



# Impact of Poison Prevention Education on the Knowledge and Behaviors of Seniors

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## ABSTRACT

**Background:** Unintentional poisoning is an important public health issue that exacts a heavy toll on our nation's seniors. However, relatively few empirical studies have examined the efficacy of poison prevention education programs on this cohort. **Purpose:** This study assessed the impact of a poison education program on the knowledge, perceptions, intentions, and behaviors of seniors in Missouri and West Virginia. **Methods:** One-hundred and twenty-seven seniors completed pre- and post-test surveys, which were designed to assess the program's efficacy. Participants were re-interviewed after four weeks to determine whether they had implemented the behaviors described in the program. **Results:** The results revealed that the program improved the knowledge of participants and impacted both their behavioral intentions and actual behaviors. **Discussion:** When taken together, these data indicate that brief educational interventions may be an effective tool in reducing the incidence of unintentional poisonings among seniors. **Translation to Health Education Practice:** More generally, these methods and findings suggest that single sessions of theory-driven health education can be effective for interventions among seniors.

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## BACKGROUND

Unintentional poisoning is an important public health issue that exacts a heavy physical, emotional and economic toll on our nation. On average, unintentional poisonings and those of an undetermined intent claim the lives of over 20,000 people per year.<sup>1</sup> Poisoning-related fatalities resulting from acute unintentional and undetermined poisonings cost over \$180 billion including medical (\$549 million), work loss (\$57.6 billion) and quality of life (\$122 billion) costs annually (inflated to 2005 dollars).<sup>2</sup>

Poisoning is particularly problematic among our nation's senior population. For instance, Rogers and Heard<sup>3</sup> found that seniors (aged  $\geq 60$ ) were at an increased risk of

death from poisoning exposures when compared to young adults, even after controlling for factors such as sex and exposure duration. Moreover, unintentional poisonings ranked sixth of 19 as a cause of unintentional

injury-related death among people aged 65 and older, with more than 900 fatalities attributed to this mechanism.<sup>1</sup> The total cost of unintentional poisoning fatalities among this age group has been estimated to

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approach \$830 million (inflated to 2005 dollars).<sup>4</sup> In addition, approximately 72,000 seniors (aged  $\geq 65$ ) have been hospitalized for unintentional poisoning injuries.<sup>5</sup> Seniors may also be at higher risk for medication-induced poisonings due to the physical, mental and physiological impairments that may accompany the aging process.<sup>6</sup> As the number of U.S. seniors continues to grow, the risk of unintentional poisonings among this group is also likely to increase.

Empirical research examining the efficacy of theory-based poison prevention education programs on seniors is lacking in the public health literature. For example, studies in this domain have typically investigated the impact of poison education programs on children and/or their parents and caregivers,<sup>7,8,9</sup> despite the presence of data indicating that other high-risk populations exist.<sup>1,10</sup> In addition, these studies often rely on indirect outcome variables (e.g., increases in poison control center [PCC] call volume due to poisoning exposures or information requests) instead of more direct outcome variables (e.g., the relative increase in poison knowledge experienced by recipients of a poison education program) to assess program effectiveness.<sup>10</sup>

In 2004, the Institute of Medicine (IOM) examined the role of public education in poison prevention programs and recommended developing a program targeting older adults. The report suggested that poison prevention educators should collaborate to develop a theory-based model program and evaluate its impact on knowledge and behavior.<sup>10</sup> To meet this need, a senior health education evaluation, titled *Taking Your Medicines Safely* (TYMS),<sup>11</sup> was developed by the Public Education Committee (PEC) of the American Association of Poison Control Centers (AAPCC) to assess both the short to medium-term impacts of a model poison prevention education program on the knowledge, perceptions and behavioral intentions of seniors. Although seniors are involved in a variety of poisonings, the program focused on medication mismanagement since medicine issues are by far the largest poisoning problem among older adults.

