

# Long-Term Impact on Alcohol-Involved Crashes of Lowering the Minimum Purchase Age in New Zealand

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Several US studies have found that raising the minimum legal drinking age is related to medium- to long-term reductions in vehicle-related harms among those younger than the drinking age.<sup>1–3</sup> An additional US study, analyzing long-term data from 50 states, found an 18.9% reduction in fatal alcohol-related traffic crashes among drivers younger than the drinking age following the introduction of a national minimum legal drinking age of 21 years even after controlling for zero tolerance driving laws, driving exposure, per capita beer consumption, and other relevant influences.<sup>4</sup>

Although evidence of the long-term consequences of raising the legal drinking age on alcohol-related harms is available, there is less evidence on the long-term effects on harms following a lowering of the drinking or purchase age. Most studies have instead focused on the immediate or short-term impacts.<sup>5–10</sup> We could not find any published study reporting the long-term relationships between lowering the legal age limit and harms in which the postlaw change period comprised 10 or more years of data (aside from studies finding cohort effects as affected age groups grew older).<sup>11,12</sup> The minimum legal purchase age for alcohol in New Zealand was lowered from 20 to 18 years<sup>13</sup> on December 1, 1999, providing a context in which to study the longer term effects of such a law change.

Several studies have previously assessed the short-term consequences of lowering the purchase age in New Zealand. Guria et al.<sup>14</sup> found an increase in alcohol-involved crashes among drivers aged 15 to 17 years directly following the lowering of the minimum purchase age. Huckle et al.<sup>9</sup> found a significant increase in drivers being in alcohol-involved vehicle crashes, particularly among those directly affected—those aged 18 to 19 years—between 1999 and 2003. Kyprilou et al.<sup>10</sup> found an alcohol-involved crash rate that was 12% larger for males aged 18 to 19 years and 14% larger for males aged 15 to 17 years (relative to their

counterparts aged 20–24 years) directly after the law change. For females, the equivalent rates were 51% larger among those aged 18 to 19 years and 24% larger among those aged 15 to 17 years. Although broadly consistent results were found between the studies in New Zealand, there were some limitations because differences in driving exposure and other influences on crashes were not explicitly accounted for.

The minimum legal purchase age has been a heavily debated policy in New Zealand. It is likely that the purchase age will be debated again in the future in New Zealand, as in other contexts. There is a need to provide evidence to inform policy decisions, particularly in jurisdictions that may be considering lowering either the legal purchase or the legal drinking age (which reflects current discussions in some US states)<sup>11,15</sup> or in jurisdictions such as New Zealand, where policymakers periodically consider raising the legal purchase age but have not voted to do so (the most recent vote was in 2012). Findings will contribute to the international debate and to the assessment of whether the New Zealand government decision

**Objectives.** We assessed the long-term effect of lowering the minimum purchase age for alcohol from age 20 to age 18 years on alcohol-involved crashes in New Zealand.

**Methods.** We modeled ratios of drivers in alcohol-involved crashes to drivers in non-alcohol-involved crashes by age group in 3 time periods using logistic regression, controlling for gender and adjusting for multiple comparisons.

**Results.** Before the law change, drivers aged 18 to 19 and 20 to 24 years had similar odds of an alcohol-involved crash ( $P = .1$ ). Directly following the law change, drivers aged 18 to 19 years had a 15% higher odds of being in an alcohol-involved crash than did drivers aged 20 to 24 years ( $P = .038$ ). In the long term, drivers aged 18 to 19 years had 21% higher odds of an alcohol-involved crash than did the age control group ( $P \leq .001$ ). We found no effects for fatal alcohol-involved crashes alone and no trickle-down effects for the youngest group.

**Conclusions.** Lowering the purchase age for alcohol was associated with a long-term impact on alcohol-involved crashes among drivers aged 18 to 19 years. Raising the minimum purchase age for alcohol would be appropriate. (*Am J Public Health*. Published online ahead of print April 17, 2014; e1–e5. doi:10.2105/AJPH.2013.301734)

in 2012 to keep the purchase age at 18 years was the appropriate policy response.

We assessed whether lowering minimum purchase age in 1999 in New Zealand was associated with long-term changes in alcohol-involved vehicle crashes among age groups affected by the law change relative to an age control group.

