LONGITUDINAL RELATIONSHIP BETWEEN THE ALCOHOL WARNING LABEL AND ALCOHOL CONSUMPTION

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Abstract
Objective: The present study reports the longitudinal relationship between alcohol warning label exposure and alcohol consumption among adolescents. Method: In-school surveys assessed adolescents at three annual time points beginning in tenth grade. There were 649 participants measured at all three time points; 51% were female. Four effects were the focus of the covariance structure, latent growth analysis of these data: (1) an exposure effect, whereby earlier alcohol use leads to more exposure to the warning label; (2) a deterrent effect, whereby earlier alcohol warning label exposure reduces subsequent alcohol consumption; (3) a harmful effect, corresponding to a positive relationship between early exposure and subsequent consumption; and (4) both exposure and deterrent effects operating at the same time. Results: There was a statistically significant exposure effect such that earlier alcohol use was associated with later exposure to the warning. The association between earlier alcohol warning label exposure and subsequent alcohol use was generally negative but not statistically significant, suggesting that the warning did not affect alcohol consumption. Conclusions: These results suggest that the alcohol warning label is having the intended effect as described in the law requiring the warning. That is, it is informing and reminding persons of the risks associated with alcohol use. The warning does not appear to significantly increase or decrease alcohol consumption. (J. Stud. Alcohol 62: 221-227, 2001) Reprinted by permission of the publisher.

Article:
Public health interpretations of health warnings pose that exposure to a warning reduces the forewarned unsafe behavior. Such a deterrent effect is consistent with commonsense interpretations of warnings as providing risk information that ultimately reduces problem behavior. Assuming a deterrent effect, the warning label present on alcohol containers should lead to reduced alcohol consumption and alcohol-related problems. Smokeless and smoking tobacco warnings are other examples of federally legislated health warnings (Comprehensive Smoking Education Act of 1984; Comprehensive Smokeless Tobacco Act of 1986) that may deter the use of these substances.

Across several studies, however, there is actually a positive cross-sectional association between substance use and exposure to the respective health warning labels. For example, positive associations between consumption and warning exposure (where exposure is measured by self-reports of seeing the warning or memory for warning content) were found among high school students, adults and pregnant women for alcohol (e.g., Hankin et al., 1993; Kaskutas and Greenfield, 1992; MacKinnon et al., 1993) and among college students for alcohol, smokeless tobacco and smoking tobacco (MacKinnon and Fenaughty, 1993). Because these health warnings are on the packaging, the positive associations have been interpreted as implying that the warnings are successful. Those persons who engage in the risky behavior and who need to be informed of the risks actually see the warning more and have more accurate memory for the warning than those who do not engage in the behavior. Furthermore, some laws requiring warnings (e.g., Alcohol Beverage Labeling Act of 1988) state that the purpose of the warning is to inform and remind persons of the potential hazards. If people see and remember the warning, they are being informed of the hazard.

In a different view, the positive relationship between substance use and memory has led some researchers to conclude that a warning is at best ineffective and at worst counterproductive because more exposure to the warning does not reduce actual use of the substance. One longitudinal study (Robinson and Killen, 1997) examining the association between cigarette warning label exposure and cigarette use found a statistically significant positive relationship between early exposure to the warning and cigarette use 3 months later. The results held up even after controlling for prior cigarette use. Robinson and Killen (1997) concluded, "The current warning labels are ineffective among adolescents" (p. 267).

The different conceptualizations of warning effects can be called the "deterrent effect" (exposure reduces...
alcohol use), the "exposure effect" (alcohol use increases exposure) and the "harmful effect" (exposure increases alcohol use). A fourth, more complex conceptualization is that both exposure and deterrent effects may operate simultaneously. In the latter case, although greater frequency of alcohol consumption may predict better memory for warnings on alcohol beverage containers, greater memory may simultaneously predict later reductions in alcohol use. The occurrence of both relationships over time is conceivable but can only be evaluated with an appropriate longitudinal design. The purpose of this study is to examine these alternatives in a longitudinal evaluation of the alcohol warning label. The empirical evaluation of these alternatives takes into account a number of previous findings from research on the effects of the alcohol warning label, which are summarized briefly below.

