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Self-Reported vs State-Recorded Motor Vehicle Collisions Among Older Community Dwelling Individuals

B.A. Singletary¹, A.N. Do¹, J.P. Donnelly¹, C. Huisin^{1,2}, M.T. Mefford¹, R. Modi¹, F.L. Mondesir¹, Y. Ye¹, C. Owsley², and G. McGwin^{1,2}

¹Department of Epidemiology, University of Alabama at Birmingham, Birmingham, AL 35294-0009, USA

²Department of Ophthalmology, School of Medicine/Eye Foundation Hospital, University of Alabama at Birmingham, Birmingham, AL 35294-0009, USA

Abstract

Introduction—Motor vehicle collisions (MVCs) continue to place an increased burden on both individuals and health care systems. Self-reported and state-recorded police reports are the most common methods for MVC evaluation in epidemiologic studies, with varying degrees of agreement of information when compared in previous studies. The objective of the current study is to address the differences in MVC reporting and provide a more robust measure of the agreement between self-reported and state-recorded MVCs in a community dwelling population of older adults.

Methods—A three-year prospective study was conducted in a population-based sample of 2000 licensed drivers aged 70 and older. At annual visits, participants were asked to self-report information on any MVC that occurred over the prior year where police were called to the scene. Information on police-reported MVCs was also ascertained from Alabama official state-recorded databases. The kappa coefficient was calculated to determine overall agreement between any self-reported and state-recorded crashes, as well as the raw number of crashes reported. In addition, agreement was stratified by demographics, health status, medication use, functional status (i.e. vision, cognition), and driving habits.

Results—1,747 participants who completed three years of follow up were involved in 225 state-recorded MVCs and 208 self-reported MVCs yielding overall substantial agreement between any self-report and state-recorded MVC (kappa=0.64). Cumulative number of self-reported and state-recorded MVCs was also compared, with agreement slightly reduced (kappa=0.55). The clinical characteristic resulting in the greatest variation in agreement with drivers was impaired contrast sensitivity showing better agreement between self-reported and state-recorded MVCs (kappa=0.9) than those with non-impaired contrast sensitivity (kappa=0.6).

Corresponding Author: Gerald McGwin, 620 20th Street South, Suite 320, Birmingham, Alabama 35233, gm McGwin@uabmc.edu.

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Conclusion—Study results showed substantial agreement between self-reported and state-recorded MVCs for any MVC involvement among the study population. When examining the reporting of the total number of MVCs over the three year period, agreement was reduced to a moderate level. There was consistency in agreement across MVC risk factors except among individuals with contrast sensitivity. These findings have implications for the design and analytic planning of epidemiologic and clinical research focused on MVCs.

Keywords

Motor Vehicle Collisions; Self-Report; State-Recorded; Agreement

Introduction

In 2012, over 2.5 million people were treated in emergency departments due to MVCs which contributed to over 18 billion dollars in medical care expenditures, one million days in hospitals, and 33 billion dollars in lifetime work losses [2, 3]. On a per mile basis, MVC related mortality disproportionately affects both younger and older adults [4]. The high mortality rate for younger drivers is attributed to their increased MVC incidence, whereas for older drivers, it is attributed to increased MVC case fatality [5]. It is well established that the risk factors for MVCs differ between younger and older populations [6]. For example, inadequate driving experience and risky behaviors, such as speeding and drunk driving, are responsible for a greater proportion of MVCs among younger populations than older [6]. In contrast, physical, medical, and cognitive factors contribute more to MVCs in older adults [7, 8]. However, research on risk factors for MVCs among older drivers has yielded inconsistent findings, which may be partly attributed to differences in how information on MVCs has been ascertained [9].

The most common methods for obtaining information on MVC occurrence are self-report and administrative records (i.e., police accident reports) [10]. Financial, political or logistical constraints may influence the decision to use one method versus another. This is not an inconsequential choice as any lack of agreement may hamper comparisons between studies seeking to identify risk factors. A number of studies have evaluated the agreement between these two methods of ascertainment and reached different conclusions [10-13]. Marottoli et al. in a study of community dwelling older adults aged 72 years and older and McGwin et al. in a study of a sample of older adults aged 55 years and older compared self-report versus state-record and found moderate agreements ($k = 0.40$ and 0.45 , respectively)[10, 11]. Similarly, Anstey et.al reported a poor agreement between two reporting methods in a prospective cohort study of older drivers aged 65-95 years[13]. In addition, Arthur et al., detected poor agreement between self-reported and police-documented MVCs in drivers aged 37 years on average [12]. Owsley et al. and Ball et al. also reported poor agreements on self-reported and state-recorded road accidents among older drivers aged 55 years and older [14, 15].