## METHODS

We obtained 1994 to 2010 data on drivers in vehicle crashes involving an injury or fatality from the New Zealand Ministry of Transport. We obtained data by age and gender. Ethnicity was available from 2002 onward but did not provide a long enough time series to use in this study.

## Determining Alcohol Involvement

New Zealand law requires that crashes involving injury or death be reported to the police. For crashes involving nonfatal injury, driver alcohol levels were available from hospital blood tests or police-administered breath tests. Alcohol involvement is coded only when

drivers have a blood alcohol content (BAC) level higher than the legal BAC limit for driving (personal written communication, W. Jones, PhD, July 12, 2013). The legal BAC limit for driving in New Zealand is 80 milligrams of alcohol per 100 milliliters of blood for adults aged 20 years and older and 30 milligrams per 100 milliliters of blood for drivers younger than 20 years (and for drivers who are on the graduated driver licensing program).<sup>16</sup> In some cases, drivers who were likely to have a BAC level higher than the legal limit left the scene of the crash and could not be breath tested; we did not include them in these data. This underreporting of crashes, however, did not occur differentially by age over time.<sup>17</sup>

For fatal crashes, a blood test was obtained at autopsy for drivers who died (with hospital blood tests or police-administered breath tests for drivers who did not). From 1994 to 2010, measured BAC levels were available for approximately 80% of fatally injured drivers in each year,<sup>18</sup> and this measurement rate is higher than is that previously reported in the United States for drivers who died in fatal crashes.<sup>19</sup> In some cases, police recorded that alcohol was suspected but did not provide an alcohol level. Evidence indicates that this is a reasonably accurate indicator of alcohol involvement.<sup>20</sup>

## Data

We used the number of drivers involved in each crash. This captured multiple vehicle crashes in which only the noninjured or non-fatally injured driver had a BAC level higher than the legal BAC limit for driving and accounted for variation in the number of cars involved in crashes over time.

The Ministry of Transport coded the data in the following way. If 2 drivers were involved in a crash in which a passenger or a driver was fatally injured, 1 driver had a BAC level higher than the legal limit for driving, and 1 had used drugs but not alcohol, classification was as follows: 1 driver in an alcohol-involved fatal crash, 1 driver in a non-alcohol-involved fatal crash. Injury and fatal crashes are mutually exclusive. If there was both an injury and a fatality in a crash, the Ministry of Transport coded the drivers as being involved in a fatal crash. Fault is not specifically considered. We included drivers who had a BAC level higher

than the legal driving limit (by the data holders) regardless of fault (personal written communication, W. Jones, PhD, July 12, 2013). However, the vast majority of drivers with a BAC level higher than the legal limit are at fault in a crash in New Zealand, and there are very few cases in which 2 drivers in a crash have a BAC level higher than the legal alcohol limit for driving (personal written communication, W. Jones, PhD, July 12, 2013).

## Measures

Because alcohol-involved crashes do not occur in controlled environments, it was necessary to adjust for factors not related to alcohol legislation that affect the number of total crashes.<sup>19,21</sup> Examples include driver age (which predicts crashes independent of driving experience<sup>22</sup>); population growth and demographic changes; driving exposure (reflected in km driven), which differs quite dramatically between adolescents and young adults in New Zealand and varies over time (Table 1); the number of drivers on the road, which has been increasing in New Zealand<sup>23,24</sup>; general changes in vehicle safety (crash worthiness); weather; road conditions; and the graduated driver licensing program in New Zealand.<sup>16</sup>

It was not possible to account for the effects of all factors influencing crashes individually as covariates (e.g., in the modeling) because we could not obtain useful measures for many. However, because we expected the potentially confounding factors to influence the total number of crashes and not to have a different relationship with alcohol-involved crashes, using drivers in non-alcohol-involved crashes (whose numbers should not be affected by the law change) as a control group provides

adjustment for the potential confounders. Similar approaches have been used previously.<sup>19,25</sup>

