming, nightmares, and sleep paralysis, it would be highly visible to browsers employing such keywords. A second explanation is that the question concerning nightmare frequency was posed at the end of a questionnaire that asked respondents to reflect upon past occurrences of 55 typical dream themes, including numerous nightmare themes. This induced reflection may have reminded many respondents of recent nightmares and thus increased their recall estimates, or it may have inadvertently biased respondents toward more artificially liberal estimates of recall.

Despite these potentially confounding factors, the findings nevertheless replicate and extend, in a single sample, two widely cited effects in the reporting of nightmares: (a) a ubiquitously higher frequency of nightmares for females than for males and (b) an age-related decrease in the frequency of nightmares. They also reveal (c) an elevated frequency of nightmares that is unique to male participants after the events of September 11, 2001.

## Gender Difference

Our observed gender difference in the reporting of nightmares is consistent for all age strata except the oldest (60–99 years). The female-to-male odds ratio (1.31) is very similar to that from our study of Canadian university students (1.47) using the same questionnaire (Nielsen et al., 2003). The gender difference also replicates and extends gender differences in nightmare prevalence and frequency that have been observed for 5- to 7-year-old children (Smedje, Broman, & Hetta, 1999), adolescents (Agargun et al., 2003; Choquet, Tesson, Stevenot, Prévost, & Antheaume, 1988; Ipsiroglu et al., 2001; Levin, 1994; Liu, Uchiyama, Okawa, & Kurita, 2000; Nielsen, Laberge, Tremblay, Vitaro, & Montplaisir, 2000; Schredl & Pallmer, 1998; Vignau et al., 1997), adults (Coren, 1994; Hublin, Kaprio, Partinen, & Koskenvuo, 1999; Klink & Quan, 1987), and the general population (Ohayon et al., 1997). Some researchers have deviated from this pattern, reporting a selective absence of the gender difference for preadolescent children (Fisher, Pauley, & McGuire, 1989; Mindell & Barrett, 2002; Schredl & Pallmer, 1998; Vela-Bueno et al., 1985), but these deviations do not necessarily contradict our own findings because we combined preadolescent and adolescent participants in a single 10–19 years stratum and demonstrated with yearly analyses that the gender difference appears at age 14. The latter result replicates a previous finding from a cross-sectional sample of a marked gender difference beginning at age 14 (Schredl & Pallmer, 1998) and a second finding from a longitudinal study of a marked and selective increase in nightmares among girls between ages 13 and 16 (Nielsen et al., 2000). The presence of a gender difference for 5- to 7-year-olds that was previously reported (Smedje et al., 1999) may not be representative of young children at large because it was based only upon participants who reported a clinically significant frequency of nightmares (at least 1 nightmare/week). Finally, the absence of a gender difference for the oldest age group in our study fails to replicate a gender difference demonstrated in a larger population study from Sweden (Asplund, 2003), a discrepancy that may reflect a low sample size for our older group ($N = 151$).

## Age-Related Decline

Our finding of a higher frequency of nightmares for females in the 20–29 years old group relative to the 10–19 years old group is partially consistent with several studies demonstrating increasing rates of disturbing dreams from childhood through adolescence (Fisher et al., 1989; MacFarlane, Allen, & Honzik, 1954; Nielsen et al., 2000; Salzarulo & Chevalier, 1983; Simonds & Parraga, 1982). The further linear decrease with increasing age after 20–29 is also consistent with similar relationships noted for women (Klink & Quan, 1987; Tanskanen et al., 2001). For men, either an increase with advancing age in a Finnish sample (Tanskanen et al., 2001) or no change in an American sample (Klink & Quan, 1987) have been reported. The source of this variability for males is unknown but may reflect factors inherent to different study populations. For example, nightmare prevalence and chronotype covary; Icelandic participants have less prevalent nightmares and go to bed and arise about an hour later than do Swedish or Belgian participants (Janson et al., 1995). Finally, the lowest levels of reporting noted for our 60–99 years old group are consistent with results of several other studies showing low nightmare reporting among older participants compared with younger cohorts (Bengtsson, Lennartsson, Lindquist, Noppa, & Sigurdsson, 1980; Partinen, 1994; Salvio, Wood, Schwartz, & Eichling, 1992; Wood, Bootzin, Quan, & Klink, 1993). To illustrate, one group who compared healthy elderly participants with college students (Salvio et al., 1992) found that the older group had only 65% of the nightmare recall frequency and were only 20% as likely to experience problems with their nightmares as were younger participants.

