Annals of Internal Medicine ORIGINAL RESEARCH

Firearm Acquisition Without Background Checks

Results of a National Survey

Matthew Miller, MD, ScD; Lisa Hepburn, PhD; and Deborah Azrael, PhD

Background: In 1994, 40% of U.S. gun owners who had recently acquired a firearm did so without a background check. No contemporary estimates exist.

Objective: To estimate the proportion of current U.S. gun owners who acquired their most recent firearm without a background check, by time since and manner of acquisition, for the nation as a whole and separately in states with and without legislation regulating private sales.

Design: Probability-based online survey.

Setting: United States, 2015.

Participants: 1613 adult gun owners.

Measurements: Current gun owners were asked where and when they acquired their last firearm; if they purchased the firearm; and whether, as part of that acquisition, they had a background check (or were asked to show a firearm license or permit).

Results: 22% (95% CI, 16% to 27%) of gun owners who reported obtaining their most recent firearm within the previous 2 years reported doing so without a background check. For firearms purchased privately within the previous 2 years (that is, other than from a store or pawnshop, including sales between individuals in person, online, or at gun shows), 50% (CI, 35% to 65%) were obtained without a background check. This percentage was 26% (CI, 5% to 47%) for owners residing in states regulating private firearm sales and 57% (CI, 40% to 75%) for those living in states without regulations on private firearm sales.

Limitation: Potential inaccuracies due to recall and social desirability bias.

Conclusion: 22% of current U.S. gun owners who acquired a firearm within the past 2 years did so without a background check. Although this represents a smaller proportion of gun owners obtaining firearms without background checks than in the past, millions of U.S. adults continue to acquire guns without background checks, especially in states that do not regulate private firearm sales.

Primary Funding Source: Fund for a Safer Future and the Joyce Foundation.

Ann Intern Med. 2017;166:xxx-xxx. doi:10.7326/M16-1590 **www.annals.org**

For author affiliations, see end of text.

This article was published at www.annals.org on 3 January 2017.

Universal background checks are favored by more than 90% of all Americans (1). Legislation requiring background checks for private firearm sales has been strongly endorsed by leading U.S. medical (2), legal (2), and law enforcement organizations (3). Despite this support, most states do not require background checks for firearm sales between private parties. The extent to which the absence of requirements for universal background checks contributes to the more than 33 000 annual firearm deaths in the United States (4) is unknown, in part because even the most basic information about background checks is not routinely collected. For example, no routinely collected data indicate how frequently firearms are transferred from one private party to another, where and between whom these transfers occur, or how often they involve background checks. What is known is that many gun offenders obtain the guns they use in crime through private sales. For example, a survey of prisoners convicted of gun offenses revealed that 96% of inmates who were prohibited from possessing a firearm at the time they committed their crime had obtained their firearm from an unlicensed private seller (5). Other studies identify unlicensed private sellers as major contributors to illegal firearm trafficking within the United States and across the U.S.-Mexico border (6, 7).

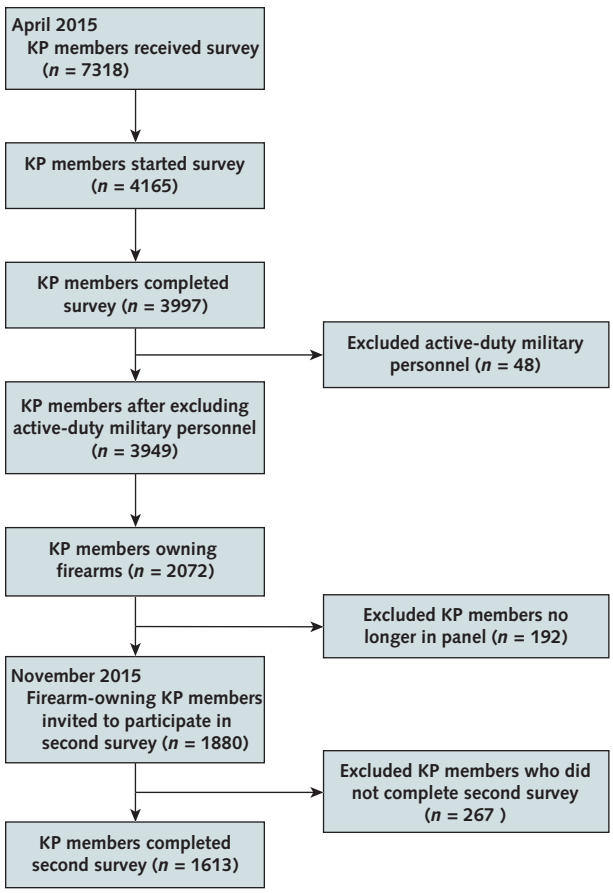
Because routinely collected data do not provide estimates of where firearms exchange hands after entering the U.S. market, or the extent to which secondary transfers are subject to background checks, researchers have relied on national surveys, the most recent of which was a random-digit dialing survey conducted in 1994, to estimate the proportion of U.S. gun owners who obtain firearms without a background check (8). That survey asked gun-owning respondents whether they had acquired firearms during the previous 2 years and, if so, whether their most recent acquisition had been "from a federally licensed firearms dealer" (the proxy used for having undergone a background check). As reported first by Cook and Ludwig (8), approximately 40% of gun-owning respondents who had acquired firearms between 1992 and 1994 did so without a background check. No contemporary estimates exist.