## PURPOSE

The present research examined the effectiveness of the TYMS evaluation on seniors in Missouri and West Virginia. Specifically, we sought to determine whether this program would improve the knowledge of the participants and impact their behavioral intentions, as well as their future medicine administration and storage behaviors. Our hypotheses were threefold. After receiving the educational intervention, we predicted that participants would: (1) demonstrate increases in poison-relevant knowledge, perceived medicine control, and perceived comfort in asking medication-relevant questions; and (2) express a greater willingness to modify their future medicine administration and storage behavior. In addition, we posited that three participants who intended to modify their future behaviors (on the post-test) would be more likely to have implemented subsequent behavioral changes than participants who did not intend to modify their future behaviors.

## METHODS

### *Design and Participants*

Using a research protocol that was approved by the Pacific Institute for Research Evaluation's (PIRE) Institutional Review Board, we recruited a convenience sample of 139 seniors residing in the states of Missouri (64%,  $n = 89$ ) and West Virginia (36%,  $N = 50$ ), from November 2006 to April 2007, to attend a poison prevention education program targeting this cohort. We used promotional flyers and Web-based ads to recruit Missouri residents from Catholic Churches in the cities of Florissant, Maryland Heights, and St. Louis, and West Virginia residents from senior centers in the cities of Elkview, Charleston, and Nitro. Given empirical evidence demonstrating that the performance of stigmatized group members (e.g., women, seniors, and those low in socioeconomic status [SES]) can be adversely impacted by even the subtle activation of group-based stereotypes prior to taking an exam in a stereotyped domain<sup>12-14</sup> (for a review, see<sup>15</sup>), we refrained from ask-

ing participants their age, race, income, or gender in this study—which precluded us from describing the sample demographically. However, anecdotal evidence obtained from interviews with educators after the evaluation sessions revealed that the majority of participants were European American women.

All participants attended educational sessions led by one of two female educators at their respective church or senior center. Each session was comprised of approximately 20 attendees, with one female educator providing instruction for Missouri residents, while a second female educator instructed West Virginia residents. Participants received a \$10 gift card for purchases at a local grocery store, a pill box and a medicine tracking form in exchange for their participation.

### *Poison Prevention Educational Intervention*

In a separate study, the *Taking Your Medicines Safely* (TYMS) poison education program was pilot tested in two sessions by the Florida Poison Information Center (Tampa) and subsequently revised—although the evaluation instrument used to assess the TYMS program was not pilot tested. Specifically, the program was designed to prevent older adults from being poisoned due to unintentional drug misuse or interaction. Since the majority of senior poisonings involve prescription and over-the-counter medicines, we targeted healthy adults between the ages of 65 and 74 to receive the intervention. However, seniors above this age threshold were allowed to participate in the study.

The educational program provides seniors with a scripted presentation that was given by a health educator—from either the Missouri Regional Poison Center or the West Virginia Poison Center—who traveled from group to group in their respective state. It covers the following concepts: (1) the dangers associated with combining prescription and over-the-counter medications with vitamin or mineral supplements, and/or natural (or herbal) remedies; (2) patient-provider communications (e.g., asking health professionals pertinent questions);



(3) informational resources (i.e., identifying reputable sources of medical information); (4) locating and organizing medication information (e.g., dosing procedures); and (5) medication management techniques. To reinforce concepts taught during the presentation, a game of Tic-Tac-Toe was played near the end of the program.

The one-hour program includes:

- Introduction (5 minutes)
- Informed Consent (5 minutes)
- Pre-Test (8 minutes)
- Educational Program Session (19 minutes)
- Tic-Tac-Toe Game (11 minutes)
- Post-Test (8 minutes)
- Debriefing and Incentive Distribution (4 minutes)

The intervention can be delivered in 30-40 minutes in a nonresearch mode excluding the pre- and post-tests. Short questionnaires, administered before and after the educational session, were used to determine seniors' knowledge of and attitudes toward poisoning prevention. Follow-up phone calls one month post-intervention were used to assess subsequent behavioral change.