## Effects of September 11, 2001

Our findings corroborate others demonstrating that the events of 9/11 had an extensive impact on population health (Hoven et al., 2005), even among individuals affected only indirectly or through the media (De Lange & Neeleman, 2004; Silver, Holman, McIntosh, Poulin, & Gil-Rivas, 2002). However, although 9/11-related symptoms of PTSD were found to diminish over time (Silver et al., 2002), the prevalence of nightmares apparently did not. The prevalence of 9/11-related PTSD symptoms among persons living outside of New York City dropped from 17% 2 months after the attacks to 5.8% 6 months after the attacks (Silver et al., 2002), whereas we observed that a post-9/11 increase in nightmare frequency remained elevated more than 2 years later. Thus, more frequent nightmares in our sample are probably not symptomatic of post-9/11 PTSD per se. On the other hand, the increase may reflect a widespread increase in residual PTSD symptoms, subclinical PTSD, or the possibility that exposure to 9/11 coverage in the media increased the vulnerability of many respondents to later, non-9/11-related, PTSD reactions.

The finding that 9/11 affected particularly the 10–29 years old male group is unexpected because females consistently reported more PTSD symptoms post-9/11 than did males (Grieger, Fullerton, & Ursano, 2003; Hoven et al., 2005; Sciancalepore & Motta, 2004; Silver et al., 2002; Torabi & Seo, 2004). A possible explanation of this differential effect is that a disproportionate number of younger males who responded to our questionnaire either identified more closely with the victims and rescuers or responded more emotionally to the aggressors than did women. The

World Trade Center and Pentagon victims were predominantly young male business, financial, government, and military agents, and the medical, rescue, and emergency medical service workers killed or working at the two sites were also predominantly male. To illustrate, the New York City Department of Health estimated in 2003 that 77% of World Trade Center victims were male; however, only 14.3% of these were 10–29 year olds (Schwartz & Li, 2003). The terrorists themselves were also predominantly young men. Studies of other disasters (e.g., Dixon, Rehling, & Shiwach, 1993) suggest that media reports can trigger PTSD, especially among individuals who consider themselves similar to the victims, who personalize the event, or who consider themselves to be at risk (De Lange & Neeleman, 2004). Consistent with this possibility is the finding of a study of post-9/11 life changes that respondents who showed increased antagonism against Arabs or Islamic cultures were uniquely male (Torabi & Seo, 2004). Younger males in particular were more likely to consider purchasing a weapon post-9/11 and less likely to effect coping activities such as turning to religion/spirituality or group activities than were females (Silver et al., 2002). A more antagonistic, protective stance may be reflected in more frequent nightmares, which often reflect themes of immanent threat, for example, pursuit, attack and injury (American Psychiatric Association, 2000). Additionally, lower perceived safety is associated with the presence of PTSD symptoms among 9/11 survivors (Grieger et al., 2003).

Our findings for dream recall also indicate that women recalled fewer dreams in general post-9/11 than they did pre-9/11, whereas recall frequency for men did not vary. This finding might be taken to suggest that men and women respond differentially to some kinds of stressful events, that is, men by recalling more dysphoric dreams and women by recalling fewer dreams in general. However, other researchers who have reported gender differences in dream recall as a function of stress (Armitage, 1992) found that women recall more dreams and men fewer dreams under high stress—a finding in direct contradiction to such a possibility.

## Validity of Internet Samples

Although the exact composition of Internet samples remains difficult, if not impossible, to authenticate, a growing body of research suggests that Internet samples constitute valid sources of personal information and are perhaps superior to other sampling methodologies in some respects. The use of Internet surveys is increasing in the areas of sleep medicine and dreaming (e.g., Cheyne, Rueffer, & Newby-Clark, 1999; Zavada, Gordijn, Beersma, Daan, & Roenneberg, 2005) as it is in other areas dealing with sensitive personal information, such as sexual health (Ross, Mansson, Daneback, Cooper, & Tikkanen, 2005) and illicit drug use (McCabe, 2004). Research suggests that people share information and experiences electronically that they might not disclose using traditional survey methodologies; further, online survey methods may reduce social desirability and yea-saying biases (see review in Rhodes, Bowie, & Hergenrather, 2003).