There are a number of possible explanations for the resulting heterogeneity between studies, such as different study populations (e.g.: cognitive status, age), study designs, and reporting methods [11-13]. For example, drivers may recall MVC events more accurately within one

year compared to five years [10, 11]. Any lack of agreement between MVC reporting methods is of a particular concern if it is systematic, thereby potentially producing biased results. The current studies aims to account for these potentially systematic differences, while considering clinical and behavioral characteristics that could influence agreement.

To address the limitations found in the previous literature, the objective of the current study is to measure the agreement between self-reported and state-recorded MVCs over a three-year period in a community dwelling population of older adults aged 70 years and older.

Methods

Study design and population

The Institutional Review Board at the University of Alabama at Birmingham approved this study. As described previously, a population of 18,544 community dwelling older drivers who resided in north-central Alabama were contacted to participate in this study [16]. People who were 70 years or older, had a current Alabama driver's license, drove in the previous 3 months and spoke English were eligible for inclusion. In total, 2000 drivers were enrolled between October 2008 and August 2011 and were followed-up at 1-year intervals for three subsequent years. Although crash data was obtained for all enrolled study participants, the analysis was limited to those with complete follow-up to most accurately assess overall agreement and MVC frequency agreement.

Data collection

Following written informed consent, self-reported baseline characteristics including demographics, chronic health conditions, medications, functional status, and driving habits and history were collected by a trained interviewer. Clinical characteristics (e.g.: health conditions, medications, visual impairment) and driving habits were included in this study to account for factors that could modify the participants ability to self-report MVCs. These factors were of particular interest due to their potential to affect recall, amount of driving exposure, or frequency of minor accidents that aren't state-reported. All participants were notified at enrollment that state-recorded MVCs would be collected as part of the study.

Participants were asked about the presence or absence of 15 chronic medical conditions. In addition, participants provided a self-reported measure of health status. The presence of common chronic eye conditions was obtained from a chart review based on a recent eye examination by an ophthalmologist or optometrist. The diagnosis of cataract, glaucoma, diabetic retinopathy, age-related macular degeneration, or intraocular lens of either eye was considered. The use of any prescription medication that the study participant was "currently taking" was assessed at the baseline visit. Participants brought their medications with them so the actual substance name and dosage could be recorded. Each prescription medication was assigned a code from the American Hospital Formulary Service classification system. For the current analysis, self-reported chronic medical conditions were summed and used as a measure of health status; a similar approach was taken for medications.

Visual function assessments were also performed. These tests were selected because of their established relevance for driving safety and were performed under habitual correction [17,

18]. All tests were administered under binocular viewing. Visual acuity was assessed using the Electronic Visual Acuity system and expressed the log minimum angle resolvable, with normal to good visual acuity defined as 20/40 to 20/20 and poor visual acuity as worse than 20/40 [19]. Contrast sensitivity was assessed using the Pelli-Robson Contrast Sensitivity Chart and scored by the letter-by-letter method, with greater than or equal to 1.5 as high contrast sensitivity and less than 1.5 as low contrast sensitivity [20, 21]. The driving visual field was used to assess peripheral vision [22]. The Useful Field of View (UFOV) subtest 2 (Visual Awareness Research Group, Punta Gorda, FL) and Trails B test were used to assess visual processing speed under divided attention [23, 24]. Impaired UFOV performance was defined as moderate impairment (scores 150-350 milliseconds (ms)) and severe impairment (scores >350 ms) [25]. Performance on Trails B was defined as scores >2.47 minutes [25, 26]. Cognitive status was measured using the Mini-Mental State Examination (MMSE) with cognitive impairment defined as a score of <23 [27].

