

## RESEARCH ARTICLE

# Wholesale and retail trade sector occupational fatal and nonfatal injuries and illnesses from 2006 to 2016: Implications for intervention

Vern Putz Anderson PhD, NIOSH  | Paul A. Schulte PhD, NIOSH  |Jeanette Novakovich PhD, NIOSH  | Donna Pfirman NIOSH |

Anasua Bhattacharya PhD, NIOSH

Department of Health and Human Services,  
Centers for Disease Control and Prevention,  
National Institute for Occupational Safety  
and Health (NIOSH), Cincinnati, Ohio

**Correspondence:** Paul A. Schulte, Department  
of Health and Human Services, Centers for  
Disease Control and Prevention, National  
Institute for Occupational Safety and  
Health (NIOSH), 1090 Tusculum Ave,  
Cincinnati, OH 45226.  
Email: pas4@cdc.gov

## Abstract

**Background:** We analyzed the Bureau of Labor Statistics (BLS) fatal and nonfatal injuries and illness data on U.S. workers in the wholesale and retail trade (WRT) sector from 2006 to 2016. The purpose was to identify elevated fatal and nonfatal injury and illness rates in WRT subsectors.

**Methods:** To assess the WRT health and economic burden, we retrieved multiple BLS data sets for fatal and nonfatal injury and illness data, affecting more than 20 million employees. We examined yearly changes in incidence rates for lost work-time across event and exposure categories.

**Results:** In 2016, 553 100 injuries and illnesses and 461 fatalities occurred among WRT workers. WRT has a disproportionately 5% larger burden of nonfatal injuries for its size. From 2006 through 2016, wholesale sector fatality rates (4.9/100 000 FTE) exceeded private industry rates (3.8/100 000 FTE). The largest causal fatal factors were transportation in wholesale and violence in retail. Private industry and WRT experienced a decline in nonfatal injuries and illnesses. Wholesale subsectors with elevated nonfatal rates included durable and nondurable goods, recycling, motor parts, lumber, metal and mineral, grocery, and alcohol merchants. Retail subsectors with elevated rates included motor parts dealers, gasoline stations, nonstores, tire dealers, home and garden centers, supermarkets, meat markets, warehouse clubs, pet stores, and fuel dealers.

**Discussion:** Through the identification of safety and health risks, researchers and safety practitioners will be able to develop interventions and focus future efforts in advancing the safety and health of WRT employees.

## KEYWORDS

BLS work-related fatal and nonfatal injuries, contact with object injuries, musculoskeletal injuries and illnesses, nonstore retail sector, overexertion injuries, recycling industry, self-employed, slips, trips, and fall injuries, sprains and strains, wholesale and retail trade

## 1 | INTRODUCTION

In 2010 we published a review based on 2006 BLS data to assess the overall occupational safety and health (OSH) burden across the wholesale and retail trade (WRT) sector.<sup>1</sup> This study was the first comprehensive study of its type on this sector. A main finding was that WRT workers had the fourth-highest number of fatalities among major industry sectors. WRT workers experienced nearly the same number of BLS nonfatal injuries and illnesses as the highest-ranking manufacturing sector. In 2006, approximately 820 500 WRT workers were injured at work. Fifty-five percent of these injuries were severe enough to require days away from work (DAFW), job transfer, or restrictions. Furthermore, 580 fatalities occurred—more than in any other sector.<sup>1</sup> We found that the majority of injuries and fatalities were attributed to a subset of high-risk workplaces, such as convenience stores, home supply stores, and gasoline stations. In sum, we found the cumulative burden of occupational injuries, illnesses, and deaths in WRT was among the largest of any sector, making this sector an important public health concern.<sup>1</sup>

Since 2006, the U.S. labor market has changed. A recent report released by the National Council on Compensation Insurance (NCCI) identified demographic changes in the U.S. workforce.<sup>2</sup> According to the report, the share of workers aged 55 and older increased.<sup>2</sup> Over the 11-year span, the WRT sector workforce grew older. In 2016, the median age of workers increased in the wholesale sector from 38 in 2006 to 45, in retail from 35 in 2006 to 38, and private industry from 39 in 2006 to 42.<sup>3,4</sup> See supporting information, Figure S1. The aging workforce is at a high risk of experiencing injuries.<sup>5,6</sup> Older workers are reported to have a higher injury frequency rate, and experience more falls, slips, and trips injuries than other age groups.<sup>2</sup> Industry sectors with a male concentration were also found to have higher injury rates.<sup>2</sup> The wholesale sector is represented by a roughly 71% male workforce, a demographic that has remained unchanged from 2006 through 2016.<sup>7</sup> See supporting information, Table SI. The large gender gap in the wholesale sector may have some significance for worker safety and health.<sup>2</sup> Another change experienced in the wholesale sector has been a shrinking labor force; from 2006 through 2016, this sector lost 1 million jobs, mostly during the 2006 to 2009 recession.<sup>7</sup> As workers are required to share a higher proportion of the material handling burden, they may experience more musculoskeletal disorders (MSDs).

Due to its size, the WRT sector has a large impact on the U.S. economy and health care system. WRT employs more than 21 million workers in nearly 1.4 million establishments.<sup>8</sup> This sector consists of 146, six-digit North American Industry Classification System (NAICS) codes, each representing a unique industry or type of business. These businesses range from a one-person, one-location workplace to a 1.7 million-employee chain store with over 3337 locations. Except for the chain or franchised business, each work site is unique. They differ in size, type of merchandise, number and bulk of products, and physical nature of the workplace. Many jobs involve some aspects of material handling. In addition, retail workers face the demands of long workdays,

prolonged standing, and frequent public contact. The temporary and seasonal nature of many jobs, especially in retail, adds to high turnover and the employment of younger and older workers. Even though retail and wholesale jobs appear to pose little risk of injury or death, especially when compared with agricultural, mining, and construction jobs, the size of its workforce means that even a small injury or illness rate can impact large numbers of workers.

Information on safety and health risks regarding this huge super-sector remains scarce. The purpose of the current study was to identify fatal and nonfatal injury and illness cases and incidence rates in the WRT sectors and in high-risk subsectors that pose an elevated health and safety risk from the years 2006 through 2016. Our aim was to determine what progress was made over the eleven-year period and identify implications for intervention and gaps in knowledge where future research is needed.