Online surveys have been successfully validated against paper-and-pencil tests (Im et al., 2005; Knapp, Seeley, & St. Lawrence, 2004), mail surveys (McCabe, 2004), and national population studies (Ross et al., 2005). Surprisingly high concordances between methods and similar patterns of gender differences have been observed. However, there is a clear self-selection bias toward younger respondents

(as in the present study) and more highly educated respondents (Ross et al., 2005). Other advantages to online research include reaching respondents from hidden populations, the reduction of error and bias, and fuller participation because participants have more control over when they complete the survey and feel less peer pressure to participate (Rhodes et al., 2003)

Some studies suggest that frequent Internet users may bear a preponderantly "night owl" chronotype, that is, go to bed later and get up later in the day (Esposito, Martoni, & Pasqualicchio, 2001). In at least one population study (Janson et al., 1995), this chronotype was found to be associated with a lower prevalence of nightmares. The high prevalence of nightmares that we observed thus contradicts this possibility, although, as indicated earlier, part of this high prevalence may be due to the dream and nightmare focus of our Web site.

In sum, the results of the present study provide a novel view of nightmare occurrence as a function of gender, age, and our changing times. They support the notion that nightmares are a prevalent public health problem whose importance may be growing, not declining, in the post-9/11 world.

## REFERENCES


Agargun, M. Y., Kara, H., Ozer, O. A., Selvi, Y., Kiran, U., & Kiran, S. (2003). Nightmares and dissociative experiences: The key role of childhood traumatic events. *Psychiatry and Clinical Neurosciences, 57,* 139–145.

American Psychiatric Association. (2000). *Diagnostic and statistical manual of mental disorders* (4th ed., text revision). Washington, DC: Author.

American Sleep Disorders Association (1997). *International classification of sleep disorders, revised: Diagnostic and coding manual.* Rochester, MN: Author.

Armitage, R. (1992). Gender differences and the effect of stress on dream recall: A 30-day diary report. *Dreaming, 2,* 137–141.

Asplund, R. (2003). Nightmares, sleep and cardiac symptoms in the elderly. *The Netherlands Journal of Medicine, 61,* 257–261.

Belicki, D., & Belicki, K. (1982). Nightmares in a university population. *Sleep Research, 11,* 116.

Bengtsson, C., Lennartsson, J., Lindquist, O., Noppa, H., & Sigurdsson, J. (1980). Sleep disturbances, nightmares and other possible central nervous disturbances in a population sample of women, with special reference to those on antihypertensive drugs. *European Journal of Clinical Pharmacology, 17,* 173–177.

Bixler, E. O., Kales, A., Soldatos, C. R., Kales, J. D., & Healy, S. (1979). Prevalence of sleep disorders in the Los Angeles metropolitan area. *American Journal of Psychiatry, 136,* 1257–1262.

Cheyne, J. A., Rueffer, S. D., & Newby-Clark, I. R. (1999). Hypnagogic and hypnopompic hallucinations during sleep paralysis: Neurological and cultural construction of the night-mare. *Consciousness and Cognition, 8,* 319–337.

Choquet, M., Tesson, F., Stevenot, A., Prévost, E., & Antheaume, M. (1988). Les adolescents et leur sommeil: Approche épidémiologique. *Neuropsychiatrie de l'Enfance et de l'Adolescence, 36,* 399–410.

Coren, S. (1994). The prevalence of self-reported sleep disturbances in young adults. *International Journal of Neuroscience, 79,* 67–73.

De Lange, A. W., & Neeleman, J. (2004). The effect of the September 11 terrorist attacks on suicide and deliberate self-harm: A time trend study. *Suicide & Life-Threatening Behavior, 34,* 439–447.

Dixon, P., Rehling, G., & Shiwach, R. (1993). Peripheral victims of the Herald of Free Enterprise disaster. *British Journal of Medical Psychology, 66,* 193–202.

Esposito, M. J., Martoni, M., & Pasqualicchio, G. (2001). Questionari Online: Valutazione della Tipologia Circadiana attraverso Internet [Internet Questionnaire: Validation of a circadian typology via Internet]. *EDES,* pp. 354–357.