We believe the current study is the first in more than 20 years to update and extend information about where, when, and how current U.S. gun owners acquired their most recent firearm and whether the transfer involved a background check. We enumerate the proportion of current gun owners who acquired their most recent firearm without undergoing a background check by acquisition type (purchased vs. nonpurchased), subtype (where acquired, from whom), and recency of acquisition. In addition, although federal law does not require background checks for firearms trans-

See also:

Editorial comment 1

Figure. Recruitment and participation of panel members.



KP = KnowledgePanel.

ferred between individuals who are not licensed dealers, some states do (9); therefore, we examine, by state-law status, the proportion of gun owners who underwent a background check for those acquiring their last firearm through a private sale.

METHODS

Design and Sampling

Data come from a nationally representative, Web-based survey designed by the investigators and conducted in April 2015 by the survey firm Growth for Knowledge (GfK). Respondents were drawn from GfK's KnowledgePanel (KP), a group of approximately 55 000 U.S. adults selected (on an ongoing basis) with an equal probability of selection. The study-specific recruitment rate (proportion of individuals who were eligible for our study and agreed to become panel members) was 14.4%. All panel members, except those currently serving in the U.S. Armed Forces, were eligible to participate. Gun owners and veterans were oversampled from the KP; sampling weights supplied by GfK were applied such that estimates from the survey are representative of U.S. adults (aged ≥ 18 years) in 2015. Invitations to participate were e-mailed; 1 reminder e-mail was sent to nonresponders 3 days later. Participants did not receive any specific incentive to complete this survey, although GfK has a point-based program through which participants accrue points for completing surveys and can redeem them later for cash, merchandise, or participation in sweepstakes. Additional details of GfK's survey design are described in the Appendix (available at www.annals.org).

The Northeastern University Institutional Review Board approved the study.

Measures

The full survey, conducted in April 2015, was designed to examine patterns of civilian gun ownership, storage, and use. It determined gun ownership status and whether the owner's most recently acquired firearm was obtained with a background check but did not ask about the timing of the most recent acquisition. To determine when, relative to the original survey, respondents acquired their most recent firearm, GfK invited all gun-owning respondents from the April 2015 survey to answer additional questions in November 2015 (Figure).

Gun ownership status was determined on the basis of responses to 2 questions, the first being, "Do you or does anyone else you live with currently own any type of gun?" Those who answered affirmatively then were asked, "Do you personally own a gun?" Respondents also were asked about their most recent firearm acquisition, including the type of gun (for example, handgun or long gun), whether they bought the gun or acquired it in some other way (such as through an inheritance), and where they acquired the firearm (for example, a gun store). Data regarding background checks are only from respondents who personally owned guns.

To determine what proportion of current firearm owners underwent a background check for their most recently acquired firearm, we asked all gun owners, "As far as you know, as part of the transfer, did you undergo a background check?" All gun owners also were asked, "Did the person who sold you a gun ask you to show a firearm license or permit before buying the gun?" Respondents could answer "yes," "no," or "no opinion/don't know" to both questions. If the response to either question was affirmative, we classified that transfer as having involved a background check. Respondents who answered "no opinion/don't know" to the background check question were included in primary analyses after imputation (described later).

In the supplemental November 2015 survey, all gun owners from the original survey still in the KP were invited to answer 2 additional questions about the timing of their most recent gun acquisition. The first question was, "When you completed the prior national firearms survey, sponsored by Northeastern University, in April 2015, you said that the gun you acquired most recently was a [insert type based on type noted in the April 2015 survey]. Thinking about this gun, approximately when did you acquire it?" Three options were offered: "within the past 2 years," "between 2 and 5 years ago," and "more than 5 years ago." The second

question was, "What was the exact year that you acquired this gun?" Respondents were asked to specify the exact year or to report that they did not know the year.

State Firearm Legislation

State laws regulating private firearm sales generally require that before a purchased firearm can be transferred between private parties, the prospective purchaser undergo (and pass) a criminal history background check. For the state-level analyses, if a state had implemented a private sales law by 1 July 2013, it was coded as having such a law for the analyses involving firearms acquired within the past 2 years. Washington and Oregon both enacted laws in the latter part of 2014 and therefore were coded as not having a background check law (10). For the analyses involving firearms acquired more than 2 years before the survey administration, Colorado and Delaware were coded as not having state laws because they implemented laws after 1 July 2013 (10). We assumed that the state in which each respondent was living at the time of the survey was the state in which he or she had acquired his or her most recent firearm. Firearm purchases made between individuals, at a gun show, or online were coded as private sales, but those that occurred at stores or pawnshops, which by federal law are required to be licensed as firearm dealers, were not.