#### *Measures and TYMS Program Implementation*

*Pre-test measure.* All participants completed an 11-item pre-test before receiving the TYMS educational intervention. This exploratory measure was developed by Poison Control Center (PCC) educators to assess participants' poison-relevant knowledge, perceived comfort in asking medicine-related questions, and perceived behavioral control as it relates to medication management. The scale for all items included responses of *Yes*, *No*, and *Do not know* which was used to avoid confusing the respondents. Responses to the first nine items were used to assess the participants' current knowledge of proper medicine administration techniques. A typical item on this measure was, "Combining prescriptions with over-the-counter products can cause serious health problems" (item 2). The remaining pre-test items measured participants' perceived comfort in asking questions about their medication(s)

and their perceived control over combining medications. Scores on these items served as our baseline assessment of the participants' current knowledge and perceptions related to safe medicine administration practices.

*Poison prevention educational program.* After completing the pre-test, all participants were presented with the poison prevention education program. This 19-minute program provided participants with strategies for taking their medication(s) safely and additional resources to facilitate medication tracking (e.g., pill boxes, wallet card). An 11-minute interactive Tic-Tac-Toe game with a focus on poisoning reduction followed the program. Specifically, the game involved grouping participants into two teams and asking them questions designed to reinforce concepts learned in the program. Correct responses were rewarded by allowing a team to choose where to place an "X" or "O" on a game board. When a team had correctly answered enough questions to win the game, they were declared the winner and given a prize. The losing team also received this reward prior to the post-test.

*Post-test measure.* The 12-item post-test was virtually identical to the pre-test. An item was added to assess the participants' intentions to change their medicine administration and storage regimen in the future. The only other difference between the pre- and post-tests was that two of the post-test items were reverse-coded to discourage respondents from engaging in response acquiescence. Because research shows that behavioral intentions and subsequent behavior are highly correlated,<sup>16</sup> we reasoned that measuring behavioral intentions was particularly important in assessing program effectiveness.

*Four-week follow-up.* Approximately four weeks after completing the TYMS program, participants were phoned by the same health educator that had administered it to them. The educator used each participant's response to the question, "What are the best days and times to reach you?" collected after the debriefing to coordinate a call schedule. Although the times of these calls varied, the educator attempted to reach each participant

three times. The educator asked 12 questions to determine whether participants had implemented the recommended techniques. Only the initial item devoted to whether they had "change(d) anything about (their) medicines or everyday routines based on the program" was examined in the present study. All participants responded to this item using a free-format response scale that had both quantitative (*Yes*, *No*) and qualitative (e.g., "If so tell me about it") components. However, only the quantitative component of this item was analyzed.

Our decision to exclude the other 11 items was twofold. First, many of the remaining items were designed to drill-down to the exact behavioral modification that had been made. For instance, the items "Are you tracking your medicines in any way?" and "Have you used the passport/pill minder we gave you?" were partially redundant with the initial item. Second, given that most participants completed these items in a manner consistent with their initial response, we decided that the potential benefit in analyzing the remaining items did not outweigh the corresponding increase in false positives that would accompany performing 11 statistical tests.

#### *Data Analysis Procedure*

Two of the items on the pre- and post-test (items 8 and 9) were ambiguously worded and were excluded from further analysis. Only the data of participants who completed the remaining items on both the pre- and post-tests was analyzed, yielding a final sample of 107 participants (77%; 107 of 139) who met our inclusion criterion. For the analysis, the *No* and *Do not know* responses were combined into an "Incorrect" response category.

After discovering that the combination of three of the poisoning knowledge items (items 1, 2, and 4) led to the creation of an internally consistent *medication (and vitamin) combination and tracking* subscale (Cronbach's  $\alpha_{\text{post-test}} = .89$ ), we computed a mean percentage correct score for all participants across these items on the pre- and post-tests, separately. To analyze performance on this sub-scale we used a



paired-samples *t*-test. The remaining four items (items 3, 5, 6, and 7) were not found to constitute a reliable measure of poison-relevant knowledge (Cronbach's  $\alpha_{\text{post-test}} = .09$ ) and were analyzed separately via independent paired-samples *t*-tests.