Fisher, B. E., Pauley, C., & McGuire, K. (1989). Children's Sleep Behavior Scale: Normative data on 870 children in grades 1 to 6. *Perceptual and Motor Skills, 68,* 227–236.

Galea, S., Ahern, J., Resnick, H., Kilpatrick, D., Bucuvalas, M., Gold, J., et al. (2002). Psychological sequelae of the September 11 terrorist attacks in New York City. *New England Journal of Medicine, 346,* 982–987.

Grieger, T. A., Fullerton, C. S., & Ursano, R. J. (2003). Posttraumatic stress disorder, alcohol use, and perceived safety after the terrorist attack on the Pentagon. *Psychiatric Services, 54,* 1380–1382.

Hartmann, E., & Basile, R. (2003). Dream imagery becomes more intense after 9/11/01. *Dreaming, 13,* 61–66.

Haynes, S. N., & Mooney, D. K. (1975). Nightmares: Etiological, theoretical, and behavioral treatment considerations. *Psychological Record, 25,* 225–236.

Hoven, C. W., Duarte, C. S., Lucas, C. P., Wu, P., Mandell, D. J., Goodwin, R. D., et al. (2005). Psychopathology among New York City public school children 6 months after September 11. *Archives of General Psychiatry, 62,* 545–552.

Hublin, C., Kaprio, J., Partinen, M., & Koskenvuo, M. (1999). Nightmares: Familial aggregation and association with psychiatric disorders in a nationwide twin cohort. *American Journal of Medical Genetics, 88,* 329–336.

Im, E. O., Chee, W., Bender, M., Cheng, C. Y., Tsai, H. M., Mi, K. N., et al. (2005). The psychometric properties of Pen-and-Pencil and Internet versions of the Midlife Women's Symptom Index (MSI). *International Journal of Nursing Studies, 42,* 167–177.

Ipsiroglu, O. S., Fatemi, A., Werner, I., Tiefenthaler, M., Urschitz, M. S., & Schwarz, B. (2001). Prevalence of sleep disorders in school children between 11 and 15 years of age. *Wiener Klinische Wochenschrift, 113,* 235–244.

Janson, C., Gislason, T., De Backer, W., Plaschke, P., Bjornsson, E., Hetta, J., et al. (1995). Prevalence of sleep disturbances among young adults in three European countries. *Sleep, 18,* 589–597.

Klink, M., & Quan, S. (1987). Prevalence of reported sleep disturbances in a general adult population and their relationship to obstructive airways disease. *Chest, 91,* 540–546.

Knapp, W. D., Seeley, S., & St Lawrence, J. S. (2004). A comparison of Web- with paper-based surveys of gay and bisexual men who vacationed in a gay resort community. *AIDS Education and Prevention, 16,* 476–485.

Levin, R. (1994). Sleep and dreaming characteristics of frequent nightmare subjects in a university population. *Dreaming, 4,* 127–137.

Levin, R., & Fireman, G. (2002). Nightmare prevalence, nightmare distress, and self-reported psychological disturbance. *Sleep, 25,* 205–212.

Levin, R., & Nielsen, T. A. (in press). Nightmares, PTSD and affect distress: A review and neurocognitive model. *Psychological Bulletin.*

Liu, X., Uchiyama, M., Okawa, M., & Kurita, H. (2000). Prevalence and correlates of self-reported sleep problems among Chinese adolescents. *Sleep, 23,* 27–34.

MacFarlane, J. W., Allen, L., & Honzik, M. P. (1954). *A developmental study of the behavior problems of normal children between twenty-one and fourteen years.* Berkeley, CA: University of California Press.

McCabe, S. E. (2004). Comparison of web and mail surveys in collecting illicit drug use data: A randomized experiment. *Journal of Drug Education, 34,* 61–72.

Mindell, J. A., & Barrett, K. M. (2002). Nightmares and anxiety in elementary-aged children: Is there a relationship? *Child: Care, Health and Development, 28,* 317–322.

Nielsen, T. A., Laberge, L., Tremblay, R., Vitaro, F., & Montplaisir, J. (2000). Development of disturbing dreams during adolescence and their relationship to anxiety symptoms. *Sleep, 23,* 727–736.

Nielsen, T. A., Zadra, A. L., Simard, V., Saucier, S., Stenstrom, P., Smith, C., et al. (2003). The typical dreams of Canadian university students. *Dreaming, 13,* 211–235.

