Changes in fall rates from before to during the COVID-19 pandemic: Findings from the prospective AMBROSIA study

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ABSTRACT

BACKGROUND: COVID-19 social distancing policies resulted in reductions in community movement, however fall rates during this time have not been described.

METHODS: This prospective study included adults ≥65 years old participating in the Ambulatory Blood Pressure in Older Adults (AMBROSIA) cohort and who completed ≥1 monthly falls calendar (August 2019-March 2021; n=250). Months were grouped to correspond to the fall 2020 phased re-opening (August-October) and the shelter-in-place policy during the winter 2020 surge (November-January) in Los Angeles, California and compared to the same months, one year earlier (i.e., before the pandemic).

RESULTS: Participants had a mean (SD) age of 75.2 (6.1) years, 49.6% were White, and 53.2% were women. We obtained 2,795 falls calendars during follow-up. Overall, 110 (44.0%) participants reported a total of 421 falls (rate 15.1 per 100 calendar months). The highest monthly fall rate during the pandemic was 22.9 (95% CI 16.4-31.1) per 100 calendar-months in August 2020. The lowest fall rate during the pandemic was 8.6 (95% CI 3.5-17.8) per 100 calendar-months in February 2021. During the pandemic, fall rates in August, September, and October 2020 were higher than the previous year (rate ratio 1.8 [95% CI 1.1-2.9]) and fall rates in November and December 2020 and January 2021 were lower than the previous year (rate ratio 0.5 [95% CI 0.4-0.8]).

CONCLUSIONS: As the pandemic continues and older adults resume community mobility after a shelter-in-place period, providers should pay attention to the risk of falls.

Abstract KEY WORDS: falls, COVID-19, older adults

INTRODUCTION

Falls are a multifactorial geriatric syndrome that often result from the interaction between individual risk factors and hazards in the environment.[1,2] For example, an older adult with poor balance may be at risk for falling when walking on uneven sidewalks in the community. While reduced community mobility may decrease exposure to fall-related environmental hazards,[3,4] it can lead to less physical activity, worse balance and strength, and may increase risk for future falls.[5,6]

Social distancing policies enacted during the coronavirus 2019 (COVID-19) pandemic resulted in restrictions in community movement.[7-9] In some states, including California, early shelter-in-place orders focused on older adults and phased re-opening recommendations cautioned against returning to pre-pandemic activities for those at increased risk for severe COVID-19.[10] It is possible that these polices reduced the likelihood that older adults encountered fall-related environmental hazards during this time. Conversely, lockdowns also decreased opportunities for physical activity, possibly increasing subsequent risk for falls.

As the COVID-19 pandemic evolves, intermittent periods of restriction in mobility followed by times of increased activity and community movement may continue. Identifying periods during the pandemic when fall rates were high could help providers anticipate high risk times for falls and develop interventions to reduce this risk. The purpose of this analysis was to estimate monthly fall rates during the COVID-19 pandemic. Additionally, we compared fall rates during versus before the COVID-19 pandemic. To accomplish these goals, we used data from an ongoing cohort study that was collecting monthly falls calendars starting in 2019.

METHODS

Study design and population

We conducted an analysis of data from the Ambulatory Blood Pressure in Older Adults (AMBROSIA) study. AMBROSIA is a prospective cohort study designed to determine the association between the difference between blood pressure (BP) measured in a clinic versus out-of-office (ambulatory BP monitoring and home BP monitoring) with fall risk among older adults taking antihypertensive medication. AMBROSIA is being conducted at Kaiser Permanente Southern California (KPSC), an integrated health care delivery system that provides comprehensive services to over 4.7 million residents of Southern California. Potentially eligible participants were identified using KPSC electronic health records (EHR), contacted by mail to introduce the study, and screened by telephone prior to in-person study visits. Inclusion criteria were age ≥ 65 years old, current KPSC membership, including a pharmacy benefit for at least 24 months, at least 2 outpatient ICD-10 diagnosis codes for hypertension in the prior 12 months, an outpatient systolic BP (SBP) of 110-179 mm Hg and diastolic BP (DBP) of 50-99 mm Hg obtained within the 12 weeks before enrollment, current use of antihypertensive medication, no change in antihypertensive medication classes or doses between the patient's last clinic BP and the enrollment date, and no serious fall injury since the last BP assessment. Exclusion criteria included 1) receiving skilled nursing, long-term, or hospice care in the year prior to enrollment, 2) history of stroke in the prior 3 months, 3) history of dementia 4) cognitive impairment based on a 6-item telephone screener, 4) non-ambulatory, 5) primary spoken and written language is not English, and 6) SBP ≥180 mm Hg or DBP ≥110 mm Hg or SBP <110 mm Hg or DBP <50 mm Hg measured during the enrollment visit. Although the COVID-19 pandemic required a pause in enrollment of new participants, completion of falls calendars continued throughout the pandemic. This analysis included 250 AMBROSIA participants who completed one or more monthly falls calendars

between August 2019 and March 2021. The study was approved by the KPSC institutional review board. Each participant provided written informed consent.