The alcohol warning label and its previously documented effects

Alcohol beverage containers manufactured since November 18, 1989 have been required to display a warning describing some of the potential risks of drinking alcohol (Alcohol Beverage Labeling Act, 1988), including risks of drinking while pregnant, driving, and operating machinery, and the potential for health problems. To date, research on the alcohol warning has been based primarily on repeated cross-sectional samples of participants measured before and after the warning was introduced. These samples have included adults (Greenfield et al., 1999; Mazis et al., 1991), adolescents (MacKinnon et al., 1993), Mormons versus non-Mormons (Mayer et al., 1991) and women visiting a prenatal clinic (Hankin et al., 1993). Following the appearance of the warning label, increases in exposure to the warning and memory for the risks on the warning were observed. After a few years, however, these exposure and memory effects leveled off (Greenfield and Kaskutas, 1998; Hankin et al., 1996; MacKinnon et al., 2000; Mazis et al., 1996). Changes in beliefs about risks on the warning or in alcohol consumption have been small and nonsignificant (Andrews, 1995; Hankin et al., 1998; MacKinnon, 1995). Possible exposure effects based on level of alcohol consumption have been observed cross-sectionally. However, no alcohol warning label research has distinguished between exposure and harmful effects, nor has it investigated the possibility of simultaneous exposure and deterrent effects.

Longitudinal data could be used to shed light on the effects of warning exposure and alcohol consumption. An exposure effect would be indicated by earlier alcohol use leading to more exposure to the warning label. A deterrent effect would be indicated by alcohol warning exposure reducing subsequent alcohol consumption. In order to distinguish these effects a more detailed analysis is necessary, one that includes measures across time so that the deterrent effect and the exposure effect can be separately estimated.

Importance of appropriate longitudinal models

During the late 1970s, the cross-lagged panel method of examining longitudinal relationships among variables was developed (Kenny, 1979). In this approach, two correlations are compared. To use the alcohol warning example, the correlation between early warning exposure and later alcohol use is compared with the correlation between early alcohol use and later warning exposure. Cross-lagged correlation approaches were criticized for several reasons, including problems due to measurement error (Kessler and Greenberg, 1981). Measurement error was later incorporated in the cross-lagged model by the estimation of latent variable models for the observed measures. These methods enjoyed several years of wide and convincing applicability (Bentler and Speckart, 1979, 1981; Kessler and Greenberg, 1981) until their limitations were clearly described (Rogosa, 1980). According to Rogosa and Willett (1985), these models do not explicitly specify individual change, do not easily generalize to more than two waves of data, and the data analysis only includes the covariance matrix and not the means. Stoolmiller and Bank (1995) added that autoregressive models fail when there is high-rank order stability over time and require the questionable assertion that the prior score on a variable causes the subsequent score on that variable. Rogosa (1988) and others advocate the use of growth curve models for longitudinal data because they avoid the problems associated with autoregressive approaches to analysis.
Summary

The present study examines the longitudinal relationship between exposure to the alcohol warning label and alcohol consumption in the same adolescents measured at three time points, from tenth grade through twelfth grade. Although high school students are under the legal drinking age, alcohol experimentation often begins during this period and it is the time when many attitudes regarding alcohol use are established (Newcomb et al., 1986). We hypothesized that alcohol use would lead to increased exposure to the alcohol warning label because the warning is present on the alcohol container. In addition, we hypothesized that exposure to the alcohol warning label would lead to later reductions in alcohol use because the warning label points out the potential harmful effects of alcohol. Alternative hypotheses, outlined earlier, were also evaluated. The hypotheses and alternatives were tested with cross-lagged correlations, autoregressive covariance structure models and latent growth curve models.

