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ORIGINAL REPORT

# Prevalence and correlates of exceeding the labeled maximum dose of acetaminophen among adults in a U.S.-based internet survey†

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## ABSTRACT

**Purpose** Acetaminophen is a commonly used analgesic; excessive doses can lead to liver damage. We sought to determine the proportion of acetaminophen users exceeding the recommended maximum daily dose of 4 g and identify correlates of such behavior.
**Methods** U.S. adults were recruited from an internet panel in summer 2010, oversampling past 30-day acetaminophen users. Among 47 738 starting the study, 5649 completed all phases; individuals with low education were underrepresented. Subjects completed a 7-day daily diary online, reporting intake of acetaminophen products selected from a comprehensive list; total daily dose was computed from product names. An exit survey elicited: attitudes/knowledge related to product ingredients, label reading, dosing behavior; demographics, medical history, general physical, and mental health status. Unconditional logistic regression identified variables independently associated with use exceeding 4 g.
**Results** Among 3618 acetaminophen users, 163 took >4 g on ≥1 day (4.5%); the median dose was 5.5 g; 26 took >8 g (0.7%). >4-g users were characterized by chronic pain, poor physical status, and heavy use of medical care. Knowledge of ingredients and recommended OTC doses for all products taken was inversely associated with >4-g use (multivariable odds ratios [ORs] = 0.5–0.6), as was the attitude to start with the lowest dose (OR = 0.6). The attitude that users could choose their own dose was positively associated (OR = 1.3).
**Conclusions** The results estimate the proportion of acetaminophen users exceeding 4 g in a group of U.S. adults, identify potentially modifiable attitudes and knowledge associated with such use, and characterize subpopulations at higher risk. Copyright © 2012 John Wiley & Sons, Ltd.

KEY WORDS—acetaminophen; dosing behavior; survey research; epidemiology; drug safety; liver damage; pharmacoepidemiology

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## INTRODUCTION

Acetaminophen is one of the most commonly used analgesic compounds worldwide and an ingredient in hundreds of over-the-counter (OTC) and prescription (Rx) products.[1] These include single-ingredient OTC pain products; combination OTC products for additional relief of symptoms of cold, flu, sinus, and allergy, and for sleeplessness; and Rx combinations with narcotic analgesics. While acetaminophen has relatively few side effects, excessive doses can lead to potentially life-threatening liver damage; intentional and unintentional overdoses are frequent causes of drug-related emergency department visits, with numbers estimated in the tens of thousands annually.[2] The labeled maximum OTC dose has been 4 g per 24 h,[3] which is intended to provide a margin of safety over higher doses that may be dangerous to the liver. In addition to those who simply take more of a specific product than recommended, the multiple indications for acetaminophen-containing products have led to concerns about inadvertent overdoses by consumers who may take more than one product without recognizing the common ingredient. This issue has received

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considerable attention over the years, with Food and Drug Administration Advisory Committee meetings in 2002[4,5] and 2009.[6] Regulations to lower the maximum recommended dose and otherwise reduce access to acetaminophen medications are being contemplated.[6–8] Changes in directions have recently been implemented (e.g. the daily dose for 500 mg OTC single ingredient acetaminophen medicines has been reduced to 3 g[9]), and other interventions are also planned.[10]

Against this backdrop, a nationally based behavioral surveillance program is being conducted to monitor U.S. consumer knowledge, attitudes, and self-dosing practices related to acetaminophen. The program is intended to document changes in these parameters over time as interventions are implemented and provide information that can improve content and targeting of future interventions. Here, we report results from a 1-week daily diary study of acetaminophen users recruited from an internet panel in summer 2010, focusing on ingestion exceeding the maximum recommended daily dose of 4 g and correlates of such behavior.