We used a chi-square ( $\chi^2$ ) goodness of fit analysis to examine whether the proportion of participants who expressed the intention of modifying their future behavior rose significantly after receiving the educational curriculum. We conducted a second chi-square ( $\chi^2$ ) analysis to examine whether the

participants' intention to modify their future behavior and their self-reported behavioral change at the four-week follow-up were consistent. All data analyses were performed using SPSS version 10.1.<sup>17</sup>

**RESULTS**

One-hundred thirty-nine ( $N = 139$ ) seniors participated in the program. Ninety-one percent ( $N = 127$ ) of these participants completed items on the pre- and post-tests including 86 (68%;  $N = 86$  of 127) Missouri residents and 41 (32%;  $N = 41$  of 127) West

Virginia residents. The number of participants responding to each item on either test varied from 120 to 127, with 107 seniors completing all pre- and post-test items. Performance on the pre- and post-tests is presented in Table 1.

**Poison-Relevant Knowledge**

As predicted, knowledge on the medication (and vitamin) combination and tracking sub-scale rose significantly following the educational curriculum. Participants were significantly more likely to correctly answer post-test items on this sub-scale ( $M = 98\%$ ,

**Table 1. Pre- and Post-Test Performance (Frequencies & Percentages) on the Poison-Relevant Knowledge Items (N=107)**

Item	Correct (M %)	t	df	P
<i>The Medication (and Vitamin) Combination and Tracking Sub-scale is a combination of items 1, 2, and 4</i>				
You need to tell your doctor about the vitamins that you are taking. (item 1)				
Combining prescription medicines with over-the-counter products can cause serious health problems. (item 2)				
You need to know the names of the medicines that you take. (item 4)				
Pre-test	101 (94%)			
Post-test	105 (98%)	3.10	106	< 0.01
<i>"What side effects could I have" is one of the key questions to ask at your doctor's office or pharmacy. (item 3)</i>				
Pre-test	102 (95%)			
Post-test	104 (97%)	0.82	106	= 0.42
<i>It is important to make sure that children cannot get into your medicines, vitamins, and home remedies. (item 5)</i>				
Pre-test	75 (70%)			
Post-test	104 (97%)	5.54	106	< 0.001
<i>Having a way to keep track of your medicines and home remedies may help you avoid taking too much or too little. (item 6)</i>				
Pre-test	106 (99%)			
Post-test	106 (99%)	0.00	106	= 1.00
<i>Joe was taking a blood thinner and decided on his own to start taking aspirin with it. This was a good decision. (item 7)</i>				
Pre-test	103 (96%)			
Post-test	105 (98%)	1.00	106	= 0.32
Note. 1 = Number of participants who responded to both the pre-and post tests. M % = Mean percentage.				



$N = 105$  of  $107$ ) when compared to their scores on the pre-test ( $M = 94\%$ ,  $N = 101$  of  $107$ ),  $t(106) = 3.10$ ,  $P < 0.01$ .

Similarly, when asked whether, “*It is important to make sure that children cannot get into your medicines, vitamins, and home remedies*” (item 5), nearly 30% of participants scored higher on the post-test ( $M = 97\%$ ,  $N = 104$  of  $107$ ), when compared to the pre-test ( $M = 70\%$ ,  $N = 75$  of  $107$ ),  $t(106) = 5.54$ ,  $P < 0.001$ . In large part because very few pretest answers were wrong, none of the remaining poison knowledge items differed significantly, all  $P_s > 0.05$ .

**Perceived Medicine Control and Comfort in Asking about One’s Medicines**

Participants increased their perception of personal control after receiving the educational curriculum. Whereas only 67% ( $N = 72$  of  $107$ ) of participants indicated that they were in control of their medicines and how they should be combined on the pre-test, 78% ( $N = 83$  of  $107$ ) indicated that they perceived such behavioral control on the post-test,  $t(106) = 2.34$ ,  $P = 0.02$ . No significant differences were detected on the perceived comfort in asking about one’s medications item,  $P > 0.90$ .