METHOD

Participants

The sample consisted of 3,165 Marion County, Indiana students surveyed during the 1989/90, 1990/91 and 1991/92 school years. The students were in the ninth or tenth grade during the first measurement. There were 1,543 students measured at all three time points. Because multiple forms of the questionnaire were used, there were 649 students measured at all three time points with complete data for all survey items. Participants were surveyed as part of the Midwestern Prevention Project (Pentz et al., 1989), a longitudinal drug abuse prevention study. The students in the present study had not participated in the prevention program. The sample was 51% female and 78% white; 51% were classified as mid to high socioeconomic status, based on reported professional or managerial parental occupation. Most of the students had consumed alcohol during their lifetime (84% in 1989/90, 87% in 1990/91 and 88% in 1991/92) and approximately half of the sample had consumed alcohol in the last month (40% in 1989/90, 45% in 1990/91 and 50% in 1991/92). These figures are consistent with national survey reports of alcohol use prevalence for same age adolescents (Johnston et al., 1996).

Design

Although the Alcohol Beverage Labeling Act (1988) required that new alcohol containers display the warning by November 18, 1989, containers produced prior to the mandated date continued to be sold without a warning. In fact, Hankin et al. (1996) reported that only 30% of distilled spirits containers on shelves in a large city contained the warning 7 months after the mandated date; however, 86% of beer containers displayed the warning. It is also possible that some alcohol containers displaying the warning were sold prior to the mandated date. Reported exposure to the alcohol warning label should be viewed as a combination of real exposure and false positives (incorrect affirmative response) both before and after the warnings date of appearance. The proportions of false positives are assumed to be similar before and after the warning appeared.

Measures

The variables for this report were included on a questionnaire administered yearly to measure attitudes, beliefs, knowledge and the consumption of drugs. The warning label questionnaire items were exposure ("Have you seen warning labels on alcohol beverage cans or bottles?"); awareness of the law ("To the best of your knowledge, is there a law requiring warning labels on cans and bottles of beer, wine and liquor?"); and recognition memory ("Alcohol use by a pregnant woman can harm the baby," "Alcohol use impairs the ability to drive," "Alcohol use impairs the ability to operate machinery," "Alcohol use can cause health problems," "Alcohol use can cause family problems" and "Alcohol use can lead to addiction"). The exposure and awareness measures had four response options: "yes, definitely," "probably," "I don't think so" and "no."
The memory measure consisted of the sum of correct recognition and rejection responses to six risks (four of which were on the alcohol warning and two "distractor risks" which were not on the warning label).

The alcohol consumption questionnaire items were the number of drinks consumed in the last month, the number of times intoxicated in the last month and the number of drinks usually consumed per occasion. The response options for the amount of alcohol consumed within the last month ranged from 1 (none) to 6 (more than 20 drinks). The response options for the number of times drunk in the last month ranged from 1 (none) to 5 (more than 6). The usual quantity of alcohol consumed ranged from 1 (none) to 6 (5 or more drinks). The alcohol consumption response options were based on prior work with adolescent samples.

**Data Analysis**

Three methods were used to test the hypotheses regarding the exposure and deterrent effects of alcohol warning labels: (1) cross-lagged correlations, (2) autoregressive structural equation models and (3) latent growth curve models. There were two constructs or latent factors, depending on method: exposure to alcohol warning labels and alcohol consumption. The latent factor of alcohol warning exposure had three indicators: (1) whether the participant had seen the warning label, (2) awareness of the law requiring the warning label and (3) recognition memory for the risks on the warning label. The awareness of the law measure may reflect exposure to the actual label, exposure to the media and other sources regarding the existence of the label. The latent factor of alcohol consumption had three indicators: (1) number of alcoholic drinks in the last month, (2) number of times intoxicated in the last month and (3) usual quantity of alcohol consumed at one time. For the cross-lagged correlations, the constructs of warning exposure and alcohol consumption consisted of the mean of the respective items. For the autoregressive covariance structure model and the latent growth curve model, latent factors of warning exposure and alcohol consumption were modeled from the respective items.