## METHODS

### *Data collection*

The study was fielded July 28–September 3, 2010 by Burke Inc., a consumer research firm, with subjects drawn from the Lightspeed Research internet panel of some 1.5 million volunteers.[11] The study was a self-administered web-based survey consisting of three parts: (i) an enrollment questionnaire that obtained demographics, developed a list of acetaminophen-containing products that respondents had on hand, and screened for eligibility; (ii) a 10-day prospective diary of OTC and Rx acetaminophen products taken in each of the 24 h in each day, completed daily, with the relatively short period selected for reasons of practicality and to allow for at least one full week of information, thereby avoiding bias from differential usage patterns on particular days of the week; and (iii) an exit questionnaire covering attitudes and knowledge related to product ingredients, label reading, and dosing behavior, additional demographics, medical history questions, a validated questionnaire on physical and mental health status, the SF-12,[12], plus information to allow the determination of dose (see questionnaires posted online). The identities of the subjects were not known to Burke or the investigators. The study was determined to be exempt from review by the Boston University Medical Campus Institutional Review Board.

A key feature was the list-based approach to identifying acetaminophen-containing medications that subjects had on hand and took during the diary period; this circumvented the need for respondents to know whether their products contained acetaminophen and de-emphasized acetaminophen as the focus of the study (nothing in any recruitment or study materials indicated this was a study of acetaminophen). A comprehensive list of 384 branded and private label acetaminophen-containing products available in the U.S. was compiled; the list included 28 single ingredient OTC products, 168 OTC multiple ingredient combinations, and 188 Rx products (all combinations). From this, each respondent initially created a list of medications on hand. A "tree-structured" approach was used to minimize the prompting list viewed at any one time: the initial question was whether anything was on hand for pain, fever, cold/flu/sinus, or allergy symptoms. For each positive response, the respondent indicated if the medications were OTC, Rx, or both. For each symptom category involving OTC medications, the respondent was shown a list of brands, and for each brand identified, specific products. Respondents then identified Rx medications by name. At enrollment, respondents indicated which of the on-hand medications they had taken during the last 30 days. The list was also used later to prompt subjects during the diary portion of the study; new medications could be added, using a similar approach.

### *Study population*

A sample of adults (age $\geq$18) was recruited at random from the internet panel. To increase the number of participants likely to use acetaminophen during the diary period, a subsequent sample of approximately equal size was restricted to those who had taken one or more acetaminophen-containing products in the past 30 days. The invitations issued each day were "balanced" in proportion to the age, sex, income, race/ethnicity, and regional distribution of the U.S. population.

A summary of subject disposition is provided in Figure 1. Overall, 215 122 invitations were emailed by Lightspeed, but it is not known how many were seen by the intended recipients. A total of 47 738 persons began the enrollment survey, with 17 613 dropping out before completing it. Of the remaining 30 125 subjects, 18 533 (61.5%) were eligible and began the diary portion of the study, and 5649 completed $\geq$7 consecutive diary days and the exit survey. These "completers" constituted 19% of the 29 365 estimated eligibles screened (i.e. 61.5% of those who started the enrollment survey); 3618 completers reported using an acetaminophen-containing product in their diaries.