States with laws regulating private sales as of 1 July 2013 include California, Colorado, Connecticut, Delaware, Hawaii, Illinois, Iowa, Maryland, Massachusetts, Michigan, Nebraska, New York, North Carolina, Pennsylvania, Rhode Island, and Washington, DC. Except for Colorado, which enacted its law in 2013, and Delaware, which in 2013 converted its law from optional to mandatory, other states that regulate private sales enacted their laws before 1996 (Table 1). All states with private-sales legislation regulate handgun sales; 11 regulate long-gun sales (long guns include rifles and shotguns) (10).

Weighting and Analysis

To ensure reliable estimates at the national level, our survey oversampled gun owners by using GfK demographic profile variables, then used the gun-owning questions in the April 2015 survey to verify gun ownership. The GfK group provided final survey weights that combined presample and study-specific poststratification weights to account for oversampling and for nonresponse to both the April 2015 and November 2015 surveys. Additional details about survey weighting are available in the Appendix.

Regarding the background check question, 148 respondents (23 of whom acquired their most recent firearm within 2 years of the survey) answered "no opinion/don't know." We did not believe these responses represented an informative outcome; therefore, in primary analyses, we used multiple imputation to account for these "missing" responses for our outcome of interest. Multiple imputation for missing values was done by using logistic regression under the missing-at-random assumption. The imputation model included predictors of background check status: place and type of firearm transfer; timing of transfer; residence in a state with laws regulating private sales; and additional covariates of age, sex, educational attainment, ethnicity, marital status, urban or rural residence, and veteran status. We generated 100 multiply imputed data sets, and estimates were derived in Stata, version 14 (StataCorp), by using the "mi" and "svy" suite of commands. An additional 15 respondents did not know when they acquired their firearm and were excluded from analyses that involved acquisition timing but included in the overall acquisition numbers. All analyses used weighting commands (using the weight variable provided by GfK) to generate national estimates reported as

Table 1. State Laws for Secondary Sales*

State	Type of Law	Effective Date	Type of Guns Covered
California	Private sales	1991	All
Colorado	Private sales	2013	All
Connecticut	Private sales	1995	All
Delaware	Private sales	1994: optional 2013: mandatory	All
District of Columbia	Registration	1976	All
Hawaii	Permit to purchase	Handgun: pre-1970 Long gun: 1988	All
Illinois	Permit to purchase	1968	All
Iowa	Permit to purchase	1990	Handguns
Missouri	Repealed permit to purchase	1981–2007 (repealed)	Handguns
Maryland	Private purchase	1996	Handguns and assault weapons
Massachusetts	Permit to purchase	Pre-1970	All
Michigan	Permit to purchase	Pre-1970	Handguns
Nebraska	Permit to purchase	1991	Handguns
New Jersey	Permit to purchase	Pre-1970	All
New York	Private sales	1934	All
North Carolina	Permit to purchase	1995	Handguns
Oregon	Private sales	2015	Handguns
Pennsylvania	Private sales	1995	Handguns
Rhode Island	Private sales	1959	All
Washington	Private sales	2014	All

* State laws vary in terms of what types of firearms transfers are subject to background checks. In 11 states and the District of Columbia, the laws apply to all firearms; in 6 states, the laws apply only to handguns. Maryland requires background checks for handguns and assault rifles. Many of these laws exclude direct transfers among immediate family members.

Table 2. Characteristics of U.S. Adults Who Own Guns

Characteristic	Survey Participants (n = 1613)	Weighted Proportion (95% CI)*
Men	1238	72 (69–75)
Age		
18–29 y	97	11 (9–14)
30–44 y	265	23 (20–24)
45–59 y	518	32 (29–34)
≥60 y	733	34 (32–37)
Race/ethnicity		
Non-Hispanic white	1391	81 (78–83)
Non-Hispanic black	72	7 (6–9)
Non-Hispanic other	17	2 (1–3)
Hispanic	74	8 (6–11)
Marital status		
Married/partnered	1225	71 (68–74)
Separated/widowed/divorced	254	16 (14–19)
Never married	134	13 (10–15)
Number of children aged <18 y in the household		
None	1247	73 (70–75)
≥1	366	27 (25–30)
Bachelor's degree or higher	552	30 (27–32)
Veteran	462	19 (17–21)
Lives in a metropolitan statistical area	1253	77 (74–80)
U.S. region		
New England†	48	3 (2–4)
Mid-Atlantic‡	149	10 (8–12)
East North Central§	265	15 (13–17)
West North Central‖	165	9 (8–11)
South Atlantic¶	335	21 (18–23)
East South Central**	126	8 (7–10)
West South Central††	207	14 (12–17)
Mountain‡‡	126	9 (7–10)
Pacific§§	192	12 (10–14)
How would you describe yourself in political matters?		
Liberal	220	14 (12–16)
Moderate	639	40 (38–43)
Conservative	729	44 (41–47)
Timing of most recent firearm acquisition		
Within the past 2 y	424	29 (26–31)
2–5 y ago	328	21 (19–24)
>5 y ago	846	49 (46–52)