Figure 1 shows which covariance structure paths would be significant for each of the hypothetical outcomes of the alcohol warning label. A positive association between early alcohol consumption and later warning exposure (Path A) would indicate an exposure effect whereby more alcohol use leads to more awareness of the warning. A negative relationship between early alcohol warning exposure and subsequent alcohol consumption (Path B) would indicate a deterrent effect, providing evidence that the warning label reduces alcohol consumption. If both of the above are true, Path A positive and Path B negative, then both exposure and deterrent effects are operating at the same time. If the relationship between early warning exposure and subsequent consumption (Path B) is positive, it would indicate a harmful effect of the warning label, early warning exposure increasing subsequent consumption.

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**Figure 1. An example of the covariance structure paths that would be significant for each of the hypothetical outcomes of the alcohol warning label.**
Cross-lagged correlations. Cross-lagged correlations between the alcohol consumption construct and warning exposure construct were calculated between two different time points. For example, the alcohol use construct at Time 1 was correlated with the warning exposure construct at Time 2 (exposure effect), and the warning exposure construct at Time 1 was correlated with the alcohol use construct at Time 2 (deterrent or harmful effect). The size of the exposure and deterrent effects was then compared with a z statistic for comparing dependent correlations (Meng et al., 1992).

Autoregressive model. The structural model included the two latent factors of exposure to the warning label and alcohol consumption at three time points (Figure 1). The exposure effect was tested by modeling a path from the alcohol use latent factor at Time 1 to the warning exposure latent factor at Time 2. The deterrent and harmful effects were tested by modeling a path from the warning exposure latent factor at Time 1 to the alcohol use latent factor at Time 2. Exposure and deterrent paths from Time 2 to Time 3 were also modeled. The measured variable errors were correlated across time (e.g., intoxicated at Time 1 with intoxicated at Time 2, and intoxicated at Time 2 with intoxicated at Time 3). The model included the mean structure as well.

Latent growth curve model. In applying latent growth modeling, higher order longitudinal growth modeling was conducted, in which a growth curve of the factor scores representing the common part of the indicator variables at each time point was examined. The parameters of interest were the intercept (initial status) and the growth rate (slope) of the latent factors. Linear growth for alcohol use and warning exposure was modeled because access to alcohol and consequent exposure to the warning is likely to increase as the adolescent ages. The intercepts represent the level of alcohol use and the level of warning exposure at tenth grade. The growth rates are the change in alcohol use and the change in warning exposure per year. Alcohol use and warning exposure were modeled as two concurrent parallel processes influencing each other. The intercept of the alcohol use factor was modeled to influence the growth rate of warning exposure to test the exposure effect. The intercept of the warning exposure factor was modeled to influence the growth rate of alcohol use to test the deterrent effect. The growth rates of alcohol use and warning exposure were allowed to correlate. The measured variable errors were correlated across time.

Statistical software. The statistical program AMOS Version 4 (Arbuckle and Wothke, 1999) was used to model a mean structure autoregressive structural equation model and a latent growth curve model. Both the autoregressive model and the latent growth curve model were analyzed twice: once with complete cases and once with all cases, which included missing data. The pattern of results for complete cases and for all cases was essentially the same. Therefore, the models presented include missing data, using recently recommended procedures for estimating missing data (Graham et al., 1997). The estimation procedure was maximum likelihood for complete cases and full information maximum likelihood for all cases (Arbuckle, 1996). Chi-square, the root mean square error of approximation (RMSEA; Browne and Cudeck, 1993) and the normed fit index (NFI; Bentler and Bonett, 1980) were used to evaluate the fit of the models. The models did not show invariance in factor loadings of the indicators and means across waves. Although invariance is necessary to infer change in constructs across waves (Pitts et al., 1996), the pattern of results with and without invariance constraints was essentially the same and, accordingly, the models presented do not include invariance constraints. Also, modeling alcohol use measures as categorical did not change the conclusions of this study. A table showing the correlation matrix, means and standard deviations, and figures displaying the path coefficients for the autoregressive covariance structure and growth curve models can be obtained from the first author.