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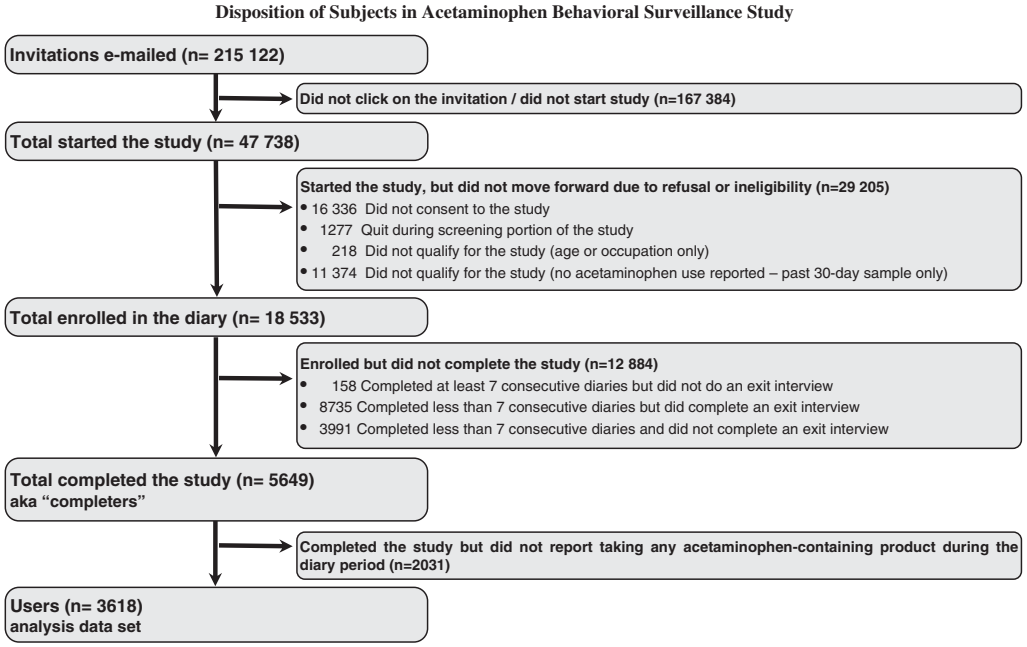


Figure 1. Disposition of subjects in acetaminophen behavioral surveillance study

Table 1 compares the 18 533 respondents who started the diary and the 5649 who completed the study with U.S. Census projections for 2009.[13] There was under-representation of participants with low education: those who did not complete high school accounted for only 2–3% compared with 15% of the U.S. adult population. There were also fewer in the lowest income category (<$25 000): 16–17% compared with 25% in the national population. With regard to other demographic factors, there was a modest underrepresentation of males, and the final sample also had a slightly higher proportion of whites than the national population. All noted differences were statistically significant.

### *Estimation of daily acetaminophen dose*

The dose of each reported acetaminophen ingestion was calculated, and ingestions were summed to determine the total dose for each day (midnight to midnight). Wherever possible, the dosage of specific medications was determined from the product name, supplemented,

Table 1. Comparison of study respondents with U.S. Census

| | | Total initial recruits (*n*=18 533) | | Final sample (*n*=5,649) | | U.S. Census (2009 projections) |
|---|---|---|---|---|---|---|
| | | No. | % | No. | % | % |
| Age (median) | | 44 | | 49 | | **47** |
| Male | | 8057 | *43* | 2481 | *44* | ***49*** |
| White race | | 14 465 | *78* | 4613 | *82* | ***77*** |
| Education* | <12 years | 389 | *3* | 139 | *2* | ***15*** |
| | HS graduate | 2110 | *15* | 877 | *16* | ***28*** |
| | Some college | 5256 | *37* | 2001 | *36* | ***29*** |
| | College graduate | 6572 | *46* | 2610 | *46* | ***28*** |
| Income*† | <$25 000 | 2878 | *17* | 824 | *16* | ***25*** |
| | $25 000–49 999 | 4537 | *27* | 1412 | *27* | ***25*** |
| | $50 000–74 999 | 3762 | *22* | 1215 | *23* | ***18*** |
| | $75 000–99 999 | 2736 | *16* | 828 | *16* | ***12*** |
| | ≥$100 000 | 3132 | *18* | 906 | *17* | ***20*** |
| Region | Northeast | 3408 | *18* | 1129 | *20* | ***18*** |
| | Midwest | 4664 | *25* | 1406 | *25* | ***22*** |
| | South | 6563 | *35* | 2066 | *37* | ***37*** |
| | West | 3898 | *21* | 1048 | *19* | ***23*** |

*Respondents with unknown education or income not included in the denominators.
†Household income.