**Future Behavioral Intentions**

A chi-square analysis revealed a statistically significant difference in the expressed preference of the participants to change how they take or store their medication in the future,  $\chi^2(1, N = 107) = 11.45$ ,  $P < 0.01$ . Among participants who responded to this

post-test item, 34% ( $N = 36$  of  $107$ ) of the participants intended to change their medicine administration or storage behaviors in the future.

**Findings for the Four-Week Follow-up**

Ninety-five participants from the original sample (of 139 participants) provided data during the four-week follow-up session yielding a response rate of 68% ( $N = 95$  of  $139$ ). This response rate is consistent with existing health-based survey research targeting seniors.<sup>18,19</sup> We used these data to determine whether the participants’ intention to modify their future administration and storage behaviors was significantly associated with their self-reported behavioral changes after four weeks.

Of the 95 participants who provided follow-up data after 4 weeks, 77 (81%) answered the post-test item devoted to whether or not they intended to modify their future medicine administration or storage behaviors and responded to the follow-up item devoted to self-reported behavioral change (Table 2). We found a statistically significant association between the participants’ behavioral intentions to modify their future medicine administration and storage behaviors and their subsequent behavioral modifications,  $\chi^2(1, N = 77) = 18.29$ ,  $P < 0.01$ . Among participants who did not intend to modify their future medicine dosage and storage behavior, 7% ( $N = 4$  of  $55$ ) indicated that they had actually changed some aspect of their medicine administra-

tion and storage regimen as a function of our intervention. Among participants who said they intended to modify their medicine administration and storage behavior, 50% ( $N = 11$  of  $22$ ) indicated that within four weeks they had changed some aspect of their medicine regimen after the intervention.

Participants who intended to change their medicine regimen and reported implementing these changes took two paths. Six of 11 (54%) indicated that the program improved their ability to adequately track their medication (because they started using a pillbox or wallet card they were given during the educational session). Five (46%) reported increased diligence about drug interactions with other medicines and grapefruit.

The majority (70%;  $N = 31$  of  $44$ ) of the participants who indicated no intention to modify their current medicine regimen, when contacted after four weeks, indicated they had not modified their regimen because they believed they already had a system that works. For instance, one participant, who neither intended to, nor had changed their medicine routine after four weeks, said that “*I already had a pill minder.*” Twenty-one percent ( $N = 9$  of  $44$ ) of these participants believed that they did not need to change their current regimen. Although the majority of these participants did not specify why they maintained such beliefs, one was not on medication, one was taking only a single pill, one was only taking vitamins, and one was not taking enough medications to bother.

**Table 2. Self-Reported Behavioral Change after 4 Weeks (Frequencies & Percentages) as a Function of Post-test Intentions to Modify Future Medicine Dosage and Storage Behaviors**

	Did you Change Something about Your Medicines or Everyday Routines based upon the Program? (4-Week Follow-up)		Total
Do You Plan to Change Something about How You Take or Store Your Medicines? (Post-Test)	Yes (N = 15)	No (N = 62)	(N = 77)
Yes	11 (50%)	11 (50%)	22
No	4 (7%)	51 (93%)	55



The remaining participants indicated that they either knew they should change, but currently had not (5%;  $N = 2$  of 44), that they only follow their doctor's orders (2%;  $N = 1$  of 44), or that they still had not implemented any of the proposed changes mentioned in the program, but that their awareness of medications had increased (2%;  $N = 1$  of 44).

### *Post hoc Comparison of Missouri and West Virginia Residents*

To examine the magnitude of the aforesaid pre- and post-test differences, we conducted *post hoc* comparisons of Missouri residents' pre-test scores to West Virginia residents' post-test scores, and vice versa, using separate independent-samples *t*-tests on all of the relevant measures save the post-test intention item. Although there was no statistical difference between the pre-test knowledge scores of Missourians and the post-test knowledge scores of West Virginians,  $t(105) = .11, P = \text{n.s.}$ , there was a significant difference between the pre- and post-test knowledge scores of West Virginia and Missouri residents, respectively,  $t(105) = 4.09, P < 0.01$ . Indeed, the post-test scores of Missouri residents on this sub-scale ( $M = 100\%, N = 77$  of 77) were significantly higher than the pre-test scores of West Virginia residents ( $M = 92\%, N = 28$  of 30).