RESULTS

The cross-lagged correlations (complete cases only) between the constructs of alcohol use and warning exposure indicate that the exposure effect \( r = 0.10 \) is significantly larger than the deterrent effect \( r = -0.00 \) between 1989 and 1990 \( z = 2.02, p < .05 \). The exposure effect \( r = 0.19 \) is also larger than the deterrent effect \( r = 0.09 \) from 1990 to 1991 \( z = 2.20, p < .05 \).

Although the \( \chi^2 \) statistic from the mean structure autoregressive structural equation model is rather large
due to the large sample size and the nonnormality of the predictors ($ \chi^2 = 858.49$, 112 df, $p < .001$), other indicators suggest the model fits the data well (RMSEA = 0.046; NFI = 0.99). There are statistically significant exposure effects, the paths from alcohol use to warning exposure, from 1989 to 1990 ($\hat{\beta} = 0.051$, SE = 0.017, $p < .05$) and from 1990 to 1991 ($\hat{\beta} = 0.047$, SE = 0.013, $p < .05$). The deterrent effect, paths from warning exposure to alcohol use, is not statistically significant from 1989 to 1990 ($\hat{\beta} = -0.050$, SE = 0.061, $p > .05$) or from 1990 to 1991 ($\hat{\beta} = 0.010$, SE = 0.054, $p < .05$).

Again, the $\chi^2$ statistic from the latent growth curve model is large ($\chi^2 = 814.05$, 117 df, $p < .001$) but the other indicators suggest a good fit for this model (RMSEA = 0.043; NFI = 0.99). There is growth in both warning exposure (mean$\_\text{slope} = 0.315$, SE$\_\text{slope} = 0.015$) and alcohol use (mean$\_\text{slope} = 0.301$, SE$\_\text{slope} = 0.016$) over time. The relationship between the intercept of alcohol use and the growth rate of warning exposure is statistically significant ($\hat{\beta} = 0.044$, SE = 0.013, $p < .05$). Exposure to the warning increases more rapidly for students who initially drank more alcohol, indicating an exposure effect. The relationship between the intercept of warning exposure and the growth rate of alcohol use is not statistically significant ($\hat{\beta} = 0.006$, SE = 0.065, $p > .05$), implying no deterrent effect. The results of the latent growth analyses are consistent with the covariance structure analyses.

**DISCUSSION**

This study examines several potential relationships between the alcohol warning label and alcohol consumption using a longitudinal sample of high school students. Possible effects of the warning are exposure, deterrent, harmful and combined effects. The results show that earlier exposure to the alcohol warning does not significantly reduce alcohol consumption, suggesting that the warning does not have a deterrent effect. In addition, early exposure does not increase alcohol consumption; therefore, there is no evidence for a harmful effect of the warning. There is an exposure effect, suggesting that a result of earlier alcohol consumption is more exposure to the warning label. The text of the alcohol warning label law states that the goal of the warning is to inform and remind persons of the risks associated with alcohol use. The exposure effect suggests that the alcohol warning label is having the intended effect, as people are increasingly seeing and remembering the warning.

The exposure effect in the present study may appear to replicate a similar study that examined cigarette warning exposure and smoking and found a positive association between awareness of the warning and smoking (Robinson and Killen, 1997). The present study, however, improves on the Robinson and Killen (1997) study because the exposure and deterrent/harmful effects are examined simultaneously and these effects are investigated across three waves using diverse analytical procedures. One of the effects in the Robinson and Killen study suggested the possibility of a harmful effect of cigarette warnings. The present investigation finds little support for a harmful effect of alcohol warnings. In addition, upon closer analysis of the Robinson and Killen study, there was not a significant relationship between cigarette warning exposure and later cigarette use among participants who were not cigarette users at baseline. Even if there had been a relationship between exposure and use for nonsmokers, persons more likely to subsequently smoke may have been more likely to be exposed to smokers at the earlier time point, leading to an exposure effect that may well be less than any deterrent effect.