Our approach accounts for the control group explicitly as part of the dependent measure by using a ratio of drivers in alcohol-involved crashes to drivers in non-alcohol-involved crashes in the same age group. Using the ratio, or the odds ratio (OR), allows us to directly compare change in the treatment group with that in the control group.<sup>19</sup> This approach standardizes the dependent variables across age groups.<sup>4</sup> Using the odds that a driver in a crash will have had a BAC level higher than the legal limit minimizes the effects of factors influencing the total number of crashes but not the proportion that are alcohol involved. Additionally, the use of the ratio reduces the potential for changes in the size of the age groups over time to affect the results.<sup>4</sup>

The dependent measures are (1) the comparison of drivers in alcohol-involved crashes involving injury or fatality with drivers in non-alcohol-involved crashes involving injury or fatality and (2) the comparison of drivers in alcohol-involved fatal crashes with drivers in non-alcohol-involved fatal crashes. The independent variables were age, grouped as 14 to 17 years (those younger than the purchase age), 18 to 19 years (those directly affected by lowering the purchase age), and 20 to 24 years (those unaffected by lowering the purchase age); gender (male or female); and year (1994–2010).

## Analysis

We grouped annual data points into 3 periods. The prepurchase age period included the years 1994–1999. In 1993 a lower BAC level of 30 milligrams of alcohol per 100 milliliters of blood<sup>26</sup> (down from 80 mg) was introduced for drivers younger than 20 years.<sup>26</sup> A prepurchase age period starting from 1994 ensured this policy change was avoided in our results. We set the postpurchase age periods to 2000–2005 and 2006–2010 to separate short-term and longer term effects.

Those aged 14 to 17 years reflected the age group below the new purchase age, and we included them to assess possible trickle-down effects of the law change in 1999. Those aged 18 to 19 years represented those directly affected by the lowering of the purchase age.

**TABLE 1—Driving Exposure in Age Groups of Interest (in Millions of Kilometers Driven): New Zealand, 1997–1998, 2003–2006, 2007–2010**

Age, y	1997–1998	2003–2006	2007–2010
15–17	4.9	4.7	3.4
18–19	4.9	6.5	7.0
20–24	22.9	20.0	22.9

Source. The New Zealand Ministry of Transport provided these data.

Those aged 20 to 24 years were the age comparison group, as they were exposed to environmental and economic conditions similar to the conditions of those aged 18 years (who were directly affected by the law change). They were most similar to those aged 18 to 19 years with respect to drinking patterns (as shown by Huckle et al. 2011<sup>27</sup>) and social behavior but were not affected by the lowering of the purchase age. Of further importance was the introduction of beer for sale in supermarkets and increasing the number of alcohol outlets permitted to sell alcohol on Sunday, which occurred on the date the purchase age was lowered. Those aged 20 to 24 years provided the control for the effects of these policy changes, as those aged 20 to 24 years were likely to have been affected by these policy changes in a manner similar to those aged 18 to 19 years. Those aged 20 to 24 years, therefore, acted as the age control group.

The data consisted of 270 516 case participants (176 222 males) involved in a crash in which the driver had crashed her or his vehicle, resulting in injury or death. We structured the data set as binary response data. The variables in the data set included gender of the driver, age of the driver, and year of the crash.

Additionally there were 2 binary indicators; alcohol involved was coded as 1 when the driver was over the legal BAC limit (25 917 people), and fatal was coded as 1 when the driver was involved in a crash resulting in a fatality (10 051 people).

We used 2 different logistic regressions to model the odds of a driver experiencing an

alcohol-involved crash. The first used all the drivers in the data, whereas the second was restricted to drivers involved in fatal crashes only. The models used the same covariates: gender, age group, and year (aggregated into 3 periods in the modeling). We controlled for gender so that the varying gender compositions in each age group could not affect the relative age comparisons over time. We did not run separate models for males and females because the numbers of drivers in alcohol-involved fatal crashes were small for females aged 18 to 19 and 14 to 17 years ( $n < 30$ ). Lastly we added an age group by period interaction term to the model to investigate how the change in the odds differed between the age groups over time. After fitting each model, we compared those aged 14 to 17 and 18 to 19 years with those aged 20 to 24 years in the 3 periods and expressed as ORs. We adjusted the multiple comparisons using the Tukey–Kramer method.

We analyzed the data using SAS version 9.2 (SAS Institute, Cary, NC). Where we have reported significant differences, these are statistically significant. We declared statistical significance for any test with  $P < .05$ .