## 2 | METHODS

### 2.1 | Data

We used the Current Population Survey (CPS) “Total Civilian Labor Force, Employed, and Nonagricultural.” The CPS provided the number of annually employed wage and salary workers from private industry and WRT sector and additional demographic information.

We collected occupational injury data from the Bureau of Labor Statistics (BLS) Census of Fatal Occupational Injuries (CFOI) for the years 2006 to 2016. The BLS gathers these data through a state and federal cooperative arrangement from all 50 states and the District of Columbia. The CFOI data served to identify and rank WRT fatalities in the United States.<sup>9</sup> Fatal injury rates rely on the census figures from CFOI and employment data from CPS. Sampling errors occur in dispersion around the estimated fatal injury rate, expressed at the 95% confidence level.<sup>10</sup>

For the years 2010 and prior, we used the BLS data definitions based on the 1992 Occupational Injury and Illness Classification Manual (OIICM), with revisions adopted in 2007.<sup>11</sup> Beginning with 2011, we used the BLS data definitions from Version 2.01 of the Occupational Injury and Illness Classification System (OIICS).<sup>12</sup> Estimates from the Survey of Occupational Injuries and Illnesses (SOII) are based on a scientifically-selected probability sample with a 95% confidence interval, rather than a census of the entire population of establishments and cases. To assess the severity of nonfatal injuries and illnesses, the BLS metric for DAFW was used. DAFW include cases with or without job transfer or restriction. Information from workplace safety and health data identified potential risk factors to advance efforts for injury and illness prevention.

To calculate worker compensation (WC) costs, we used data from the National Academy of Social Insurance (NASI) reports from the 2006 and 2016 WC data.<sup>13</sup> NASI is a nonprofit and nonpartisan academy that publishes annual reports on trends in WC benefits, costs, and coverage. Using NASI cases and costs, average medical and

indemnity costs were estimated and used to calculate medical costs, wage losses, and total costs of occupational nonfatal injuries in the WRT sector. The Consumer Price Index (CPI) Inflation calculator was used to adjust 2006 costs for inflation.

## 2.2 | BLS data variables

The primary outcomes of interest for this study were total recordable cases and rates of fatal and nonfatal injuries and illnesses in the wholesale and retail sectors in whole years from 2006 through 2016. Fatality cases were categorized by their exposures and the events that are known to be key causal factors impacting wholesale and retail. Retail and wholesale subsectors with high fatality rates were identified for intervention. The incidence rates for nonfatal injuries and illnesses were collected from BLS data to assess the changes associated with each of the primary event and exposure categories impacting the WRT workforce from 2006 through 2016. Three nonfatal exposure events, including overexertion and bodily reaction, contact with objects, and slips, trips and falls were selected for inclusion in the study because they comprise over 90% of the total nonfatal injuries and illnesses. Definitions, rules of selection, titles, and descriptions of each of the event and exposure categories are available from the 2010 BLS OIICS manual.<sup>12</sup>

## 2.3 | Analysis

In sum, we analyzed the private industry, wholesale, and retail fatal cases and their incidence rates, and similarly, the reportable nonfatal injury and illness cases and their incidence rates from 2006 through 2016. Subsequently, we identified and analyzed the exposures and event categories that contributed to fatal and nonfatal injuries and illnesses. Lastly, we followed up this analysis by determining which of the wholesale and retail subsectors were responsible for the largest burden to workers in the wholesale and retail subsectors.

We analyzed the BLS CFOI fatal and SOII nonfatal injury and illness rates for the private industry and the wholesale and retail sectors from 2006 through 2016. Private industry served as a national average or a benchmark for assessing the changes observed in each year from 2006 through 2016. Subsequently, we analyzed BLS CFOI data to determine the number of recordable fatality cases for each of the six exposure and event categories. BLS CFOI data sets were used to identify WRT subsectors with fatal injury rates that equaled or exceeded their respective WRT sector-level fatal injury rates for 2006 and or 2016.<sup>14</sup>

The BLS SOII served to identify and rank WRT injuries and illnesses.<sup>15</sup> All BLS data sets were based on the private industry, wage and salary, self-employed, and nonagricultural U.S. workforce most aligned with the WRT sector. BLS SOII data sets were used to identify subsectors with the highest total recordable cases and DAFW and associated incidence rates.<sup>16,17</sup> WRT subsectors with BLS nonfatal injury and illness incidence rates that equaled or exceeded their respective WRT sector nonfatal injury and illness rates in 2006

and 2016 were identified as high risk or "hot spots" in need of further investigation to identify appropriate interventions.

From 2006 through 2016, we plotted in 1-year increments private industry, wholesale, and retail fatal and nonfatal injuries and illnesses. We also plotted in 1-year increments wholesale and retail fatal and nonfatal exposures and events.

Fatal injury rates were calculated by the BLS as the number of fatal work injuries in an industry sector divided by the total hours worked in that industry and multiplied by 200 000 000 (the base for 100 000 equivalent full-time workers (FTE) working 40 hours per week, 50 weeks per year). Nonfatal incidence rates represent the number of injuries and illnesses per 100 FTE and were calculated as:  $(N/EH) \times 200\,000$ , where  $N$  is the number of injuries and illnesses and  $EH$  the total hours worked by all employees during the calendar year. Data management and analysis were performed using Microsoft Excel 2016.