* Representative of the U.S. adult population aged ≥18 y.
† Connecticut, Maine, Massachusetts, New Hampshire, Rhode Island, and Vermont.
‡ New Jersey, New York, and Pennsylvania.
§ Illinois, Indiana, Michigan, Ohio, and Wisconsin.
‖ Iowa, Kansas, Minnesota, Missouri, Nebraska, North Dakota, and South Dakota.
¶ Delaware, Florida, Georgia, Maryland, North Carolina, South Carolina, Virginia, District of Columbia, and West Virginia.
** Alabama, Kentucky, Missouri, and Tennessee.
†† Arkansas, Louisiana, Oklahoma, and Texas.
‡‡ Arizona, Colorado, Idaho, Montana, Nevada, New Mexico, Utah, and Wyoming.
§§ Alaska, California, Hawaii, Oregon, and Washington.

weighted percentages, with 95% CIs, following the STROBE (Strengthening the Reporting of Observational Studies in Epidemiology) guidelines for reporting (11).

We conducted sensitivity analyses to examine how our estimate of the proportion of gun owners who acquired their most recent firearm without a background check varied depending on how we handled respondents who answered "no opinion/don't know" to the background check question. First, we categorized all such respondents (n = 148) as having undergone a background check (effectively producing a lower bound for our estimates of what percentage of gun owners did not have a background check). Next, we categorized all 148 respondents as not having undergone a background check (producing an upper bound). We conducted 2 additional sensitivity analyses pertaining to respondents who acquired their most recent firearm in 2013, because asking respondents to indicate whether they had acquired their most recent firearm "within the past 2 years" versus "between 2 and 5 years ago" may have introduced ambiguity for those who acquired their most recent firearm in 2013. The first excluded the 134 respondents who acquired their most recent firearm in 2013 from the "within the past 2 years" group; the second included all 134 in the "within the past 2 years" group.

Role of the Funding Source

The funders did not play a role in the design, conduct, or reporting of the research or in the decision to submit the manuscript for publication.

RESULTS

Of the 7318 invited panel members, 4165 started and 3949 completed the April 2015 survey (excluding 48 active-duty military personnel who started the survey but were ineligible to complete it), yielding a survey completion rate of 54.6% (12). Of the 2072 gun-owning respondents in the original April 2015 survey, 1880 were still in the KP in November; all were invited to answer the additional set of questions about the timing of their most recent gun acquisition. Of the 1880, 1613 (86%) responded. Respondents to the supplemental survey did not differ from the participants in the original survey with respect to age, sex, race, type of gun most recently acquired, acquisition patterns, or proportion who reported having a background check.

Half of our respondents acquired their most recent gun within the past 5 years (29% within the past 2 years, 21% between 2 and 5 years ago, and the remainder more than 5 years ago) (Table 2). For gun owners who reported acquiring their last firearm within 2 years of the April survey, 22% (95% CI, 16% to 27%) obtained their most recent gun without a background check (Table 3). Sensitivity analyses excluding the 134 respondents who acquired their most recent firearm in 2013, 79 of whom indicated they had acquired their most recent firearm within 2 years of the survey, yielded similar results: 20% (CI, 14% to 26%). Analyses including all

Table 3. Summary of Most Recent Firearm Transfer, by Type of Acquisition*

Type of Acquisition	Transfer Past 2 y (*n* = 424)		Transfer 2–5 y Ago (*n* = 328)		Transfer >5 y Ago (*n* = 846)		Transfer All Periods (*n* = 1598)†	
	Where Transfer Occurred	Gun Owners Without BC (95% CI)	Where Transfer Occurred	Gun Owners Without BC (95% CI)	Where Transfer Occurred	Gun Owners Without BC (95% CI)	Where Transfer Occurred	Gun Owners Without BC (95% CI)
Purchased transfers								
Any store	64	4 (0–7)	52	4 (0–9)	41	31 (25–38)	49	16 (12–19)
Family	2	54 (12–97)	3	62 (26–98)	3	68 (41–95)	3	64 (45–83)
Friend/acquaintance	5	77 (62–92)	10	68 (45–91)	7	82 (69–94)	7	77 (67–87)
Gun show	4	0 (NA)	3	17 (0–39)	2	41 (18–64)	3	22 (8–35)
Online	2	45 (9–82)	1	59 (2–100)	0.5	0 (NA)	1	39 (11–66)
Other	3	62 (24–100)	3	72 (41–100)	3	67 (47–88)	3	67 (50–84)
All purchased firearms	80	13 (8–18)	78	19 (12–25)	60	41 (35–47)	70	27 (23–30)
Nonpurchased transfers								
Gift	8	60 (40–80)	14	69 (47–90)	15	77 (68–87)	12	72 (63–81)
Inheritance	5	82 (60–100)	7	96 (89–100)	21	91 (85–97)	13	91 (85–96)
Other	6	35 (7–62)	1	52 (11–94)	3	57 (32–83)	4	42 (27–59)
All nonpurchased firearms	19	57 (42–72)	23	76 (62–90)	39	83 (77–89)	30	77 (71–83)
All transfers	100	22 (16–27)	100	32 (24–39)	100	57 (52–62)	100	42 (38–45)

BC = background check; NA = not applicable.
* Values are percentages. All results presented are weighted values and account for the complex sampling design.
† 15 respondents did not know when their most recent gun was acquired and were excluded.