It should be noted that there are subtle differences in the meaning of the exposure effect and the deterrent effect tested in the longitudinal models discussed in the present study. The cross-lagged correlations represent the extent to which a person who scores high on one construct (e.g., alcohol use) at the earlier wave also scores high on the other construct (e.g., exposure) at the later wave. The autoregressive structural model's interpretation is similar to the cross-lagged correlations, but the autoregressive model accounts for measurement error in the predictors with the use of latent variables. In addition, the effect of each factor at Time 1 on the other factor at Time 2 is modeled simultaneously, producing path coefficients closer to the true relationship between the two factors. In the latent growth curve model, these effects refer to the effects of the
initial level of one factor (e.g., alcohol use) on the change in the other factor (e.g., exposure to warning) over time. For example, the significant exposure effect suggests that the more alcohol the adolescents use at baseline, the bigger the change over time in exposure to the warning (i.e., on average, the growth of warning exposure is steeper for the adolescents who used more alcohol in tenth grade). This is slightly different from proposing that more alcohol use at baseline is associated with more exposure later, as in the cross-lagged correlation and autoregressive models. Regardless of analytical method and conceptualization, the exposure effect is supported in this study, whereas neither deterrent nor harmful effects are supported.

There are several limitations to consider when evaluating this study. First, the alcohol warning label represents a universal, large-scale intervention delivered to the entire United States (Stratton et al., 1996). Thus, exposure to the message is not under experimental control but is primarily a function of alcohol use or other exposure to the alcohol container. Second, there is no validation of the students' self-reported behaviors, although the effect of self-report would have to change across measurements for it to invalidate the results. Third, the analyses at 1-year intervals may not detect effects that were immediate and then dissipated. Fourth, although the high school student sample is large and representative, the results may not generalize to adults. Studies of adolescents and adults, however, have shown similar results even though adults generally have more familiarity with alcohol.

A reasonable question is whether the warning has any deterrent effect overall. The warning label has appeared on alcohol containers for over 10 years. Our data examined only the first 3 of those years, which may not be enough time for the warning information to have diffused through the population and caused reductions in alcohol use and negative alcohol use consequences. Nevertheless, small behavioral changes have been reported in some studies. For example, label recall was associated with self-reported limiting driving after drinking (Greenfield and Kaskutas, 1993) and slight declines in alcohol consumption during pregnancy (Hankin et al., 1996). Other studies, however, have not found changes in self-reported driving after drinking (e.g., MacKinnon et al., 2000) and the decreased alcohol consumption while pregnant only occurred for those women who were low-risk drinkers in the first place (Hankin et al., 1993). The results of this study in conjunction with prior results for both adolescents and adults support the conclusion that the alcohol warning label does not reduce alcohol-related risk behaviors.

Given the evidence against a deterrent effect of the warning reducing alcohol-related risk behaviors, by what process would we expect an effect to be present? It is perhaps unreasonable for a person in a drinking situation to read the warning and immediately change his/her behavior as a result of seeing the information. A more plausible scenario is that one's beliefs about alcohol use consequences change slowly over time, consistent with the cultivation of effects described by Gerbner et al. (1986) for the effects of media. As more people are exposed to the warning and slightly adjust their beliefs, societal norms slowly begin to change. As societal norms change, behavior changes. Assuming that societal norm change is necessary, it may take an entire generation growing up with the alcohol warning before behavior change is apparent. From this perspective, behavioral effects of the alcohol warning may not be expected until those born after the warning appeared are adults (i.e., around the year 2009). Nevertheless, even if the warning never reduces alcohol-related consequences, there is evidence that the warning is informing the public about the possible consequences of alcohol consumption.

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ADDED MATERIAL

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