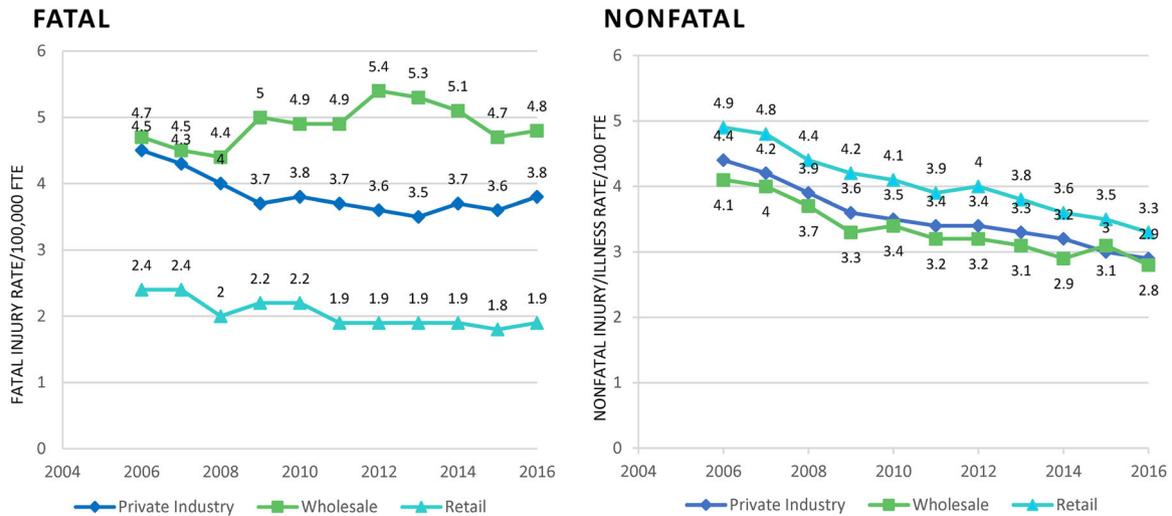
## 3 | RESULTS

In 2016, BLS reported 553 100 injuries and illnesses and 461 fatalities for the WTR sector. Overall, from 2006 through 2016, the WRT workforce experienced a 5% disproportionate share of nonfatal injuries and illnesses as compared with private industry's burden of nonfatal injuries and illnesses.<sup>18,19</sup> See supporting information for data, Table SII.

### 3.1 | Wholesale and retail fatal and nonfatal injuries from 2006 through 2016

Figure 1 shows in 1-year increments the wholesale and retail fatal and nonfatal injury and illness incidence rates benchmarked with private industry. The wholesale sector suffered disproportionately in terms of average fatal injury rates (4.9/100 000 FTEs) compared with private industry (3.8) and retail (2.0). From 2006 through 2016, the wholesale sector fatal injury rate exceeded private industry for all years. The retail sector fatality rates were lower than private industry fatality rates throughout this time period.<sup>14</sup> From 2006 through 2016, retail fatality rates declined by 21%, private industry fatality rates declined by about 16%; whereas wholesale fatality rates increased slightly, around 2%.<sup>14</sup> The retail sector suffered disproportionately in terms of total recorded cases of nonfatal injuries and illness with an average incidence rate (4.0/100 FTE), compared with private industry (3.5), and wholesale (3.3). The total recorded cases of nonfatal injuries and illnesses in the retail sector declined from 2006 through 2016 by 33%, in the wholesale sector by 32%, and in private industry by 30%.<sup>20</sup>

In 2006, WRT nonfatal injuries at work cost employers \$23,127 billion adjusted for inflation for WC medical benefits and lost wages; in 2016, these injuries cost employers \$17 635 billion.<sup>13</sup> This represents a 24% reduction in WC benefits paid for nonfatal injuries in the WRT sector between 2006 and 2016. See supporting information, Table SIII.



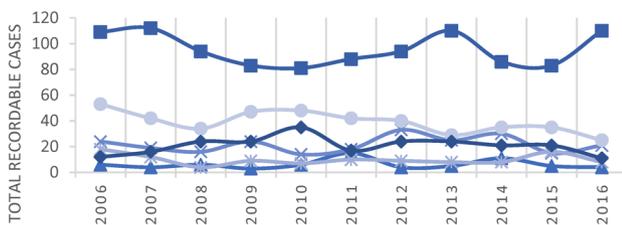
**FIGURE 1** Wholesale and retail fatal and nonfatal injury and illness: 2006 to 2016.<sup>14,20</sup> Fatal injury rates are calculated per 100 000 FTE, and nonfatal injury and illness incidence rates per 100 FTE. FTE, full-time workers [Color figure can be viewed at wileyonlinelibrary.com]

### 3.2 | Wholesale and retail fatal and nonfatal injuries by events and exposures

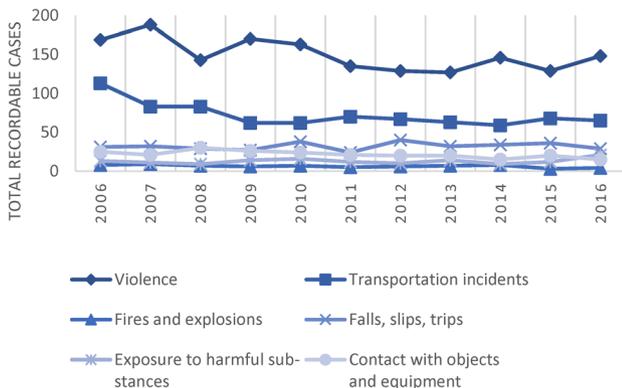
Figure 2 shows the number of fatality cases by event and exposure categories in the wholesale and retail sectors from 2006 through 2016.<sup>21</sup> In the wholesale sector, transportation-related incidents remained the leading fatality event. Transportation-related incidents

accounted for 1050 occupational deaths from 2006 through 2016. In the wholesale sector, contact with objects and equipment, fatal falls, and assaults are the next leading causes of occupational death, with exposures to harmful substances and fires and explosions contributing the least.<sup>21</sup> The retail sector was particularly vulnerable to events and exposures associated with violence, which contributed to 1647 additional cases from 2006 through 2016. The second leading event, transportation contributed to 795 occupational additional deaths during that time period. Fatalities from slips, trips, and falls, contact with objects, exposure to harmful substances, and fires and explosions were the smallest contributors to occupational deaths in the wholesale and retail sectors.<sup>21</sup>