Similar results emerged on the question devoted to asking one's doctor or pharmacist about potential medication side effects (item 3). Once again, no differences emerged between the pre-test scores of Missouri residents and the post-scores of West Virginia residents,  $P > 0.10$ . However, Missourians exhibited post-test scores (99%,  $N = 76$  of 77) that were significantly higher than the pre-test scores of West Virginians ( $M = 87\%, N = 26$  of 30) on this item,  $t(105) = 2.72, P < 0.01$ . When participants were asked whether it was important to ensure that children cannot get into one's medicines, vitamins and home remedies (item 5), post-test scores for both Missourians ( $M = 99\%, N = 76$  of 77) and West Virginians ( $M = 93\%, N = 28$  of 30) were significantly higher than their counterparts' pre-test scores ( $M = 67\%, N = 20$  of 30,  $t(105) =$

$5.51, P < 0.001$  and  $M = 71\%, N = 55$  of 77,  $t(105) = 2.49, P = 0.014$ , respectively). In addition, although there were no differences between the pre- and post-test scores of West Virginia and Missouri residents, respectively, on the perceived behavioral control measure ( $P = \text{n.s.}$ ), West Virginians expressed more perceived control over their medicines on the post-test ( $M = 83\%, N = 25$  of 30) than Missourians did on the pre-test ( $M = 64\%, N = 49$  of 77),  $t(105) = 2.00, P < 0.05$ . No other significant differences emerged, all  $P_s > 0.10$ .

### DISCUSSION

When taken together, these data suggest that the *Taking Your Medicines Safely* poison education program impacted the knowledge of the participants and had some bearing on their behavioral intentions and their future medicine administration and storage behaviors. We posited that participants would increase their poison-relevant knowledge, their perceptions of medicine control, and their perceived comfort in asking questions about their medicines, as a function of the program. Our analyses provide statistical support for most of these hypotheses, with the exception of items where virtually all of the participants were knowledgeable prior to the education session.

In addition, 78% of the participants expressed a greater degree of perceived control of their medications after receiving the educational curriculum. Although we found that a statistically significant number of participants planned to change how they take or store their medications in the future (after receiving the educational curriculum), the majority of participants felt they already had a sound system and did not need to modify it.

The high degree of poison-relevant knowledge among our sample is notable. Collectively, the participants only scored below 90% on one of the pre-test knowledge items.

In retrospect, our pre- and post-test questions may have been too easy. An alternative explanation of this finding can be offered for senior center attendees who

composed nearly 40% of the sample. Prior research has demonstrated that senior center attendees have better mental health, greater awareness of service agencies (e.g., the local Division of Aging), and consult more formal resources (e.g., medical professionals, social workers) when making health-relevant decisions, in comparison to non-senior center attendees.<sup>20</sup> Given that a large portion of the participants were among the former demographic, it stands to reason that they may have been more mentally aware of the deleterious effects of medication mixing and/or inclined to seek out such information from health professionals in the past. Although this heightened awareness hypothesis may partially explain the high level of performance among senior center attendees, it does little to explain the performance of church attendees.

Despite the sample's high degree of initial poison knowledge, almost 20% of these seniors improved their dosage and storage behaviors as a result of the training. This finding underscores the reasonableness of delivering a poison prevention education program in a single session. Furthermore, it stands to reason the training might have an even greater impact on a sample with a lower level of poisoning knowledge.