The Driving Habits Questionnaire (DHQ) was used to collect information on driving exposure (miles, days, trips, and places driven in a typical week, and estimated yearly mileage driven) [28]. At each follow-up visit, the DHQ was also used to ask participants to report if they were involved in any MVC in the past 12 months where they were the driver, whether they were at-fault, the month and year of the MVC and whether the police were called to the scene. For the current analysis, only MVCs where police were called to the scene were considered. Examiners were unaware of the crash histories of study participants. In addition, information regarding police-reported MVCs was obtained from the Alabama Department of Public Safety (AL DPS). Only those MVCs that occurred between each participant's enrollment date and the date of the three-year follow-up visit were included in the analysis.

Statistical analysis

Baseline demographic, visual, and clinical characteristics were summarized for the total study sample using data collected from the initial interviews. The kappa coefficient was calculated to determine overall agreement between information obtained from self-reported and state-recorded crashes (obtained from police reports) as well as agreement stratified by demographics, health status, medication use, functional status (i.e. vision, cognition), and driving habits. Qualitative interpretation of the kappa coefficient was defined as <0 = no agreement; 0-0.20 = slight; 0.21-0.40 = fair; 0.41-0.60 = moderate; 0.61-0.80 = substantial; and 0.81-1.0 = almost perfect [29]. Risk ratios were calculated for the association between selected risk factors and self-reported versus state-recorded MVCs.

Results

Of the 2,000 enrolled participants, 1,747 completed three years of follow up and were therefore included in the analysis. Demographic, health, visual, and driving characteristics are listed in Table 1. The average age was approximately 77 years and ranged from 70 to 96. A majority of the participants were male (55%) and white (82.4%), with two thirds (66.7%) having some college education or higher, and based on MMSE the majority were in the non-demented range (MMSE >24, 98.5%). Approximately half of the participants were never

smokers (48.8%) and 61.5% consumed less than 1 alcoholic drink per week. Most participants reported their overall perception of health as good to excellent (91.4%). Despite this, over half of the study population reported having 4 medical conditions (55.2%) and taking 5 prescription medications (52.7%) at baseline. Eye conditions reported at baseline were also prevalent; these included cataract (57.4%), glaucoma (18.4%), diabetic retinopathy or diabetic macular degeneration (2.9%), age-related macular degeneration (17.4%), and intraocular lens (46.6%). The majority of participants had visual acuity of 20/40 or better (92.5%) and did not have impaired contrast sensitivity (94% 1.5). Slightly more than half of participants had impaired UFOV (59.1%) and approximately two thirds had impaired Trails B (65.5%). Participants drove on average 9466 miles per year; approximately half reported driving seven days per week (51.1%).

Of 1,747 study participants, drivers were compared with respect to self-report and state-recorded MVCs based on any MVC involvement (Table 2) and the number of MVCs (Table 3). In total, over a three year period 225 state-recorded MVCs and 208 self-reported MVCs where police were called to the scene were documented. There was substantial agreement between any self-report and state-recorded MVC ($\kappa=0.64$). The cumulative number of self-reported and state-recorded MVCs was also compared (Table 3) and the agreement was reduced ($\kappa=0.55$).

Table 4 presents kappa coefficients for self-reported and state-recorded MVCs stratified by risk factors. Agreement did not appear to be modified by any of the risk factors with one exception. Drivers with impaired contrast sensitivity had better agreement between self-reported and state-recorded MVCs ($\kappa=0.9$) than those with non-impaired contrast sensitivity ($\kappa=0.6$). A similar pattern of results was observed when comparing kappas based on the cumulative number of MVCs. Additional analyses were pursued to examine the association between contrast sensitivity and any MVC involvement with separate models for self-report versus state-recorded MVCs. The estimated risk ratio for the occurrence of any state-recorded MVC was 1.36 (95% Confidence Interval: 0.88-2.11) and self-reported was 1.39 (95% CI: 0.88-2.19). Therefore the pattern of results is consistent between the outcomes, showing no statistically significant differences.

Discussion

The objective of the current study was to measure agreement between two different reporting methods of MVC involvement, self-report and state-recorded. Our results indicate substantial agreement between any self-reported and state-recorded MVC involvement among older drivers in a population based study, compared to moderate agreement for the number of collisions over three years of follow-up. Agreement was consistent by the risk factors assessed in this study, with the exception of contrast sensitivity, which showed greater agreement for those with contrast sensitivity impairment.. The findings of the current study provide key insights regarding the use of self-reported MVCs in epidemiological and clinical research.