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for Rx products, with information on actual pill markings reported at the exit survey. For store-brand OTC medications, the dose reported by the respondent in the exit survey was used if plausible; otherwise, it was assigned based on the labeling of available private-label equivalents for corresponding brand-name products. For Rx medications where the drug name and/or markings reported by the respondent did not resolve to a known dose, the weighted average of the doses of all marketed strengths of the medication based on sales data was used; if market data were not available, the dose was imputed from the survey data, based on the weighted mean dose for that class. Some form of imputation was necessary for 2474 use occasions (use of an individual product during one of the 24 h on one diary day) from 414 individual respondents (9.6% and 11.4% of the respective totals).

### *Analyses*

The analyses were confined to the first seven consecutive diary days of the 3618 respondents who completed ≥7 days and the exit survey, and reported taking an acetaminophen-containing product. The 7-day period was intended to cover variations in use by day of the week. There were 25 878 use occasions.

The prevalence of exceeding 4 g was estimated among acetaminophen users, along with the distribution of dosage levels on usage days. To elucidate correlates of excess dosing, individuals who ingested >4 g in a day were compared to those who did not with respect to various factors. These included demographics, history of chronic and other pain, history of other conditions such as arthritis and depression, alcohol and tobacco consumption, medical care utilization, SF-12 physical and mental component scales, knowledge of product ingredients and label recommendations, attitudes about how to use medications, and label reading behavior. In addition to univariate comparisons, unconditional logistic regression[14] was used to estimate the independent contribution of selected variables to the risk of exceeding 4 g. The multivariable model was restricted due to the relatively small number of >4-g users, and because a number of variables measured similar attributes of common factors, e.g. chronic pain and SF-12 scales were included instead of history of various mental and physical conditions. The final model is shown in Table 3. As explained below, a number of the variables were calculated, rather than reflecting untransformed raw data.

The SF-12 was scored according to validated algorithms.[15,16] Summary scales indicate the degree of physical and mental impairment (most to least impaired), with a population mean of 50 and SD of 10.

Knowledge was assessed based on responses to questions in the exit survey about each of the products reported in the diary, including knowledge of acetaminophen as an ingredient, and for OTC products, the recommended maximum one-time dose, maximum daily dose, and minimum dosing interval. Knowledge of dosing recommendations was considered "correct" if the subject reported the same or a lower maximum amount or a longer minimum interval compared with the label. We considered respondents knowledgeable in each domain only if they were correct for *all* of the medications they took, as lack of correct knowledge about even one medication could increase the risk of excess dosing.

There were 24 items in the exit survey about attitudes towards medications, covering topics such as level of risk and importance of reading and following labels; respondents were asked to rate each on a five-point agreement/disagreement scale. To identify attitudinal themes, factor analysis was performed using the principal component method and varimax rotation with Kaiser Normalization.[17] This left seven factors (scored as standard deviates) which explained 68% of the item variance: (i) I choose my dose regardless of label directions; (ii) it is important to start with the lowest dose and take more only if needed; (iii) OTC drugs have risks; (iv) complying with OTC label directions is important to avoid potential harm; (v) complying with physician directions for Rx medications is important to avoid potential harm; (vi) it is important to know the active ingredients of products taken; and (vii) it is not possible to overdose on OTC pain/fever medications.

Respondents reported, on a five-point scale (never to always), how often they read labels for active ingredients, directions, warnings, and usage, the first time taking a medication and subsequent times. We summed the answers, creating scores ranging from 4 to 20.

## RESULTS

### *Prevalence of acetaminophen use >4 g*

A total of 163 (4.5%) of the 3618 acetaminophen *users* exceeded 4 g on at least one day. The preponderance of >4-g users (64%) exceeded the threshold on one or 2 days during the diary week, while 9% exceeded it on all 7 days (Table 2). The 4-g limit was exceeded on 3.1% of the 13 852 usage *days* (Figure 2); the median dose on those days was 5.5 g. On most usage days, ingestion was ≤1 g. Twenty-six respondents took >8 g (0.7% of users); the maximum reported dose was 18.2 g.