Also worth noting were the 7% of participants who had not intended to modify their future medicine dosage and storage behavior, but indicated that they had actually done so after four weeks. Closer inspection of these cases indicated that their adopted behavioral changes were both cognitive (e.g., becoming more aware of harmful grapefruit-medicine interactions) and procedural in nature (i.e., using a pill box). This finding is important because it demonstrates that the lessons learned from educational programming can have residual effects, even among groups that lack behavioral intentions. Such ironic outcomes may be a byproduct of subconscious processing or more deliberate rationalizations that occur after comparing one's current behaviors to a set of best practices. However, these results must be tempered by the small proportion of participants who fell into this category.



Finally, we found at least partial support for our prediction that participants who intended to modify their future behaviors would be more likely to have implemented subsequent behavioral change compared to participants with no such behavioral intentions. But only one-half of the participants who said they intended to modify their medicine dosage and storage behavior in the future actually did so within 4 weeks. Future research is warranted to see if a 4-week follow-up survey stimulates action by some of those who had not followed through despite intending to change.

### Limitations

The present study has several limitations. First, our analyses revealed that reverse coding items can result in confusion in the interpretation of a given item, potentially leading seniors and the less literate to respond to parallel items in an inconsistent manner. This was the reason we deleted one item from the original instrument. It is also plausible that differences in pre- and post-test scores resulted from testing or recall bias. Specifically, seniors may have been confused by reverse-coded items because they simply remembered the pre-test items and provided a similar response on the post-test without reading each question thoroughly. In addition, our decision to employ a pre-test response set that treated a 'yes' response as 'correct' may have introduced bias into our study. However, we made a conscious effort to minimize such bias on the post-test.

Second, a further limitation of our study is that it is based on a convenience sample of senior center and church attendees. Thus, there is ambiguity as to whether these results would generalize to other senior populations. Albeit speculative, we believe there is no reason to presume that they would not.

Third, these data must be interpreted with some degree of caution because we did not test the construct validity of our survey. For instance, although the instrument appears to have face validity as a measure of poison-relevant knowledge, it is unclear whether this measure would correlate with other measures of poison knowledge (e.g., behavioral measures).

Fourth, given that we did not use a non-treatment control group in our study, we are limited in our ability to determine the magnitude of the TYMS program's impact on subsequent knowledge, intentions, and behaviors when compared to what might occur under control conditions. However, *post hoc* comparisons of Missouri and West Virginia residents' on all relevant pre- and post-test measures indicated that the magnitude of our secondary findings were consistent with those obtained in the primary analysis—that is, when both state's pre-test scores were used as controls. Therefore, future studies should consider the use of a comparison group in their methodological design.

Future research would also benefit from examining the impact of attitudes on poison-relevant behaviors. Research shows that attitudes are powerful predictors of subsequent behavior in a host of different domains.<sup>21</sup> Given that empirical research investigating the effects of attitudes on poison-relevant behavioral change among seniors is lacking,<sup>22</sup> adding this component to future research in this area would be a worthwhile investment. In addition, future studies would be well served by employing a methodological design that allows for the collection of demographic information without inducing added pressure upon stigmatized groups that stems from fears of confirming stereotypes about their age, race, gender, and/or SES in the testing context.

### TRANSLATION TO HEALTH EDUCATION PRACTICE

We believe that the merits of our research outweigh the aforesaid shortcomings. Despite its limitations, our study shows that using brief educational interventions with senior populations can be an effective tool for poisoning prevention. For instance, such programming can be used in multifaceted approaches to reducing the incidence of unintentional poisoning mortality and morbidity, as well as the societal costs of these injuries.

Specifically, our study provides a framework for prevention scientists and practitioners conducting poisoning-related research

among the elderly and offers direction as to what questions *do* and *do not* work with this population. In addition, our findings indicate that future senior poisoning prevention interventions must be sensitive to the knowledge levels of their samples. Research, programming and funding that targets senior populations with lower knowledge levels (e.g., low literacy and/or low SES groups) may yield the most return on resource investment. More generally, these methods and findings not only offer guidance in combating poisoning among seniors, but they suggest that single sessions of theory-driven health education can be effective for interventions designed to reduce the incidence of other types of injuries (e.g., falls) among this cohort.

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