134 respondents who indicated that they had obtained their last firearm in 2013 or thereafter likewise yielded similar results: 23% (CI, 18% to 29%).

Among gun owners who acquired their most recent firearm within the past 2 years by way of purchase, 13% (CI, 8% to 18%) did so without a background check. For gun owners who purchased their most recent gun from a friend or an acquaintance within the past 2 years, 77% (CI, 62% to 92%) did so without a background check. For those purchasing online, 45% (CI, 9% to 82%) did not have a background check. Among gun owners overall, regardless of when their most recent acquisition occurred, 70% purchased their most recent firearm, and 27% of the latter group (CI, 23% to 30%) did so without a background check. Overall, across all periods, 42% (CI, 38% to 45%) acquired their most recent firearm without a background check.

When respondents who answered "no opinion/don't know" were assumed either to have or to have not undergone a background check, resulting point estimates fell within the 95% CIs of our primary analyses. For example, with respect to firearm transfers within 2 years of the survey, the lower and upper bounds for point estimates produced by coding missing data in this manner were 18% and 26%, respectively.

For firearms purchased privately within the past 2 years, 50% (CI, 35% to 65%) were obtained without a background check. Among gun owners who reported obtaining their most recent firearm within the past 2 years by way of purchase from a private seller, those who lived in states regulating private firearm sales reported doing so without a background check 26% (CI, 5% to 47%) of the time. Among respondents residing in states without regulations on private firearm sales, 57% (CI, 40% to 75%) of such transfers occurred without background checks (Table 4).

DISCUSSION

The number of new guns available for purchase by the U.S. civilian population, all of which are subject to background checks when first acquired, is published annually by the Bureau of Alcohol, Tobacco, Firearms and Explosives (ATF). The ATF data indicate that more than 360 million firearms entered the U.S. market between 1899 and 2013, with 16 million entering in 2013 alone (13). These data, however, do not explain how many of the 55 million U.S. adults who currently own firearms (9) obtained their guns without background checks.

Our finding that 22% (CI, 16% to 27%) of gun owners who recently acquired firearms did so without a background check is lower than the 1994 estimate of "about" 40% (8), which was based on a survey with 2568 respondents (789 gun owners, 251 of whom acquired a firearm within 2 years of the survey) and a 1.4% margin of error for the full sample. No CIs around the 40% statistic were reported. The apparent decline

Table 4. Percentage of Current Firearm Owners Whose Most Recent Private-Sale Firearm Acquisition Occurred Without a BC or the Equivalent, by State Law Status and Time of Transfer*

All Private Sales	Without a BC (95% CI), %	
	Transfer Within the Past 2 y	Transfer 2–5 y Ago
In states with laws regulating private sales	26 (5–47)	51 (21–81)
In states without laws regulating private sales	57 (40–75)	62 (44–79)

BC = background check.
* Private sales are defined as firearm purchases made outside of a store or pawnshop setting, including sales between individuals in person, online, or at gun shows. Background check equivalents include a permit or license shown at the time of transfer.

in firearm acquisition without background checks over the past 2 decades, based on comparing our findings with those from the 1994 survey, cannot be attributed to differences in the period assessed (both surveys focused on the 2 years before the survey). Our survey asked respondents explicitly about background checks and permits or licenses to purchase, and the 1994 survey asked respondents whether their last acquisition was through a federally licensed firearms dealer. However, the differences in how the 2 surveys assessed background check status also seem unlikely to explain the apparent decline in the proportion of gun owners who reported not having undergone a background check for recent acquisitions. In the 1994 survey, for example, some respondents were not sure whether the source was a federally licensed firearms dealer, and others indicated that the source was a federally licensed firearms dealer but then reported that the transaction was a trade rather than a cash sale or that the source was an acquaintance or a family member (8). Regardless of which of these cases were included or excluded, the proportion without a background check ranged from 36% to 43%. Likewise, sensitivity analyses in our survey produced similar estimates regardless of whether we imputed background check status for respondents who indicted "no opinion/don't know" to the background check question, as in our primary analyses, or eliminated these respondents from analyses altogether. Even when we generated upper and lower bounds for our point estimates by assigning all such respondents to either having had or not having had a background check, estimates of the proportion of gun owners who did not have a background check ranged only from 18% to 26%. Lastly, results within our 2015 survey are consistent with a decline since 1994: 31% (CI, 25% to 34%) of current gun owners who obtained their last firearm between 2 and 5 years before our survey and 57% (CI, 53% to 62%) whose last acquisition was more than 5 years before our survey reported completing the transaction without a background check.