The observed agreement between state-recorded and self-reported MVC involvement was higher in the current study compared to existing literature. In two studies with similar

designs, McGwin, et al. and Marottoli, et al. reported overall observed agreement that was slightly lower compared to the results of the current study, kappa=0.25 and 0.4 respectively, for reporting the frequency of MVC involvement; McGwin, et al. also assessed any MVC involvement again showing lower agreement, kappa=0.45, when compared to the results of the current study. In contrast, Anstey, et al. reported substantially lower agreement for both frequency of MVC occurrence and any MVC involvement (kappa=0.19 and kappa=-0.01, respectively). In addition, Arthur, et al. also detected poor agreement between self-reported and documented MVCs in a population of adults aged 17-87 years.

There are a number of factors that may explain the observed discrepancy between the current study and the existing literature. One of these factors is the differential recall of MVCs attributable to the differing time periods over which participants were asked to recall events. For example, study participants may have more difficulty recalling events occurring over the prior 3-5 year period than 1 year, which was used in the current study. With the exception of Marottoli, et al. prior studies have used longer recall periods, potentially leading to difficulty recalling events, and therefore reduced agreement. Another potential explanation is inconsistencies between countries and states with respect to how MVCs are recorded. For example, a state or country may only record MVCs involving property damage or bodily injury, while another may include all MVCs for which police were called to the scene. This could impact comparisons between self-reported and state-recorded MVCs if the participant is not directed to recall collisions in accordance with specific state reporting policies. A third potential explanation is differences in study populations. McGwin, et al., Marottoli, et al. and Anstey, et al. studied older drivers aged 55 or older; however, Arthur, et al. examined a much wider age range (i.e. drivers aged 17-87 years). There are a number of potential explanations for why the inclusion of younger drivers may have led to worse agreement. These explanations could include biological factors such as better memory or less serious health implications to sociological factors like engaging in risky driving and the negative ramifications of MVC involvement. Another potential explanation is that small numbers of either self-reported or state-recorded MVCs could have led to instability in agreement estimates for a given study. Finally, studies could have employed different consent processes, allowing for some participants to have greater awareness that driving records would be obtained.

Our finding of substantial agreement between self-reported and state-recorded collisions has implications for the design and analysis of epidemiologic and clinical research focused on MVCs. In many states, access to driving records for research purposes is limited and it has been suggested that obtaining such information may not be necessary with the availability of self-reported collisions. Our results support this claim, as there was general agreement between self-report and state-recorded MVCs within this population of prospectively followed older adults. It would be an understatement to say that implications for designing studies of self-reported MVCs include consideration of the recall periods used as well as questionnaire design and structure in order to achieve a study capable of providing robust estimates. For researchers who are limited to using self-report data, the analysis should focus on any MVC involvement as opposed to the frequency of MVCs, due to the consistently higher agreement observed in our study. While overall agreement is of concern, differential agreement across subgroups is perhaps a greater concern.

In our stratified analysis we found that participants with poorer contrast sensitivity had greater agreement for any MVC involvement. Though the difference in agreement was not as wide, this pattern was also observed for visual acuity and UFOV test results. This difference in agreement could potentially affect studies seeking to identify risk factors associated with MVC involvement. These vision based risk factors were of particular interest given the study population and its potential effect on hours spent driving and possible association with an increase or decrease in exposure to MVCs. These factors could lead to individuals over/under self-reporting MVC's which would mitigate our agreement estimates. As shown in previous studies impaired vision does show an association with MVC occurrence and frequency.[30, 31] Additionally, studies continue to examine the effect driving exposure and MVC frequency has on the ability to accurately self-report MVCs.[9,14] In order to determine whether or not the difference in agreement by contrast sensitivity impairment would impact risk estimates, we fit log-binomial models with both MVC definitions and estimated risk ratios. Results were similar for both definitions. This suggests that the use of self-reported MVCs in place of state-recorded collisions may not bias results differentially in populations similar to ours.