#### WHOLESALE



#### RETAIL

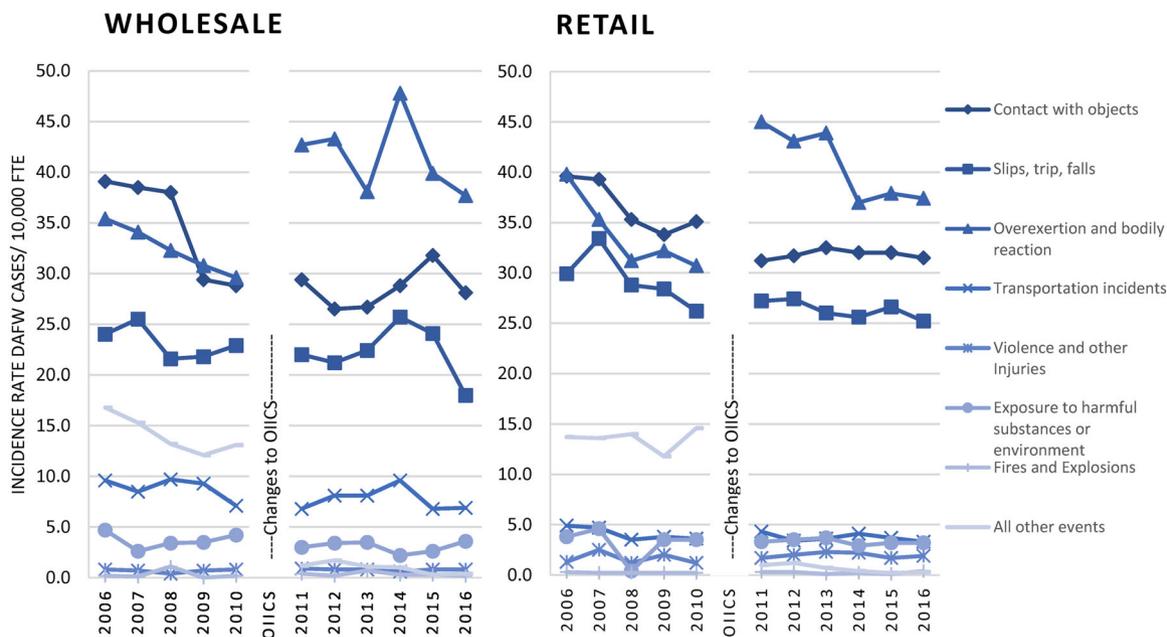


**FIGURE 2** Wholesale and retail fatalities by event or exposure: 2006 to 2016.<sup>21</sup> After 2011 data reflects BLS Version 2.01 of the Occupational Injury and Illness Classification System (OIICS) [Color figure can be viewed at wileyonlinelibrary.com]

Figure 3 shows the wholesale and retail nonfatal incidence rates by event or exposure from 2006 through 2016.<sup>22</sup> In 2016, the combination of overexertion and bodily reactions, contact with objects and equipment, and falls, slips, and trips to all levels accounted for nearly 90% of the WRT nonfatal injuries.<sup>22</sup> The category overexertion and bodily reactions accounted for more than one-third of the WRT nonfatal injuries and illnesses and was shown to be decreasing in both the wholesale and retail sectors.

### 3.3 | Nonfatal wholesale, retail, and private industry by main events and exposures

Figure 4 shows the variations in incidence rates for overexertion and bodily reaction.<sup>23,24</sup> Wholesale and retail incidence rates were consistently larger than private industry incidence rates for overexertion and bodily reactions during both the 2010 and prior, and 2011 and forward years. Figure 5 illustrates data for the contact with objects and equipment event/exposure category.<sup>25,26</sup> Data show a declining trend in incidence rates across both the private industry and wholesale sector during the 2010 and prior interval. The retail incidence rate for contact with objects declined during the years following 2006, rebounding in 2010. During the



**FIGURE 3** Wholesale and retail sector nonfatal injuries by event/exposure, involving days away from work (DAFW).<sup>22</sup> SOII Industry nonfatal injuries and illnesses with days away from work 10 000 full-time employment. After 2011 data reflects BLS Version 2.01 of the Occupational Injury and Illness Classification System (OIICS) [Color figure can be viewed at wileyonlinelibrary.com]

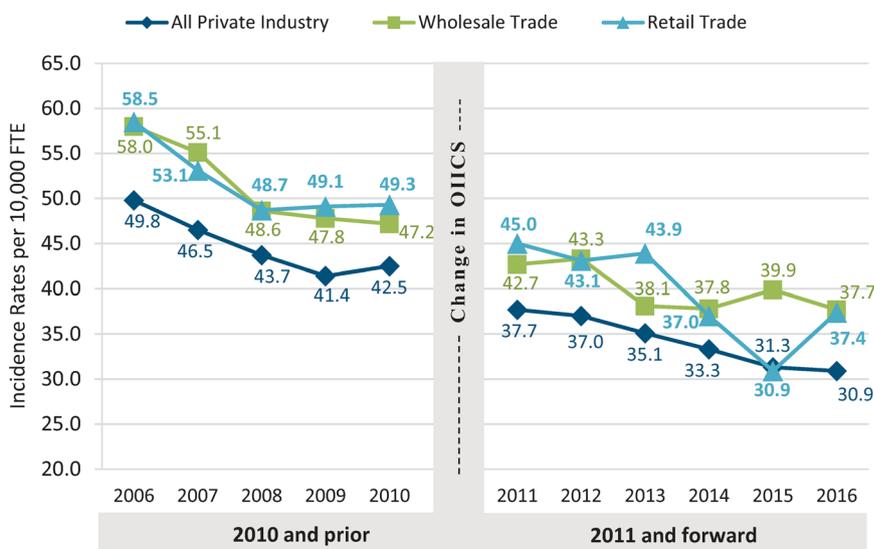
2011 and forward period, the retail incidence rate remained constant. The wholesale and retail sectors registered higher incidence rates throughout the 11-year period than did private industry. Contacts with objects continue to contribute disproportionately to the number of injuries and illnesses experienced by WRT employees.