One reason background checks have become more common in recent years is that compared with gun owners who acquired their most recent firearm several years ago, those who acquired a gun more recently are more likely to have purchased their firearm from a store (where background checks are required by federal law), as Table 2 indicates. Another factor may be that several states have enacted background check regulations for the private sale of firearms. Consistent with the goals of these state-level regulations, we found that 26% (CI, 5% to 47%) of gun owners who lived in a state regulating private sales and who purchased firearms from a private seller in the past 2 years did so without a background check, compared with 57% (CI, 40% to 75%) of those who lived in states that adhered to federal requirements alone.

As with findings from all self-reported surveys, our study's results should be interpreted in light of potential inaccuracies due to recall and social desirability bias (14), especially for respondent answers that relate to more remote periods. In addition, firearm owners may have acquired their gun in a state with private-sale laws that differ from those of the state in which they resided at the time of the survey. For these reasons, we emphasize our findings related to firearm acquisitions within 2 years of our survey. With respect to potential inaccuracies due to recall and social desirability bias, research suggests that online panel surveys, such as ours, may reduce social desirability bias and yield more accurate estimates of respondent characteristics compared with telephone surveys (15, 16). Another advantage of online panels is high completion rates for those who begin the survey and the availability of information about panelists who do not elect to take the survey in the first place (12). In our study, 99% of respondents completed the survey, fewer than 1% declined to answer our stem question about household gun ownership, no one declined to answer the subsequent question regarding whether they personally owned a gun, and fewer than 2% declined to answer the background check questions. Finally, our survey completion rate (55%) is higher than the rates for typical nonprobability, opt-in, online surveys, which are 2% to 16% (12); higher than those of previous national injury surveys that included questions about firearm ownership (17, 18); and similar to those from other surveys conducted by GfK (19). Nevertheless, panel members who chose not to participate in our survey may have differed in important ways related to the likelihood of undergoing background checks compared with panel members who chose to participate.

In 2015, 8 national health professional organizations and the American Bar Association called for legislation requiring background checks for all firearm sales between private parties (2). In providing empirical context, the alliance estimated that 6.6 million firearms are sold annually without background checks, an extrapolation based on the most recent data available: the 1994 National Survey on Private Ownership and Use of Firearms, which found that approximately 40% of gun owners who had recently acquired a firearm did so without a background check (8). Although our estimate suggests that a smaller proportion of gun owners (22%) obtain firearms without background checks today than in the past, our findings nevertheless indicate that millions of U.S. adults annually continue to acquire guns without background checks, often from friends or acquaintances, and disproportionately so in states that do not regulate private firearm sales.

From Northeastern University and Harvard School of Public Health, Boston, Massachusetts.

Acknowledgment: The authors thank their Northeastern University colleagues Carmel Salhi, ScD, for generously running and thoughtfully conceiving and operationalizing their imputation strategy, and Justin Manjourides, ScD, for helping them think about their imputation approach.

Financial Support: Fund for a Safer Future and the Joyce Foundation.

Disclosures: Authors have disclosed no conflicts of interest. Forms can be viewed at www.acponline.org/authors/icmje/ConflictOfInterestForms.do?msNum=M16-1590.

Reproducible Research Statement: *Study protocol:* See the Appendix. *Statistical code:* Available from Dr. Miller (e-mail, ma.miller@neu.edu). *Data set:* Not available.

Requests for Single Reprints: Matthew Miller, MD, ScD, Northeastern University, Bouv College of Health Sciences, Department of Health Sciences, Room 316, Robinson Hall, 360 Huntington Avenue, Boston, MA 02115; e-mail, ma.miller@neu.edu.

Current author addresses and author contributions are available at www.annals.org.