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Table 2. Number of days during the 1-week diary period that acetaminophen users exceeded 4 g

| No. of days exceeding 4 g | No. of users | *% of >4-g users (n=163)* | *% of all users (n=3618)* |
|---|---|---|---|
| 1 | 73 | *45* | *2.0* |
| 2 | 32 | *20* | *0.9* |
| 3 | 16 | *10* | *0.4* |
| 4 | 7 | *4.3* | *0.2* |
| 5 | 7 | *4.3* | *0.2* |
| 6 | 13 | *8.0* | *0.4* |
| 7 | 15 | *9.2* | *0.4* |

### *Correlates of acetaminophen use >4 g*

Table 3 shows the results of multivariable analysis, with odds ratios (ORs) and their 95% confidence intervals reflecting the independent relation of each variable to exceeding 4 g. The >4-g users were somewhat more likely to have some college education (OR = 1.7, 95% CI = 1.1–2.6) compared to being a college graduate, and the point estimate for <12 years was also elevated (OR = 1.9, CI = 0.8–4.7), although not statistically significant. Median ages were similar in both groups of users (see continuous variables in Table 3); there were no material associations with sex, race, or region. Virtually all >4-g users reported having some ongoing pain during the diary period, with 64% reporting that it had lasted at least 6 months (chronic pain, OR = 4.9, CI = 2.6–9.2); the OR was 4.2 (CI = 2.2–7.9) for shorter lasting ongoing pain compared to no ongoing pain. There was also an association with daily smoking (OR = 2.2, CI = 1.5–3.2)). Both physical and mental component SF-12 scores were lower among those taking more than 4 g, indicating more compromised status; the difference was greater for the physical component, and the OR of 0.7 (CI = 0.6–0.8) for every 1-SD difference indicated a strong inverse association with this continuous variable. Contact with health care providers was also associated with >4-g use, with an OR of 2.3 (CI = 1.4–3.9) for ≥10 visits in the previous year.

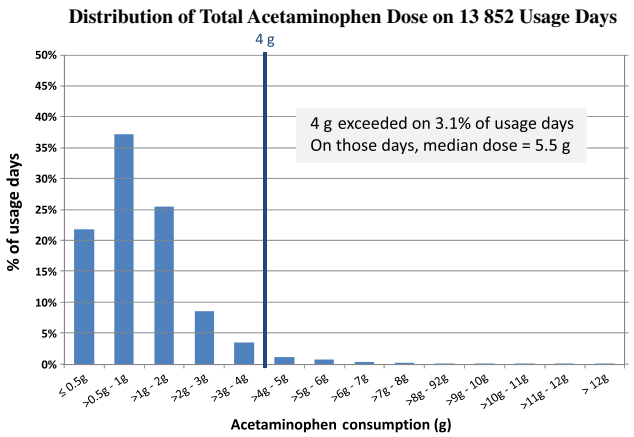


Figure 2. Distribution of total acetaminophen dose on 13 852 usage days

Knowledge of product ingredients and OTC label instructions for the maximum amount to take at one time and in 24 h were inversely associated with >4-g use, with ORs in the range of 0.5–0.6 and upper 95% confidence limits of 0.8–0.9. There was no material association with knowledge of the minimum dosing interval. Notably, even among users who did not exceed 4 g, only 53% knew that all the relevant products they had taken contained acetaminophen. It is also noteworthy that respondents' reports of reading labels when they were taking products for the first time were unrelated to exceeding 4 g; the same was true for reports on products taken previously (data not shown).