Figure 6 traces the incidence rates for falls occurring across private industry and the WRT sectors.<sup>27,28</sup> Wholesale sector incidence rates were consistently lower than private industry. However, retail sector falls were consistently higher than private industry with an exception 1 year. Falls continue to pose a serious hazard for retail employees and cause both fatal and nonfatal injuries and illnesses. Falls, both to the same level and lower levels, are responsible for most bruises and bone fractures.<sup>29</sup>

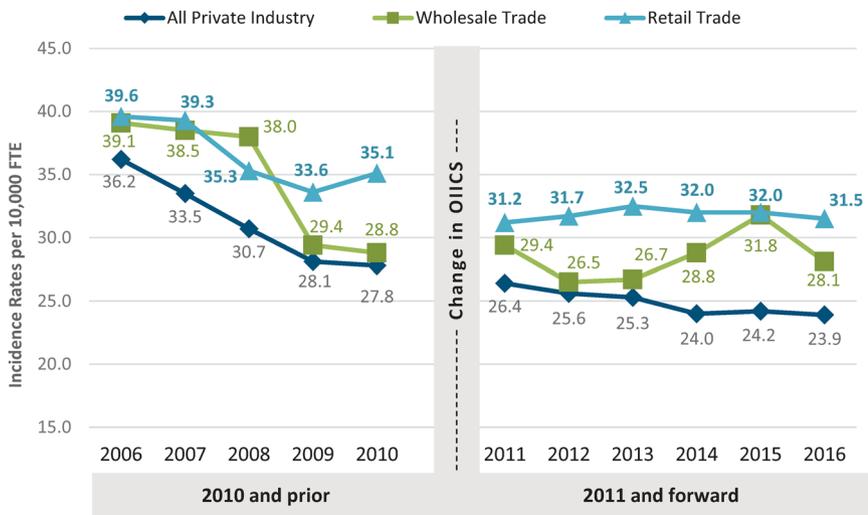
### 3.4 | WRT subsector fatality hot-spots

Table 1 compares 2006 and 2016 fatality measures among selected wholesale and retail subsectors. Five wholesale and five retail subsectors had fatal injury rates that equaled or exceeded their respective WRT sector-level fatal injury rates for 2006 and or 2016.<sup>30,31</sup> Collectively, these 10 WRT subsectors represented potential “hot-spots or high-risk fatal wholesale and retail subsectors responsible for most WRT fatalities.

In wholesale subsectors, merchant wholesalers who handled durable goods experienced increased fatality incidence rates. Recyclable material merchant wholesalers also recorded a fatal injury incidence rate, consisting of a more than six-fold increase over the incidence rate among private industry workers. Retail fatality rates decreased with one exception, miscellaneous-store retailers.



**FIGURE 4** Overexertion and bodily reaction incidence rates.<sup>23,24</sup> FTE, full-time workers [Color figure can be viewed at wileyonlinelibrary.com]



**FIGURE 5** Contact with objects and equipment incidence rates.<sup>25,26</sup> FTE, full-time workers [Color figure can be viewed at wileyonlinelibrary.com]

Although the incidence rate for fatalities in gasoline stations decreased, gasoline station employees continue to experience a disproportionately high risk for fatalities. Overall, ten WRT subsectors stood out as high risk for work-related fatalities.<sup>30,31</sup>

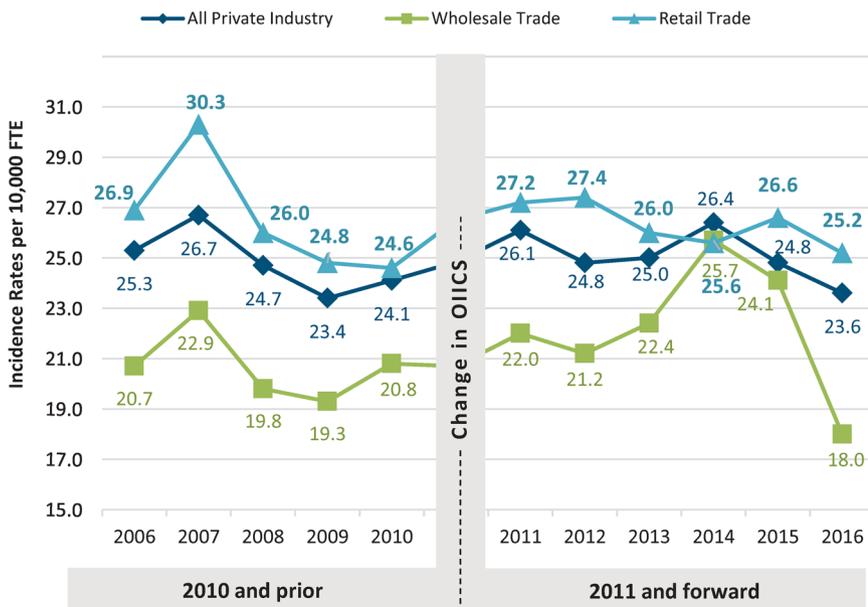
The BLS provides the number of fatal injuries for self-employed WRT workers, but not the rates. The number of self-employed fatalities in the wholesale sector was small at 14 and 13 for 2006 and 2016, respectively.<sup>30,31</sup> In 2006, out of 359 retail fatalities, 85 were self-employed, or nearly one in four fatalities.<sup>30</sup> In 2016, self-employed retail fatalities decreased to 53 out of 282 total retail fatalities, which is about one in five fatal retail incidents.<sup>31</sup>

### 3.5 | WRT subsector nonfatal injury and illness hot-spots

Table 2 compares BLS 2006 and 2016 nonfatal injury and illness data among selected subsector hotspots in the wholesale and

retail sectors.<sup>32</sup> Five wholesale and eleven retail subsectors were identified as potential “hot-spots” responsible for most of the WRT nonfatal injury and illness cases and DAFW. As a form of benchmarking, the private industry total recordable cases for nonfatal injuries and illnesses decreased 30% and DAFW decreased 25%. WRT total recordable cases decreased 33% and DAFW decreased 26%. Of private industry’s total recordable cases in 2016, approximately 30% were serious enough to require one or more DAFW.

Wholesaler merchants who deal in metal and mineral-based materials and grocery-related products showed an increase in the number of DAFW cases and incidence rates. Retailers who operate nursery and garden centers and farm supply stores also showed an increase in the number of DAFW cases and incidence rates. Retail fuel dealers registered an increase in incidence rates. Meat markets were the only retail subsector to show a substantial increase in both the number of total recordable cases and DAFW incidence rates. The pet and pet supplies stores, which had insufficient data in 2006,



**FIGURE 6** All falls incidence rates.<sup>27,28</sup> FTE, full-time workers [Color figure can be viewed at wileyonlinelibrary.com]

**TABLE 1** Fatal occupational injuries among private industry, self-employed, and select wholesale and retail trade subsectors: 2006 to 2016<sup>30,31</sup>