References

1. **Barry CL, McGinty EE, Vernick JS, Webster DW.** After Newtown-public opinion on gun policy and mental illness. N Engl J Med. 2013;368:1077-81. [PMID: 23356490] doi:10.1056/NEJMp1300512
2. **Weinberger SE, Hoyt DB, Lawrence HC 3rd, Levin S, Henley DE, Alden ER, et al.** Firearm-related injury and death in the United States: a call to action from 8 health professional organizations and the American Bar Association. Ann Intern Med. 2015;162:513-6. [PMID: 25706470] doi:10.7326/M15-0337
3. **International Association of Chiefs of Police.** Taking a Stand: Reducing Gun Violence in Our Communities. A Report from the International Association of Chiefs of Police 2007 Great Lakes Summit on Gun Violence. Alexandria, VA: International Association of Chiefs of Police; 2007. Accessed at www.theiacp.org/Portals/0/pdfs/GVR_A-page-iii_IACP-Taking-A-Stand.pdf on 1 October 2016.
4. **Centers for Disease Control and Prevention.** Wide-Ranging Online Data for Epidemiologic Research (WONDER) online databases. 2016. Accessed at http://wonder.cdc.gov on 31 August 2016.
5. **Vittes KA, Vernick JS, Webster DW.** Legal status and source of offenders' firearms in states with the least stringent criteria for gun ownership. Inj Prev. 2013;19:26-31. [PMID: 22729164] doi:10.1136/injuryprev-2011-040290
6. **Webster DW, Vernick JS, Bulzacchelli MT.** Effects of state-level firearm seller accountability policies on firearm trafficking. J Urban Health. 2009;86:525-37. [PMID: 19479382] doi:10.1007/s11524-009-9351-x
7. **U.S. Department of the Treasury; Bureau of Alcohol, Tobacco, and Firearms.** Following the Gun: Enforcing Federal Laws against Firearms Traffickers. Washington, DC: US Gov Pr Office; 2000. Accessed at http://everytown.org/wp-content/uploads/2014/08/Following-the-Gun_Enforcing-Federal-Laws-Against-Firearms-Traffickers.pdf on 5 August 2016.
8. **Cook PJ, Ludwig J.** Guns in America: National Survey on Private Ownership and Use of Firearms. Washington, DC: U.S. Department of Justice; 1997.
9. **Azrael D, Hepburn LM, Hemenway D, Miller M.** The stock and flow of US firearms: results from the 2015 National Firearms Survey. 2016. Accessed at www.russellsage.org/sites/all/files/RSF_Journal/Cook_Pollack//Azrael_et_al.pdf on 1 October 2016.
10. **Law Center to Prevent Gun Violence.** 2016. Accessed at http://smartgunlaws.org on 31 August 2016.
11. **von Elm E, Altman DG, Egger M, Pocock SJ, G tzsche PC, Vandenbroucke JP; STROBE Initiative.** The Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) statement: guidelines for reporting observational studies. Ann Intern Med. 2007;147:573-7. [PMID: 17938396]
12. **Callegaro M, DiSogra C.** Computing response metrics for online panels. Public Opin Q. 2008;72:1008-32.
13. **Department of Justice; Bureau of Alcohol, Tobacco, Firearms and Explosives.** Firearms commerce in the United States: annual statistical update 2015. 2016. Accessed at www.atf.gov/file/89561/download on 5 August 2016.
14. **Aday L, Cornelius L.** Designing and Conducting Health Surveys. 1st ed. San Francisco: Jossey-Bass; 1989.
15. **Kreuter F, Presser S, Tourangeau R.** Social desirability bias in CATI, IVR, and web surveys: the effects of mode and question sensitivity. Public Opin Q. 2008;72:847-65.
16. **Chang L, Krosnick J.** National surveys via RDD telephone interviewing versus the internet: comparing sample representativeness and response quality. Public Opin Q. 2009;73:641-78.
17. **Hepburn L, Miller M, Azrael D, Hemenway D.** The US gun stock: results from the 2004 national firearms survey. Inj Prev. 2007;13:15-9. [PMID: 17296683]
18. **Betz ME, Barber C, Miller M.** Suicidal behavior and firearm access: results from the second injury control and risk survey. Suicide Life Threat Behav. 2011;41:384-91. [PMID: 21535097] doi:10.1111/j.1943-278X.2011.00036.x
19. **Board of Governors of the Federal Reserve System.** Report on the economic well-being of U.S. households in 2014. May 2015. Accessed at www.federalreserve.gov/econresdata/2014-report-economic-well-being-us-households-201505.pdf on 5 August 2016.

Current Author Addresses: Dr. Miller: Northeastern University, Bouv College of Health Sciences, Department of Health Sciences, Room 316, Robinson Hall, 360 Huntington Avenue, Boston, MA 02115.
Drs. Hepburn and Azrael: Harvard Injury Control Research Center, 677 Huntington Avenue, Kresge 310, Boston, MA 02115.

Author Contributions: Conception and design: M. Miller, L. Hepburn, D. Azrael.
Analysis and interpretation of the data: M. Miller, L. Hepburn, D. Azrael.
Drafting of the article: M. Miller, L. Hepburn.
Critical revision for important intellectual content: M. Miller, L. Hepburn, D. Azrael.
Final approval of the article: M. Miller, L. Hepburn, D. Azrael.
Statistical expertise: M. Miller, L. Hepburn, D. Azrael.
Obtaining of funding: M. Miller, D. Azrael.
Administrative, technical, or logistic support: M. Miller.
Collection and assembly of data: M. Miller, D. Azrael.

Appendix: Detailed Survey Methods

Study Design

Northeastern University (principal investigator, M. Miller) contracted GfK (formerly Knowledge Networks; www.gfk.com) to conduct the National Firearms Survey, which aimed to examine firearm ownership and use in the United States. The survey was done in a sample from KP, an online research panel that represents the entire U.S. population.

KP Details

Panel members are recruited by GfK randomly through probability-based sampling, and households are provided with access to the Internet and hardware if needed. For recruiting, GfK uses address-based sampling methods (previously it relied on random-digit dialing methods). After accepting the invitation to join the panel, participants are asked to complete a short demographic survey (the initial profile survey), answers to which allow efficient panel sampling and weighting for future surveys. Completion of the profile survey allows participants to become panel members, and as in the past, all respondents are given the same privacy terms and confidentiality protections. For our survey, the profile rate was 63.8%, defined as *((Profile Completes))/((Profile Complete+Partial Profile Complete)+(Profile Refusals+Profile Noncontacts+Other Profile Cases))*.