This study should be interpreted in light of several strengths and limitations. We asked participants to recall MVCs occurring in the past year; this is a relatively short recall period compared to prior efforts, which have asked participants to recall MVCs as distant as 5 years prior. Despite this relatively brief recall period, it is possible agreement could have improved with a greater number of follow-up measurements at even shorter intervals. We asked participants explicitly only to recall MVCs for which police were called to the scene. However, using state-recorded MVCs may not have captured all of these collisions. Although we examined a comprehensive subset of MVC risk factors, agreement could have differed across other, unmeasured variables. Even though our results may not be generalizable to drivers of all ages, our study represented a large, population based group of older licensed drivers.

In conclusion, given that this was a cohort of older drivers undergoing annual follow-up, there was moderate to substantial agreement between self-reported and state-recorded MVCs among older adults, and agreement did not differ much across MVC risk factors except among individuals with contrast sensitivity. In similar situations as observed in this study, self-report may be a valid method of MVC identification in the absence of state-recorded data. Ultimately, greater emphasis must be placed on consistent, valid study design and methods moving forward.

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Highlights

- We examine motor vehicle collisions (MVC) in 2,000 licensed drivers age 70 and older.
- Overall agreement between self-reported and state-recorded MVCs was assessed.
- Substantial agreement was observed for any involvement in a MVC.
- Agreement was slightly reduced when cumulative number of MVCs was compared.

Table 1
Demographic, Clinical, and Driver Characteristics of the Study Population (N=1747)

Characteristic	
Mean age (SD)	76.8 (4.7)
Gender N, (%)	
Male	962 (55.0)
Female	785 (45.0)
Race N, (%)	
White	1440 (82.4)
Non-white	307 (17.6)
Education * N, (%)	
High School	582 (33.3)
>High School	1164 (66.7)
No. of medical comorbidities N, (%)	
0-3	783 (44.8)
4	964 (55.2)
No. of prescriptions medications at baseline N, (%)	
0-4	827 (47.3)
5	920 (52.7)
Eye Conditions ** N, (%)	
Cataract	961 (57.4)
Glaucoma	307 (18.4)
Diabetic retinopathy or diabetic macular degeneration	49 (2.9)
Age-related macular degeneration	291 (17.4)
Intraocular lens	763 (46.6)
Smoking * N, (%)	
Never	850 (48.8)
Previous	822 (47.2)
Current smoker	71 (4.0)
Alcohol use, drinks per week N, (%)	
Low (0 - <1)	1074 (61.5)
Moderate (1 - 7)	483 (27.6)
Heavy (>7)	190 (10.9)
Mental Status (MMSE) N, (%)	
24-30	1720 (98.5)
<23	27 (1.5)
Self-report health status N, (%)	
Excellent	317 (18.2)
Very good	732 (41.9)
Good	547 (31.3)
Fair to Poor	151 (8.6)

Characteristic	
Visual acuity [*] N, (%)	
20/40 to 20/20	1614 (92.5)
Wt 20/40	131 (7.5)
Contrast sensitivity [*] (OU) N, (%)	
1.5	1641 (94.0)
<1.5	105 (6.0)
UFOV subtest 2 [*] N, (%)	
<150	1031 (59.1)
150-350	556 (31.8)
>350	159 (9.1)
Trails B [*] (min) N, (%)	
<2.47	1143 (65.5)
2.47	602 (34.5)
Annual miles driven [*] – Mean (SD)	9466.35 (8199.74)
Days driven per week N, (%)	
<7	855 (48.9)
7	892 (51.1)

Note: SD = Standard deviation

^{*} Contains missing values data for some subjects;

[†] Based on chart abstraction

Table 2
Overall reporting of any MVC involvement between self-reported versus state-recorded

Self-Report	State-Recorded		
	No	Yes	Total
No	1462	77	1539
Yes	60	148	208
Total	1522	225	1747

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Table 3
Total number of MVCs reported, cross-classified by self-report and state-recorded

	Number of State-Recorded MVCs				
	0	1	2	3+	Total
Number of Self-Reported MVCs	0	1	2	3+	Total
0	1462	72	5	0	1539
1	54	110	12	1	177
2	6	19	1	1	27
3+	0	3	0	1	4
Total	1522	204	18	3	1747