## RESULTS

The interaction between age group and period were statistically significant in the model ( $P \leq .001$ ). Before the lowering of the purchase age, the odds of experiencing an alcohol-involved crash (involving injury or fatality) was similar among drivers aged 18 to 19 and 20 to 24 years ( $P = .1$ ; Table 2). Directly after the

lowering of the purchase age, drivers aged 18 to 19 years had a 15% higher odds of experiencing an alcohol-involved crash (involving injury or fatality) than did drivers aged 20 to 24 years ( $P = .038$ ; Table 2).

Longer term, in 2006–2010, drivers aged 18 to 19 years had a 21% higher odds of experiencing an alcohol-involved crash (involving injury or fatality) than did drivers aged 20 to 24 years ( $P \leq .001$ ; Table 2). The odds of drivers aged 14 to 17 years experiencing an alcohol-involved crash (involving injury or fatality) were significantly lower than were the odds of those aged 20 to 24 years in each period analyzed (Table 2). In other words, there was no apparent change over time among drivers aged 14 to 17 years (compared with drivers aged 20–24 years). The age group and period interaction was not statistically significant ( $P = .283$ ).

Despite the nonsignificance of the interaction term, we produced comparisons. For fatal alcohol-involved crashes, we found no significant differences in the odds for drivers aged 18 to 19 years compared with drivers aged 20 to 24 years in each period (showing no change over time; Table 2). Drivers aged 14 to 17 years had the same odds of experiencing a fatal alcohol-involved crash as did those aged 20 to 24 years in all periods except 2006–2010, when there was some evidence of lower odds (Table 2).

## DISCUSSION

Lowering the minimum purchase age for alcohol has previously been found to result in

**TABLE 2—Alcohol-Involved Crashes by Age: New Zealand, 1994–1999, 2000–2005, 2006–2010**

Outcomes	Before Minimum Purchase Age Lowered (1994–1999)		Directly After Minimum Purchase Age Lowered (2000–2005)		Longer Term (2006–2010)	
	OR (95% CI)	P	OR (95% CI)	P	OR (95% CI)	P
Alcohol-involved crashes involving injury or fatality, age, y						
14–17	0.62 (0.54, 0.72)	$\leq .001$	0.77 (0.66, 0.90)	$\leq .001$	0.82 (0.70, 0.95)	.001
18–19	0.89 (0.78, 1.00)	.1	1.15 (1.00, 1.33)	.038	1.21 (1.05, 1.39)	$\leq .001$
20–24 (Ref)	1.00	...	1.00	...	1.00	...
Alcohol-involved crashes involving fatality, age, y						
14–17	0.54 (0.28, 1.03)	.08	0.70 (0.37, 1.32)	.802	0.49 (0.24, 0.99)	.045
18–19	0.91 (0.55, 1.50)	$\geq .99$	0.86 (0.46, 1.60)	.999	1.01 (0.52, 1.97)	$\geq .99$
20–24 (Ref)	1.00	...	1.00	...	1.00	...

Note. CI = confidence interval; OR = odds ratio.

short-term increases in alcohol-related harms<sup>5-10,28</sup>; however, it was not known whether a lowered purchase age would continue to contribute to harmful outcomes over the long term.

Our findings indicate that lowering the minimum purchase age in New Zealand has had a long-term impact on drivers experiencing alcohol-involved crashes among the age group directly affected: those aged 18 to 19 years. Although the odds of a driver aged 18 to 19 years experiencing an alcohol-involved crash resulting in an injury or fatality were similar to the odds of the age control group before the law change, their odds became significantly higher following the law change. The main effect was found in the short term (2000–2005); however, the higher odds were maintained in the long term (2006–2010). To the best of our knowledge, no previous study has analyzed the long-term effects of a lowered purchase age (aside from cohort studies with a different focus).<sup>11,12</sup>

Lowering the purchase age had no impact on fatal alcohol-involved crashes among drivers aged 18 to 19 years compared with drivers aged 20 to 24 years. Numbers of alcohol-involved fatal crashes were smaller, which may have reduced statistical power. However, the ratios of alcohol-involved fatal crashes to non-alcohol-involved fatal crashes among drivers aged 18 to 19 and aged 20 to 24 years were similar in each period; therefore, it is unlikely that the law change has had an effect on fatal crashes among those aged 18 to 19 years. Those aged 20 to 24 years had a higher BAC limit than did those who were younger (80 mg vs 30 mg of alcohol per 100 ml of blood),<sup>26</sup> and the higher the BAC level, the higher the probability of death in an alcohol-involved crash.<sup>29</sup> However, the BAC limits were consistent over each of the periods investigated, so they did not affect our relative age comparisons over time.