Types of businesses	NAICS code	2006		2016	
		Number fatal injuries	Fatal injury rate <sup>a</sup>	Number fatal injuries	Fatal injury rate <sup>a</sup>
Private industry (wage and salary and self-employed)		5840	4.2	5190	3.6
Wage and salary workers		4808	3.7	4098	3.0
Self-employed (unincorporated)		1032	10.6	1092	13.1
Wholesale trade (wage and salary + self-employed)	<b>42</b>	222	4.7	179	4.8
Wholesale self-employed (unincorporated number)	<b>42</b>	14	-	13	-
Merchant wholesalers, durable goods	423	111	4.4	91	5.2
Machinery, equipment/supplies merchants	4238	32	5.4	26	6.8
Recyclable material merchant wholesalers	42393	16	-	17	20.0
Merchant wholesalers, nondurable goods	424	103	5.0	86	4.7
Grocery and related products, wholesalers	4244	39	4.3	30	3.7
Retail trade (wage and salary + self-employed)	<b>44-45</b>	359	2.4	282	1.9
Retail self-employed (unincorporated number)	<b>44-45</b>	85	-	53	-
Motor vehicle and parts dealers	441	71	3.2	42	1.9
Food and beverage stores	445	82	3.2	71	2.7
Gasoline stations	447	52	10.4	44	9.4
Miscellaneous-store retailers	453	21	2.1	21	2.2
Nonstore retailers	454	19	3.2	15	2.4

Abbreviation: NAICS, North American Industry Classification System.

Bold values represent hot or high risk subsectors with high fatal injury rates.

<sup>a</sup>Fatal injury rates are calculated per 100 000 FTE.

registered in 2016, an incidence rate nearly twice that of the retail-case-based incidence rate. The incidence rates for home centers, supermarket and other grocery, and warehouse clubs and supercenters declined.

## 4 | DISCUSSION

Our main finding replicated the results from the 2010 report.<sup>1</sup> Namely, the WRT sector experienced a disproportionate number of serious work-related injuries and illnesses for the size of the work population when compared to similar data from private industry. Overall, the burden for the WRT sectors remained stable over the 11-year period and, in this sense, little progress was made in terms of reducing the sector's burden.

### 4.1 | Wholesale and retail fatal and nonfatal injuries and illnesses

From 2006 through 2016, wholesale sector fatality rates exceeded private industry rates. Overall, the wholesale sector experienced an increase in the number of fatal injuries. Retail experienced an overall decline in the number of fatalities. A steep decline in injury and illness cases across the private sector and within the retail and wholesale sectors may have contributed to a decline in WC costs for employers.

### 4.2 | Wholesale and retail main events and exposures for fatal and nonfatal injuries and illnesses

Two fatal events and exposures were of concern to the wholesale and retail sectors; specifically, transportation and assault-related occupational deaths. Transportation incidents were the leading cause of occupational death in the wholesale sector and second leading cause in the retail sector. Several safety practices have been shown to help reduce transportation incidents, including fatigue management, provisional driver training, mobile phone record checking, and collision response procedures.<sup>33</sup> Interventions will not only prevent transportation fatalities, they can also help to reduce the number of nonfatal transportation-related injuries. See supporting information, Figure S2. Assaults were the leading cause of death in the retail sector. An effective workplace violence prevention program includes management commitment and employee participation, worksite analysis, hazard prevention and control, safety and health training, and recordkeeping and program evaluation. One of the best protections employers can offer their workers is to establish a zero-tolerance policy toward workplace violence.<sup>34,35</sup>

Overexertion and bodily reactions are widely recognized as responsible for several nonfatal injury and illness cases adversely impacting WRT employees' health and productivity.<sup>36,37</sup> Despite, a slow decline in the overexertion and bodily reactions incidence rates, the 2016 WRT sectors incidence rate was higher than private industry incidence rates. One of the most frequently reported WRT

**TABLE 2** The wholesale and retail trade subsectors at high-risk for nonfatal injuries and illnesses<sup>32</sup>

Type of Business	2006					2016				
	NAICS code (2012)	Total recordable cases (thousands)	Incidence rate/ 100 workers	DAFW cases (thousands)	DAFW incidence rates/ 10 000	Total recordable cases (thousands)	Incidence rate/ 100 workers	DAFW cases (thousands)	DAFW incidence rates/ 10 000	DAFW incidence rates/ 10 000
Private industry		4085.4	4.4	1183.5	1.3	2857.4	2.9	892.3	0.9	0.9
Wholesale trade		232.0	4.1	75.7	1.3	157.1	2.8	54.3	1.0	1.0
Motor vehicle and vehicle parts supplies merchants	4231	15.8	5.0	4.8	1.5	10.8	3.4	3.6	1.1	1.1
Lumber and other construction materials merchants	4233	16.7	6.3	5.3	2.0	10.0	4.7	3.6	1.7	1.7
Metal and mineral (except petroleum) merchants	4235	7.6	5.8	2.2	1.7	6.4	5.0	2.4	1.9	1.9
Grocery and related product merchant wholesalers	4244	49.0	7.0	15.9	2.3	35.2	4.7	13.1	1.8	1.8
Beer, wine, distilled alcoholic beverage merchants	4248	12.5	8.4	4.3	2.9	11.7	6.0	...	...	...
Retail trade		588.5	4.9	162.8	1.4	395.9	3.3	122.4	1.0	1.0
Recreational vehicle dealers	44 121	1.9	5.1	0.6	1.5	1.8	4.7	0.5	1.3	1.3
Tire dealers	44 132	10.8	6.7	3.6	2.2	7.9	4.4	2.9	1.6	1.6
Other home furnishings stores	44 229	6.6	5.5	3.0	2.5	5.4	4.9	2.5	2.3	2.3
Home centers	44 411	55.2	8.8	13.5	2.1	28.8	5.3	8.3	1.5	1.5
Other building material dealers	44 419	20.9	7.1	6.8	2.3	10.2	4.6	4.2	1.9	1.9
Nursery, garden center, and farm supply stores	44 422	5.4	5.9	1.5	1.6	4.3	4.7	1.8	2.0	2.0
Supermarkets/other grocery (except convenience)	44 511	108.0	6.5	31.3	1.9	81.5	4.5	26.3	1.5	1.5
Meat markets	44 521	1.1	2.9	0.2	0.6	1.7	4.9	0.5	1.5	1.5
Warehouse clubs and supercenters	45 291	61.0	7.3	14.2	1.7	53.1	4.6	13.2	1.1	1.1
Pet and pet supplies stores	45 391	...	...	...	...	5.0	6.1	1.3	1.6	1.6
Fuel dealers	45 431	4.4	5.3	2.0	2.4	4.1	5.5	1.6	2.1	2.1