Data collection

EHR data were used to identify information on each participant's age, sex, race and ethnicity, smoking status, body mass index (BMI), and the presence of chronic conditions including diabetes mellitus, arthritis, coronary heart disease (CHD), and number of antihypertensive medication classes prescribed. Chronic conditions were based on the presence of diagnosis codes in the two years preceding the study visit. During the enrollment study visit, BP was measured in a seated position after a 5-minute rest using an Omron Model HEM-907XL oscillometric device with three measures in the dominant arm followed by three measures in the non-dominant arm. SBP and DBP were calculated as the mean of all six measures. Standing SBP and DBP were measured and orthostatic hypotension was defined as a decline of ≥20 mm Hg in SBP or ≥10 mm Hg in DBP after 1 or 3 minutes of standing. Data were also collected on self-reported history of falls and life-space mobility. Life-space mobility is a measure of community mobility and social participation based on self-reported movement from the room where one sleeps to areas outside of one's town over the last 4 weeks.[11] The composite life-space mobility score takes into account how far people go, how often they go there, and how much assistance they need with higher scores indicating greater life-space. Physical performance was measured using the short physical performance battery.[12]

Fall assessment

Data on falls in the year following enrollment were collected prospectively using monthly falls calendars. Participants were provided with 13 calendars, prepaid postage envelopes, and instructions for completing and returning the falls calendars at the end of each month.

Participants were asked to report "any fall where part of your body hits a lower surface, including falls that occur on stairs" by marking each day of the calendar indicating if a fall had occurred or not. A broad definition of falls was chosen to limit variability in interpretation by participants.[13,14] This definition does not require participants to make judgements about the mechanism of the fall or if the fall was accidental. On a second page of the falls calendar, participants were asked to provide information on the fall timing, location, and if they required medical care because of the fall. Participants who did not return a fall calendar within 2 weeks after the end of a month received a telephone, email, or text reminder. We obtained 2,795 falls calendars between August 2019 and March 2021, 95.4% of the 2,929 expected calendars.

Statistical analysis

Participant characteristics were estimated as means (standard deviations [SD]) or percentages as appropriate. Fall rates (95% confidence intervals [CI]) were calculated per 100 person-months overall and for each month, separately. To provide stable estimates of monthly falls rates, we restricted our timeframe to months between August 2019 and March 2021 which included a minimum of at least 40 calendars in each month. Monthly fall rates and COVID-19 case counts in Los Angeles (LA) county, the county for which the majority of AMBROSIA participants live, were plotted for each month. To assess the impact of the COVID-19 pandemic on falls, we compared fall rates in the calendar periods during versus before the pandemic. Months prior to March 2020 were considered pre-pandemic. Poisson regression with adjustment for over-dispersion of the count data was used to estimate rate ratios (95% CI) comparing August, September, and October during versus before the pandemic, and separately, November, December, and January during versus before the pandemic. Three-month time periods were chosen to provide more stable estimates of fall

rates. Excluding March, the month in which the pandemic began, we had available data before and during the pandemic for August, September, October, November, December, and January. These months were grouped (i.e., August, September, October and November, December, January) to best correspond to the fall 2020 phased re-opening and subsequent winter 2020 surge in LA County. We conducted a sensitivity analysis assessing fall rates restricted to the 211 participants who completed all expected falls calendars. All analyses were performed using SAS 9.4 Cary, NC.

RESULTS

Participant characteristics

Participants had a mean (SD) age of 75.2 (6.1) years, 49.6% were White, and 53.2% were women (**Table 1**). Mean (SD) SBP and DBP were 133.1 (14.2) mm Hg and 69.4 (9.8) mm Hg, respectively. The majority of participants (59.2%) were taking medications from ≥2 different antihypertensive classes. A fall in the year prior to baseline was reported by 36.8% of participants.

Fall rates before and during the pandemic

Overall, 110 (44.0%) participants reported a total of 421 falls (fall rate 15.1 per 100 calendar months). Among participants who fell, the median number of falls (25^{th}, 75^{th} percentiles) was 2 (1, 3), 81% of falls occurred during the day, 72% occurred at home, and 6% of falls required medical care. Monthly fall rates (95% CI), COVID-19 case counts in LA county, and COVID-19 social distancing policy dates are displayed in **Figure 1**. During the pandemic, falls rates (95% CI) were lower in the spring of 2020 (11.1 [7.0, 16.7] per 100 calendar-months in April) and in the winter 2021 (8.6 [3.5, 17.8] per 100 calendar-months in February). The highest monthly fall rate during the pandemic was 22.9 (16.4, 31.1) per 100

calendar-months in August 2020. Higher fall rates in September 2020 and lower fall rates in February 2021, compared to other months during the pandemic, were present when the analysis was restricted to those who completed all of their falls calendars (**Supplemental Figure**). During the pandemic, fall rates in August, September, and October were higher than the previous year (rate ratio 1.8 [1.1, 2.9]) and fall rates in November, December, and January were lower than the previous year (rate ratio 0.5 [0.4, 0.8]) (**Table 2**).