There was no evidence of a trickle-down effect for those aged 14 to 17 years. The odds of a driver aged 14 to 17 years being in an alcohol-involved crash (involving injury or fatality or fatality only) did not move significantly closer toward, or above, the odds among the age control participants in any period following the law change. This may be related to the graduated driver licensing program, which affects those in the youngest group and prohibits their access to vehicles. Between 1994 and 2010,

drivers on learner's licenses were required to be supervised at all times while driving. Those on restricted licenses were legally limited from driving vehicles between 10 P.M. and 5 A.M. unless accompanied by a supervisor who had held a current full New Zealand driver's license for at least 2 years. All drivers on a learner's or restricted license had a lower legal BAC limit (30 mg of alcohol per 100 ml of blood).<sup>30</sup>

### Limitations

We used drivers aged 20 to 24 years as the age control group. Although this is logical, as they are most similar to the age group directly affected by the law change and are hypothesized not to be affected by the lowering of the purchase age, we cannot guarantee they have not been affected. There is the possibility of a cohort effect, when long-term data are assessed, as the newly affected drivers aged 18 to 19 years become part of the aged 20 to 24 years group several years later. Cohort effects related to alcohol-related harms and a lower legal drinking age have been found previously in the literature.<sup>11,12</sup> If those aged 20 to 24 years in New Zealand have been affected by the lowered purchase age, then effects of the law change may be underestimated for those aged 18 to 19 years. We plan cohort analyses of these data for a future date.

Beer was introduced for sale in supermarkets and an increased number of outlets were permitted to sell alcohol on Sunday in New Zealand in 1999 on the same date that the purchase age was lowered.<sup>13</sup> If these additional policy changes had more effect on those aged 18 to 19 years than on those aged 20 to 24 years, effects that we are attributing to the lowering of the purchase age may be overestimated for those aged 18 to 19 years. Currently we have no evidence to suggest that these policy changes have had different effects in these age groups.

Using crash data of drivers (and not crash events) may inflate the number of non-alcohol-involved drivers in our data, as alcohol-involved crashes are more likely to have a single vehicle lose control or run off the road (personal written communication, W. Jones, PhD, July 7, 2013). If numbers of non-alcohol-involved drivers were inflated, this would have the effect of underestimating the effects of the law change.

In some instances, police suspicion of alcohol involvement was recorded when test results were not available. Previous evidence has suggested this is a relatively reliable indicator of alcohol involvement<sup>20</sup>; however, it is possible drivers were incorrectly identified. This would be most detrimental to our findings if police recording of alcohol involvement occurred differentially by age group. There is currently no evidence to suggest that this occurs.

A driver may be in more than 1 age group in any 1 of the 3 periods considered in our analysis. A driver may also be in more than 1 period if, for example, a driver was in a crash at age 18 years in 2005 (period 2: 2000–2005) and then in a different crash in 2007 at age 20 years (period 3: 2006–2010). There was no way to identify these case participants in the data, so we could not make adjustments in the modeling. This may have led to a very small underestimation of the SEs; however, we do not anticipate that this would affect model outcomes.

### Conclusions

The lowering of the purchase age in 1999 was associated with a long-term impact on alcohol-involved crashes among drivers directly affected: those aged 18 to 19 years. We found the main increase in the odds of experiencing an alcohol-involved crash for drivers aged 18 to 19 years directly following the law change compared with the age control group, but the increased odds was maintained long term. Raising the minimum purchase age for alcohol in New Zealand would be an appropriate public health intervention. ■

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### Contributors

T. Huckle conceptualized and formulated the study, including the methodology and overall analysis concept, and wrote the article. K. Parker designed and implemented the modeling, provided methodological input, wrote the analysis section, and reviewed the article.

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## Human Participant Protection

Institutional review board approval was not needed because data were obtained from secondary sources and were already de-identified.

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