Two attitudinal factors were associated with exceeding 4 g: respondents who feel they can make their own decisions about how much to take, regardless of recommendations, were more likely to take more than the limit (OR = 1.3 [95% CI = 1.1–1.5] per 1-SD increase in score); in contrast, those with the attitude of starting with the lowest dose and increasing it only if necessary were less likely to exceed 4 g (OR = 0.6 [CI = 0.5–0.7] per 1-SD increase). None of the other attitudinal factors were significantly associated on multivariable analysis.

## DISCUSSION

The present study examined patterns of acetaminophen use in a large national sample of adult users. We found that 4.5% of users took more than 4 g on at least one day in a week, that such use most commonly occurred on only 1 or 2 days, and that the median dose on days when intake exceeded 4 g was 5.5 g. Chronic pain, daily smoking, a poor general physical status, and high utilization of medical care were all associated with this behavior. Reported *label reading* did not appear to be associated, but actual *knowledge* that acetaminophen was an ingredient in all products taken and knowledge of maximum recommended OTC doses carried a substantially reduced likelihood of exceeding 4 g. Certain *attitudes* also appeared to be important correlates, in particular the view that a consumer can choose his or her dose regardless of recommendations (positively associated with going over 4 g), and the conservative attitude of starting with a low dose and only increasing it if needed (inversely associated).

A recent report suggests that physicians may sometimes prescribe daily doses exceeding 4 g, but we are not aware of published data on consumers' actual use of the range of acetaminophen products, or how usage patterns relate to consumer knowledge and attitudes.[18] Thus, if the present findings can be extrapolated to the



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Table 3. Various factors among acetaminophen users who exceeded 4 g and those who did not

| Factor | Category | Users who exceeded 4 g (*n*=163) | | Users who did not exceed 4 g (*n*=3455) | | Multivariable odds ratio* (95% CI) |
|---|---|---|---|---|---|---|
| | | No. | % | No. | % | |
| Male | | 90 | *55* | 1426 | *41* | 1.4 (1.0–2.0) |
| Nonwhite race | | 35 | *21* | 621 | *18* | 1.2 (0.8–1.9) |
| Region | Northeast | 24 | *15* | 675 | *20* | 1.0† |
| | Midwest | 40 | *25* | 895 | *26* | 1.3 (0.7–2.2) |
| | South | 71 | *44* | 1272 | *37* | 1.4 (0.8–2.4) |
| | West | 28 | *17* | 613 | *18* | 1.1 (0.6–2.1) |
| Education | <12 years | 8 | *5* | 86 | *2* | 1.9 (0.8–4.7) |
| | HS graduate | 24 | *15* | 578 | *17* | 0.9 (0.5–1.5) |
| | Some college | 89 | *55* | 1290 | *37* | **1.7 (1.1–2.6)** |
| | College graduate | 42 | *26* | 1501 | *43* | 1.0† |
| Pain | Chronic pain (>6 mo) | 105 | *64* | 1184 | *34* | **4.9 (2.6–9.2)** |
| | Other ongoing pain | 44 | *27* | 764 | *22* | **4.2 (2.2–7.9)** |
| | No ongoing pain | 14 | *9* | 1507 | *44* | 1.0† |
| Smoking | Daily | 57 | *35* | 483 | *14* | **2.2 (1.5–3.2)** |
| | Occasional | 8 | *5* | 104 | *3* | 1.8 (0.8–4.2) |
| | None | 98 | *60* | 2868 | *83* | 1.0† |
| No. of times seen HCP in past year | <3 | 43 | *26* | 1574 | *46* | 1.0† |
| | 3–9 | 75 | *46* | 1471 | *43* | 1.3 (0.8–2.0) |
| | ≥10 | 45 | *28* | 410 | *12* | **2.3 (1.4–3.9)** |
| Knowledge | Acetaminophen is ingredient | 58 | *36* | 1847 | *53* | **0.6 (0.4–0.9)** |
| | Max at one time‡ | 112 | *76* | 2770 | *90* | **0.5 (0.3–0.8)** |
| | Max in 24 h‡ | 62 | *50* | 1585 | *65* | **0.5 (0.3–0.9)** |
| | Min dosing interval‡ | 54 | *43* | 1183 | *49* | 1.3 (0.8–2.1) |
| Label reading score, first time use§ | 1–15 | 41 | *25* | 672 | *19* | 1.1 (0.7–2.0) |
| | 16–18 | 49 | *30* | 1159 | *34* | 0.9 (0.6–1.3) |
| | 19–20 | 73 | *45* | 1624 | *47* | 1.0† |
| *(continuous variables)* | | Median score | | Median score | | |
| Age[d] (10 yr OR units) | | 50 | | 49 | | 1.0 (0.9–1.1) |
| SF-12 | Physical component | 37 | | 49 | | **0.7 (0.6–0.8)** |
| | Mental component | 46 | | 52 | | 0.9 (0.7–1.0) |
| Attitudes[e] | Choose my dose | 0.245 | | −0.197 | | **1.3 (1.1–1.5)** |
| | Start lowest dose | −0.419 | | 0.076 | | **0.6 (0.5–0.7)** |
| | OTC drugs have risks | 0.273 | | 0.061 | | 1.1 (0.9–1.3) |
| | Comply w/OTC label | 0.224 | | 0.190 | | 1.0 (0.8–1.1) |
| | Comply w/Rx instructions | 0.242 | | 0.269 | | 0.9 (0.8–1.1) |
| | Know ingredients | 0.212 | | 0.130 | | 1.1 (0.9–1.3) |
| | Can't OD on OTC | 0.007 | | −0.121 | | 1.2 (1.0–1.4) |