Abbreviation: NAICS, North American Industry Classification System.



injury and illness outcomes of overexertion injuries are MSDs. MSDs as a work-related injury and illness outcome are responsible for the more costly WRT worker compensation claims, resulting in lost productivity, lost wages, and employees suffering and pain.<sup>29,38</sup> See supporting information, Figure S3. In the growing online retail nonstore subsector, recent reports suggest that manual material handling is one of the more demanding job functions that employees perform.<sup>39,40</sup> See supporting information, Figure S4. This retail subsector includes well-recognized companies as Amazon, Wayfair, and eBay. Although retail nonstores have invested heavily in automation, employees continue to perform manual material handling to meet quotas and deadlines for delivery. Employees frequently report experiencing overexertion injuries from awkward postures, repetitive motions, and forceful exertions that over time can manifest as either strains or sprains or MSDs.<sup>41</sup> MSDs are also a risk for the aging wholesale population. When older workers' physical abilities do not meet job demands, they face increased injury risk.<sup>5</sup> A key finding in the Baidwan et al<sup>6</sup> study was that the risk of experiencing a work-related injury event was more than two times greater among older workers whose job required physical effort, including heavy lifting and bending.

Hazards associated with contact with objects and equipment posed a greater risk to the wholesale work population than they posed for private industry. Forklift injuries happen in close quarters around other employees. Machinery can catch parts of the body, as well as loose clothing or dangling jewelry. Contact injuries are an underrated workplace hazards as they are often responsible for loss of body parts, resulting in permanent disability and even loss of life. Moreover, as autonomous robots are introduced into WRT workplaces, there is likely to be a greater risk of both nonfatal and fatal injuries.<sup>42,43</sup> WRT researchers and practitioners, particularly those who specialize in the wholesale sector, should focus on the contact-related hazards in their efforts to improve the safety and health of this workforce.

Fall-related hazards in the retail sector are emerging as a growing risk factor, accounting for a nearly one of every four DAFW nonfatal injury and illness case.<sup>36,44</sup> Socias-Morales et al found that work-related falls are more common among older workers, with the highest rate occurring among workers older than 64 and with the highest frequency of falls occurring among workers aged 45 to 54.<sup>45</sup> Falls to the same level are likely to increase as the working population ages.<sup>46,47</sup> Recognizing fall-related hazards and the need to eliminate those hazardous conditions should be a priority for researchers.

### 4.3 | Elevated fatality rates in WRT subsectors

Five wholesale and five retail subsectors with high rates of fatal injuries were identified as candidates for intervention. Employees with jobs linked to wholesale businesses involved in handling durable goods experienced most of the 2016-wholesale fatalities. Merchant wholesalers who buy and sell durable goods employ nearly 3 million workers in over 350 thousand companies.<sup>48</sup> Safety and health practitioners should accelerate prevention efforts to address the loss

of lives in this subsector. Despite encouraging declines in fatalities, warehouses and distribution centers pose a serious risk for warehouse workers in the use of forklifts and conveyors. When forklift operators transfer loads from transportation vehicles, they are at risk of being pinned and crushed from overturned units. Powered conveyors also pose a risk to workers who may be caught in the equipment or struck by falling objects and merchandise.

In 2006, the recycling industry reported 16 fatalities; even so, the BLS did not have sufficient data to compute a fatality-injury rate. Eleven years later in 2016, the BLS reported the recyclable material-merchant wholesaler fatality-injury rate was nearly seven times higher than the overall private industry 2016 fatality rate.<sup>16,17</sup> The U.S. recycling industry in 2015 consisted of nearly 14 000 wholesale companies providing more than 757 000 jobs and \$6.7 billion annually in tax revenues. Of 17 deaths recorded in the recycling subsector, 7 were caused by transportation-related events and 6 were caused by contact with objects and equipment. Employees working in the recycling industry are also exposed to toxic exposures. This occurs most frequently in the recycling of electronic waste. Two recent NIOSH Health Hazard Evaluations provide further insight on recycling industry hazards.<sup>49,50</sup>

Five retail subsectors were responsible for 65% of all the 2016 retail fatalities. This group includes motor vehicle and parts dealers, food and beverage stores, miscellaneous merchandise stores, nonstore retailers, and gasoline stations. Motor vehicle and parts dealers employ nearly 2 million employees working in 210 000 companies.<sup>51</sup> Food and beverage stores collectively employ more than three million workers in over 300 thousand different companies.<sup>52</sup> And gasoline stations operate with a work population of nearly one million.<sup>53</sup> In 2016, this retail subsector had a fatality incidence rate more than four times higher than the overall retail sector. Gasoline stations have the unfavorable distinction of the highest risk for fatal retail work injuries. Such stores are usually open 24/7, often staffed with three or fewer employees, and exchange money in high-risk locations, making them convenient for criminal activity.<sup>35</sup> This study environment poses a high risk of fatalities in the form of assaults and violent acts.<sup>54-56</sup> Additional research should identify the barriers that impede the implementation of recognized and effective interventions. Fundamental research on the causes of violence may also be required for efforts aimed at prevention.<sup>34</sup>

### 4.4 | Elevated nonfatal injury and illness rates in WRT subsectors

Five wholesale subsectors in 2016 had elevated incidence rates for nonfatal injuries and illnesses. Collectively, nearly 2 million employees working in over 200 000 of these subsectors are at risk for disabling injuries and illnesses each day. The metal and mineral merchants employing about 150 000 in nearly 12 000 companies are at the greatest risk, with a lost-time rate almost twice that which occurs across the retail sector and private industry.<sup>57</sup> Each of these populated subsectors offer opportunities for researchers to

investigate organizational and work-related risk factors that lead to lost work-time, loss of productivity, and additional costs to employees, employers, WC systems, private health insurance, and government agencies.<sup>58,59</sup>

Eleven retail subsectors in 2016 reported elevated incidence rates for nonfatal injuries and illnesses, including tire dealers, home centers, other building materials dealers, supermarkets/other grocery, and warehouse clubs/supercenters. Six additional retail establishments deserve closer observation as their individual incidence rates were twice or nearly twice that of the 2016-retail sector rate. They include nursery/garden centers/farm supplies, other home furnishing stores, other building materials dealers, and retail fuel dealers. Collectively, these establishments represent more than 88 000 unique companies, employing nearly one million workers.