Ohayon, M. M., Morselli, P. L., & Guilleminault, C. (1997). Prevalence of nightmares and their relationship to psychopathology and daytime functioning in insomnia subjects. *Sleep, 20,* 340–348.

Pagel, J. F., Vann, B. H., & Altomare, C. A. (1995). Reported association of stress and dreaming—community background levels and changes with disaster (hurricane Iniki). *Dreaming, 5,* 43–50.

Partinen, M. (1994). Epidemiology of sleep disorders. In M. H. Kryger, T. Roth, & W. C. Dement (Eds.), *Principles and practice of sleep medicine* (2nd ed., pp. 437–452). Philadelphia: WB Saunders.

Rhodes, S. D., Bowie, D. A., & Hergenrather, K. C. (2003). Collecting behavioural data using the world wide web: Considerations for researchers. *Journal of Epidemiology and Community Health, 57,* 68–73.

Ross, M. W., Mansson, S. A., Daneback, K., Cooper, A., & Tikkanen, R. (2005). Biases in internet sexual health samples: Comparison of an internet sexuality survey and a national sexual health survey in Sweden. *Social Science & Medicine, 61,* 245–252.

Salvio, M. A., Wood, J. M., Schwartz, J., & Eichling, P. S. (1992). Nightmare prevalence in the healthy elderly. *Psychology and Aging, 7,* 324–325.

Salzarulo, P., & Chevalier, A. (1983). Sleep problems in children and their relationship with early disturbances of the waking-sleeping rhythms. *Sleep, 6,* 47–51.

Schredl, M., & Pallmer, R. (1998). Geschlechtsspezifische Unterschiede in Angsttraumen von Schulerinnen und Schulern [Gender differences in anxiety dreams of school-aged children]. *Praxis der Kinderpsychologie und Kinderpsychiatrie, 47,* 463–476.

Schwartz, S., & Li, W. (2003). *Summary of vital statistics 2002. The City of New York.* New York: Bureau of Vital Statistics, New York City Department of Health and Mental Hygiene.

Sciancalepore, R., & Motta, R. W. (2004). Gender related correlates of posttraumatic stress symptoms in a World Trade Center tragedy sample. *International Journal of Emergency Mental Health, 6,* 15–24.

Silver, R. C., Holman, E. A., McIntosh, D. N., Poulin, M., & Gil-Rivas, V. (2002). Nationwide longitudinal study of psychological responses to September 11. *Journal of the American Medical Association, 288,* 1235–1244.

Simonds, J. F., & Parraga, H. (1982). Prevalence of sleep disorders and sleep behaviors in children and adolescents. *Journal of the American Academy of Child and Adolescent Psychiatry, 21,* 383–388.

Smedje, H., Broman, J. E., & Hetta, J. (1999). Parents' reports of disturbed sleep in 5–7-year-old Swedish children. *Acta Paediatrica, 88,* 858–865.

Tanskanen, A., Tuomilehto, J., Viinamaki, H., Vartiainen, E., Lehtonen, J., & Puska, P. (2001). Nightmares as predictors of suicide. *Sleep, 24,* 845–848.

Torabi, M. R., & Seo, D. C. (2004). National study of behavioral and life changes since September 11. *Health Education & Behavior, 31,* 179–192.

Vela-Bueno, A., Bixler, E. O., Dobladez-Blanco, B., Rubio, M. E., Mattison, R. E., & Kales, A. (1985). Prevalence of night terrors and nightmares in elementary school children: A pilot study. *Research Communications in Psychology, Psychiatry and Behavior, 10,* 177–188.

Vignau, J., Bailly, D., Duhamel, A., Vervaecke, P., Beuscart, R., & Collinet, C. (1997). Epidemiology study of sleep quality and troubles in French secondary school adolescents. *Journal of Adolescent Health Care, 21,* 343–350.

Wood, J. M., Bootzin, R., Quan, S. F., & Klink, M. E. (1993). Prevalence of nightmares among patients with asthma and chronic obstructive airways disease. *Dreaming, 3,* 231–241.

Zavada, A., Gordijn, M. C., Beersma, D. G., Daan, S., & Roenneberg, T. (2005). Comparison of the Munich Chronotype Questionnaire with the Horne-Ostberg's Morningness-Eveningness Score. *Chronobiology International, 22,* 267–278.