*Based on unconditional logistic regression. Bold type indicates statistically significant result.
†Reference category.
‡Denominator for percents based on known values.
§Label reading scores computed by summing the answers to questions about how often the respondent reads the label for active ingredients, directions, warnings, and usage. Questions were answered on a fivr-point scale, and the possible range of the scores is 4–20. Results shown are for label reading when a medication was first used; results were similar for repeat uses.
**Based on unconditional logistic regression. Bold type indicates statistically significant result. Units are 1 SD unless stated otherwise.
[d]Median year of age.
[e]Derived from factor analysis using the principal component method and varimax rotation with Kaiser Normalization. Scores are normal deviates with mean=0 and SD=1 in the sample.

general population of acetaminophen users in the U.S., they shed new light both on the frequency with which 4 g is exceeded and the characteristics of individuals who do so. These findings may help inform strategies for consumer and healthcare provider interventions to reduce such behavior by improving knowledge and modifying attitudes. Is extrapolation appropriate? The approach of recruiting respondents from an internet panel addresses an important limitation that increasingly affects telephone surveys: the inability to include individuals who do not have landline service, now a large and growing segment of the population.[19] Although restricting enrollment to those who have internet access imposes its own limitations, this method has been shown to produce valid results when compared with other sources.[20–23] In the present study,



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as with many population surveys, there was substantial underrepresentation of subjects of low education and income, to the extent that it was not possible to conclude whether low education is a predictor of increased acetaminophen dosing. If that were to be the case, then our findings could be underrepresenting the prevalence of exceeding 4 g in the population as a whole.

Other differences between the study and national populations – more women and subjects of white race – are consistent with a higher prevalence of analgesic use among women and whites,[24,25] and not surprising since the enrollment was designed to oversample acetaminophen users and the analyses were confined to users. The overall response rate was low, which raises the possibility of biased recruitment. While this cannot be ruled out and must be considered in interpreting the results, it seems unlikely that among acetaminophen users, there was preferential enrollment of individuals based on the likelihood that they would exceed 4 g, particularly as enrollees did not know the study focused on acetaminophen. Also, a recent evaluation of internet panels compared with random digit dialing telephone surveys suggested that lower completion rates do not necessarily result in reduced accuracy of results.[26]

Another limitation is that the study was conducted during the summer. There may be seasonal variations in how acetaminophen products are used, particularly because many are taken to treat cold and flu symptoms. While seasonality is not addressed by the present data, ongoing surveillance will eventually provide information on usage patterns throughout the year.