## 5 | FUTURE RESEARCH

The BLS does not provide information on employee stress. A 2016 national survey found that 42% of employees working in the retail sector felt their "current job is bad for stress levels."<sup>60</sup> Nearly 30% of employees in stores and warehouses reported unhealthy stress level based on their current job.<sup>61</sup> Work-related stress may arise from multiple work organizational conditions that include long work hours, fatigue, and lack of family friendly work conditions.<sup>62</sup> No suitable metrics exist to document the extent and nature of workplace stress and its consequences. Objective methods are needed for this purpose.

The self-employed fatality rates across the private industry were strikingly high, between three and four times higher than the fatality rates for the wage and salary and private industry workers.<sup>63</sup> Since the definitions of self-employed workers and how they are counted are dependent on whether they are incorporated or unincorporated, the plight of the self-employed is difficult to assess. A lack of BLS rates for self-employed WRT workers made it impossible to determine their level of risk. Toivanen et al<sup>64</sup> reported that self-employed workers operating as sole proprietors experience higher mortality rates in trade industries, transportation, and welfare industry than paid employees in the same industries. In general, little is known about the health effects of the self-employed. This population deserves more attention in OSH research. Moreover, we know little or nothing about the extent and nature of the self-employed nonfatal injuries and illnesses. Future studies of the self-employed owners of WRT small businesses should assess the burden of occupational fatal and nonfatal injury and illness cases unique to self-employed workers.

Determining the true economic burden of occupational injuries and illnesses will potentially benefit employers, employees, and society by improving workplace safety and health. Workplaces with elevated rates of fatal and nonfatal injuries cause immense losses affecting employers, employees, and the economy. WC covers some of the losses. The remaining losses are distributed, according to Leigh

and Bhattacharya et al, to the employers in the form of lost productivity, to the employees and their family members in lost income, as well as pain and suffering; and to society from the employee's partial or permanent disability.<sup>61</sup> There are also conditions and incentives that discourage the submission of a WC claim.<sup>65,66</sup> The personal and financial burden posed by work-related injuries and illnesses is becoming clear as economists assess the total cost to society.<sup>67</sup> In 2007, Leigh identified 5600 occupational fatalities, at a cost of \$6 billion in the United States and almost 8 559 000 nonfatal injuries and illnesses at a cost of \$186 billion.<sup>61</sup> Many of the employers in the WRT sector are small businesses with low profit margins. A single fatality or serious nonfatal or injury and illness can have near catastrophic effects and threaten the existence of a small business.

## 6 | LIMITATIONS

This study has a limitation in making assumptions about the reductions of WRT nonfatal injuries and illnesses over the 11-year span from 2006 through 2016. Over the last two decades, there is a well-known general decline in the number of cases reported to BLS of nonfatal injuries and illnesses.<sup>68,69</sup> One may attribute this decline to an overall improvement in the safety and health of the work population. However, when the BLS data are compared to other data sources that track aspects of work-related injuries and illnesses, large discrepancies appear in the magnitude of the problem. It remains for researchers and safety practitioners to determine whether this finding represents real progress in prevention of nonfatal injuries and illnesses or simply reflects changes in how employers record or report nonfatal injury and illness data.<sup>68,70</sup>

Another limitation involves comparing rates and numbers over a lengthy period. The BLS made several changes to the definition or criteria used to identify and classify the events/exposures, the nature of the injuries and illnesses, and related metrics. As a result, studies that attempt to examine or document changes in the incidence rates and number of injury and illness cases before 2011 with changes subsequent to 2011 and after would likely be imprecise.

## 7 | CONCLUSION

This article presents a comprehensive review of fatal and nonfatal injuries, and illnesses in the WRT sector, one of the largest economic sectors in the United States. Even a small increase in the burden is substantial. WRT's disproportionate share of nonfatal injuries and illnesses impacts large numbers of workers, their families, employers, communities, and society. Many of the employers in the WRT sector are small businesses with low profit margins. A single fatality or serious nonfatal or injury and illness can have near catastrophic effects and threaten the existence of a small business. A review of the BLS data from 2006 through 2016 highlighted numerous subsectors that merit preventative interventions.

Researchers can adopt several strategies to eliminate or minimize workplace hazards. They can prioritize based on the size of the work population at risk, the seriousness of the injury and illness, or the number of fatalities. Others may want to focus on the amenability factor or potential to make significant progress in a given subsector by improving existing interventions known to be successful. As the diversity of the workforce increases, researchers may prioritize WRT subsectors that include a diverse work population, such as older workers. The "prevention index" is also useful as it treats frequency and relative risk as equally important.<sup>69</sup> The most practical approach is to focus on unique strengths and consider the resources available for making improvements in the safety and health of high-risk WRT populations.

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The authors declare that there are no conflicts of interest.

## DISCLOSURE BY AJIM EDITOR OF RECORD

John Meyer declares that he has no conflict of interest in the review and publication decision regarding this article.

## AUTHOR CONTRIBUTIONS

VPA conceptualized and drafted the manuscript. PAS served as the manager of the project providing oversight and technical input. JN assisted in critically revising the manuscript for important intellectual content, ensuring the narrative accurately and clearly interpreted the multiple data tables and charts. DP drafted and outlined the manuscript and developed tables and charts. AB collected economic data and conducted analysis. All authors have seen and approved the final version to be published.

## INSTITUTION AND ETHICS APPROVAL AND INFORMED CONSENT

No ethics review or informed consent was considered necessary; only deidentified data collected by the BLS for surveillance was used.

## DISCLAIMER

The findings and conclusions in this report are those of the authors and do not necessarily represent the official position of the

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## ORCID

Vern Putz Anderson  <http://orcid.org/0000-0002-3588-3259>

Paul A. Schulte  <http://orcid.org/0000-0002-0696-0446>

Jeanette Novakovich  <http://orcid.org/0000-0002-9015-3435>

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## SUPPORTING INFORMATION

Additional supporting information may be found online in the Supporting Information section.

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