Once household members are recruited for the panel and assigned to a study sample, they are notified by e-mail for survey taking, or panelists may visit their online member page to take the survey (instead of being contacted by telephone or postal mail). The latter approach reduces the burden placed on respondents because e-mail notification is less intrusive than telephone calls, and most respondents find answering Web questionnaires more interesting and engaging than being questioned by a telephone interviewer. Furthermore, respondents have the convenience of choosing what time of day to complete their assigned survey. To assist panel members with their survey taking, each member has a personalized "home page" listing all the surveys that have been assigned to him or her and have yet to be completed.

Additional documentation regarding KP sampling, data collection procedures, weighting, and issues related to institutional review board approval is available at the following online resources:

www.knowledgenetworks.com/ganp/reviewer-info.html

www.knowledgenetworks.com/knpanel/docs/knowledgepanel(R)-design-summary-description.pdf

www.knowledgenetworks.com/ganp/irbsupport/

Sampling

The parent survey used for this study was conducted in a target population comprising adults aged 18 years or older who fell into 1 of 3 groups: gun owners, non-gun owners living in a gun-owning household, or non-gun owners living in a non-gun-owning household. An additional target population was veterans (who could fall into any of the 3 aforementioned groups). To sample this population, GfK targeted respondents in its master panel who met our study criteria and reconfirmed their gun ownership and veteran status in the study-specific survey.

The study-specific survey had 3 stages: initial screening for gun ownership and veteran status, the main survey conducted in April 2015 that included study-eligible respondents (gun owners and non-gun owners), and a 7-question supplemental survey in November 2015 targeting all gun owners identified in the April survey (pertinent to this study, questions related to the timing of their last firearm acquisition; an additional 2 questions concerned firearm theft). To qualify for the main survey, a panel member must have been aged 18 years or older and was not currently serving on active duty in the U.S. Armed Forces.

Data Collection

Survey pretesting occurred in March 2015, with administration of the final survey in April 2015. Potentially eligible panel members received an e-mail notifying them that a new survey was available for them to take. The e-mail contained a direct link to the survey questionnaire; no login name or password was required. After 3 days, automatic e-mail reminders were sent to all nonresponding panel members in the sample. Participants completed the main survey in a median of 14 minutes.

The goal of GfK in structuring recruitment for the KP is a group that represents the U.S. adult population with respect to a broad set of geodemographic distributions as well as subgroups of hard-to-reach adults

(for example, those without a landline telephone or those who primarily speak Spanish). In selecting general population samples from the KP, GfK uses an equal probability of selection design by weighting the entire KP to the benchmarks from the latest March supplement of the U.S. Census Bureau's Current Population Survey (www.census.gov/cps/data/). The geodemographic dimensions used for weighting the entire KP typically include sex, age, race, ethnicity, education, census region, household income, home ownership status, metropolitan area, and Internet access. With these weights as the measure of size for each panel member, a probability proportional to size is used in the next step to select study-specific samples. Application of the proportional-to-size methodology with the aforementioned measure of size values produces fully self-weighing KP samples, for which each sample member can carry a design weight of unity.

Study-Specific Poststratification Weights

Once the study sample was selected and fielded and all the survey data were edited and made final, design weights were adjusted for any survey nonresponse (to the initial and to the supplemental survey) as well as any under- or overcoverage imposed by the study-specific sample design. For this study, the following strata of gun ownership from weighted KP data and veteran status from the 2014 veteran supplemental survey of the Current Population Survey were used for the raking adjustment of weights:

Sex, by age (18 to 29, 30 to 44, 45 to 59, 60 to 69, or =70 years)

Census region (Northeast, Midwest, South, West), by metropolitan area (yes or no)

Sex, by veteran status (yes or no)

Age (18 to 29, 30 to 44, 45 to 59, 60 to 69, or =70 years), by veteran status (yes or no)

Race/Hispanic ethnicity (white/non-Hispanic, black/Non-Hispanic, other/Non-Hispanic, =2 races/Non-Hispanic, Hispanic), by veteran status (yes or no)

Census region (Northeast, Midwest, South, West), by veteran status (yes or no)

Metropolitan area (yes or no), by veteran status (yes or no)

Education (less than high school/high school, some college, bachelor or greater), by veteran status (yes or no)

Household income (<$25 000, $25 000 to <$50 000, $50 000 to <$75 000, =$75 000 per year), by veteran status (yes or no)

Internet access (yes or no), by veteran status (yes or no)

Veteran serving years (<2, 2 to 3, 4 to 9, or =10 years)

Armed services branch (Air Force, Army, Coast Guard/Marines/other, Navy)

Iterative proportional fitting (raking) was performed to produce final weights aligned with respect to all strata simultaneously. In the final step, calculated weights were examined to identify and, if necessary, trim outliers at the extreme upper and lower tails of the weight distribution. The resulting weights then were scaled to the sum of the total sample size of all eligible respondents.

We report the study "completion rate" for our survey on the basis of the formula developed by Callegaro and DiSogra (12) for response rates calculated applicable to Web panels. The study completion rate = *((Study Completes))/((Study Completes+Study Partial Completes)+(Study Refusals+Study Noncontacts+Other Study Cases))*.