The survey had design features intended to enhance the completeness and accuracy of the information. Respondents identified products that they had taken from a comprehensive list and were not required to know that these contained acetaminophen. The daily diary allowed for systematic recording of product use on an hour-by-hour basis; in most instances, the recall period was 24 h, and with the limited "backfilling" allowed, never more than 48 h. Respondents reported their behavior to a computer rather than a person, which has been shown to elicit more honest responses.[27,28] Overall, we believe that with the caveats noted above, the present results provide a meaningful picture of acetaminophen dosing behavior that can be extended to the majority of U.S. users.

Our results are important because acetaminophen is one of the most commonly used compounds worldwide. It has been reported that as much as 23% of the U.S. adult population take one or more acetaminophen-containing products in any given week,[24,29] and that 39% take OTC acetaminophen over a 1-month period.[25] With the large number of OTC products available, consumers' decisions about which and how much medication to take for common conditions such as pain, fever, colds/flu, and allergies account for a substantial proportion of use. The plethora of combination products that contain acetaminophen – prescription narcotic pain medications as well as OTC products – raises concerns about inadvertent overdoses from the use of multiple products that could lead to liver damage. These concerns are supported by the many emergency department visits for liver problems attributed to acetaminophen overdose, reported to range from 44 000–78 000.[2] Although significant harm is usually associated with considerably higher doses,[30] our finding that a material proportion of acetaminophen users exceed the recommended maximum daily dose of 4 g reinforces the need for interventions to reduce over-use. The data from this study support certain intervention approaches, e.g. educating consumers and patients about which products contain acetaminophen and what the proper doses are, and influencing their attitudes about dosing. The data also suggest channels for such interventions, e.g. through healthcare providers, especially those who treat chronic pain or patients for whom other analgesics are not a therapeutic option.

In summary, the present study has estimated the proportion of acetaminophen users in a major segment of the U.S. adult population that exceeds the recommended 4-g per day limit, and has identified characteristics of individuals who do so. Continuing surveillance is planned to assess the impact of interventions and regulatory or marketing changes on knowledge and attitudes, and eventually, on excess ingestion of this very commonly used compound.

## CONFLICT OF INTEREST

DWK received research support from Bayer HealthCare Pharmaceuticals during the conduct of the study and was a consultant to UCB. JMR and Pinney Associates are consultants to McNeil Consumer Healthcare and other companies that market OTC analgesics, including Bayer, Chattem, GlaxoSmithKline, and Pfizer. MKM is a consultant to McNeil Consumer Healthcare on other projects. RBW is an employee of Janssen Research and Development, LLC. Both McNeil Consumer Healthcare and Janssen Research and Development are part of Johnson & Johnson. SS and Pinney Associates are consultants to McNeil Consumer Healthcare and other companies that market OTC analgesics, including Bayer, Chattem, GlaxoSmithKline, and Pfizer.



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KEY POINTS

- 4.5% of adult acetaminophen users in the U.S. exceed 4 g on a given day, with a median dose of 5.5 g.
- >4-g users tend to have chronic pain, poor physical status, and heavy use of medical care.
- The attitude that users can choose their own dose regardless of recommendations, along with poor knowledge of ingredients and recommended OTC doses, is associated with exceeding 4 g. The attitude to start with the lowest effective dose is inversely associated.
- In addition to estimating the proportion of acetaminophen use in the U.S. adult population that exceeds the 4-g limit, the results have identified potentially modifiable attitudes and knowledge associated with such use and characterized subpopulations at higher risk.

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## SUPPORTING INFORMATION

Additional supporting information may be found in the online version of this article:

Acetaminophen behavior and attitudes survey.

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