Table 4
Agreement for any and count level MVCs, stratified by risk factors

Characteristic	Kappa ¹	Kappa ²
Age		
70-79	0.63 (0.56-0.69)	0.54 (0.48-0.61)
80+	0.67 (0.57-0.78)	0.57 (0.47-0.67)
Gender		
Male	0.66 (0.58-0.73)	0.55 (0.48-0.62)
Female	0.61 (0.53-0.70)	0.55 (0.47-0.64)
Race		
White	0.64 (0.58-0.70)	0.56 (0.50-0.62)
Non-white	0.64 (0.52-0.76)	0.52 (0.40-0.64)
Education*		
High School	0.60 (0.50-0.70)	0.53 (0.44-0.63)
>High School	0.66 (0.59-0.72)	0.56 (0.49-0.63)
No. of medical comorbidities		
0-3	0.59 (0.50-0.68)	0.53 (0.44-0.62)
4	0.67 (0.60-0.74)	0.57 (0.50-0.64)
No. of prescriptions medications at baseline		
0-4	0.63 (0.54-0.71)	0.55 (0.47-0.64)
5	0.65 (0.58-0.72)	0.55 (0.48-0.62)
Eye Conditions*†		
Cataract	0.65 (0.58-0.73)	0.57 (0.49-0.64)
No cataract	0.63 (0.54-0.71)	0.55 (0.46-0.63)
Glaucoma	0.64 (0.52-0.76)	0.56 (0.45-0.68)
No glaucoma	0.64 (0.58-0.71)	0.55 (0.49-0.62)
Diabetic retinopathy or diabetic macular degeneration	0.51 (0.17-0.84)	0.51 (0.17-0.84)
No diabetic retinopathy or diabetic macular degeneration	0.65 (0.59-0.70)	0.56 (0.50-0.62)
Age-related macular degeneration	0.64 (0.50-0.77)	
No age-related macular degeneration	0.64 (0.58-0.71)	0.56 (0.49-0.62)
Intraocular lens	0.63 (0.54-0.72)	0.54 (0.46-0.63)
No intraocular lens	0.65 (0.58-0.73)	0.57 (0.49-0.64)
Smoking*		
Never	0.64 (0.56-0.72)	0.55 (0.47-0.63)
Previous	0.65 (0.57-0.73)	0.57 (0.49-0.65)
Current smoker	0.46 (0.18-0.75)	0.37 (0.12-0.63)
Alcohol use, drinks per week		
Low (0 - <1)	0.63 (0.56-0.70)	0.54 (0.47-0.61)
Moderate (1 - 7)	0.61 (0.51-0.72)	0.51 (0.41-0.61)
Heavy (>7)	0.83 (0.69-0.98)	0.80 (0.65-0.95)
Mental Status (MMSE)		
24-30	0.64 (0.59-0.70)	0.55 (0.50-0.61)

Characteristic	Kappa ¹	Kappa ²
<23	0.49 (0.11-0.88)	0.49 (0.11-0.88)
Visual acuity*		
20/40 to 20/20	0.63 (0.57-0.69)	0.55 (0.49-0.61)
Wt 20/40	0.75 (0.59-0.91)	0.57 (0.41-0.72)
Contrast sensitivity* (OU)		
1.5	0.62 (0.56-0.68)	0.54 (0.48-0.60)
<1.5	0.90 (0.78-1.00)	0.70 (0.55-0.85)
UFOV subtest 2*		
<150	0.65 (0.58 -0.72)	0.57 (0.50-0.64)
150-350	0.59 (0.49-0.70)	0.51 (0.41-0.61)
>350	0.72 (0.56-0.87)	0.55 (0.40-0.70)
Trails B* (min)		
<2.47	0.66 (0.59-0.73)	0.57 (0.51-0.64)
2.47	0.61 (0.51-0.70)	0.51 (0.42-0.60)
Days driven per week		
<7	0.67 (0.59-0.75)	0.59 (0.51-0.66)
7	0.61 (0.53-0.69)	0.52 (0.44-0.59)
Annual miles driven		
(- median)	0.62 (0.54-0.70)	0.52 (0.44-0.60)
(+ median)	0.65 (0.57-0.74)	0.58 (0.50-0.66)

Note:

¹Kappa is the agreement for any MVC.

²Kappa is the agreement for cumulative number of MVCs.