DISCUSSION

Among community-dwelling older adults taking antihypertensive medication who completed prospective monthly falls calendars between August 2019 and March 2021, overall fall rates were high before and during the pandemic. However, monthly fall rates varied over time. Lower fall rates were present during months with social distancing polices (e.g., California shelter-in-place orders during April 2020 and again in December 2020). The lowest fall rates occurred in January and February of 2021 following the COVID-19 surge in December 2020. Fall rates in August, September, and October 2020 were higher than the previous year and fall rates in November and December 2020 and January 2021 were lower than the previous year. These findings suggest that within a population of older adults, fall rates may have changed in response to social distancing polices during the pandemic.

The COVID-19 pandemic resulted in major disruptions in day-to-day life. Social distancing polices were designed to reduce infection among vulnerable populations such as older adults. However, reduced community movement in older adults also had unintended consequences. For example, older adults were less likely to seek out non-emergency care, visit with family members, or maintain daily routines.[15] One study of older adults found a high prevalence of being homebound reduced both interaction with caregivers outside of ones' household and

willingness to engage in video telehealth with providers during the pandemic.[15] These unintended consequences of social distancing were most common among older adults with underlying cognitive and functional limitations and those experiencing depressive symptoms.[14] Recent studies have also shown that older adults had less physical activity, worse physical function, and restricted life-space mobility during the pandemic.[7,9,16] Older adults also experienced greater loneliness which was associated with a higher prevalence of depression and more symptoms of anxiety.[17] Taken together with the current study showing increased falls, these findings suggest that as the pandemic continues providers will need to pay attention to the physical, psychological, and social needs of older adults.

As falls are a leading cause of preventable morbidity among older adults,[18] identifying times of higher and lower risk for falls could have important clinical implications. Multicomponent interventions have been shown to be at effective addressing risk factors for falls.[19] A recent multicenter, cluster-randomized, pragmatic trial conducted in primary care practices found that providing risk assessments and individualized fall prevention plans is feasible in and associated with a lower rate of injurious falls.[20] However, this difference was not statistically significant and may have been explained in part by lower than expected rates of injurious falls. The current study suggests that temporal trends in fall rates may be seen during the pandemic. Whether or not multicomponent strategies can reduce fall injuries during high risk periods has not been previously studied. Findings from the current study may also be used to encourage providers to ask about fall risk. Older adults may not bring up falls and routine care was disrupted during the pandemic. Reports of changing rates of falls during the pandemic could be used to encourage providers to ask about falls, especially during times of greater community movement. Home exercise programs may be a strategy to help older

adults maintain physical activating during pandemics and be better prepared for increase community mobility when re-opening occurs.[18]

Findings from the current study should be considered in the context of known limitations. As the parent AMBROSIA study was focused on the comparison of clinic BP with out-of-office BP during a period of stable treatment, older adults were excluded if they had a recent change in antihypertensive medications or a possible reason for changing antihypertensive medication (i.e., very high or low BP, recent stroke, or serious fall injury). Additionally, to align the study population with the target treatment population for self-management of hypertension, AMBROSIA was restricted to community-dwelling older adults without cognitive impairment. Therefore, findings of higher rates of falls during times of greater community mobility may not be generalizable to all older adults. As AMBROSIA data collection began before the pandemic, longitudinal assessments of measures of behaviors were not planned and therefore we do not have individual level data on social distancing or community mobility. The timeframe over which falls data were available allowed for only a partial description of seasonal changes in fall rates. Some have hypothesized that cold weather and ice or reductions in vitamin D may impact fall rates; however, prior studies of seasonal trends in injurious falls have not found consistent associations between season and falls.[21,22] It is also unlikely that weather hazards played a role in changes in fall rates in Southern California which is similar to a Mediterranean climate (i.e., average low temperatures ranging 45-65 degrees Fahrenheit). Lastly, as new recruitment for AMBROSIA was paused during times of shutdowns of in-person study visits, falls data for this analysis did not cover the entirety of the pandemic including after vaccines became more widely available. Despite these limitations, the current study provided a unique opportunity to study

fall rates using monthly falls calendars, the gold-standard approach, with data covering over 2,700 person-months.

In conclusion, among older adults participating in the AMBROSIA study, fall rates were high throughout the first year of the pandemic. Fall rates were lower during time periods when community mobility was restricted and higher in times of phased reopening. As the COVID-19 pandemic continues to evolve, in the case that new variants arise, or when we face future pandemics, providers may anticipate times of higher and lower fall risk and plan for strategies to reduce fall injuries.

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Author Contributions: C.B.B. contributed to the study design and data collection on falls and developed the research question and drafted the manuscript for the current analysis. R.X.W and L.Q. conducted analyses, interpreted findings, and contributed to preparation of the manuscript. D.S., K.L.C., T.N.H, K.R. led the data collection, data access, study design, interpretation of findings and manuscript preparation. All co-authors contributed to the manuscript and approved this submission.

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Table 1. Characteristics of AMBROSIA participants who completed monthly falls calendars before and during the COVID-19 pandemic (n=250)	
Characteristics	
Age in years, mean (SD)	75.2 (6.1)
Women, n (%)	133 (53.2%)
Race/Ethnicity, n (%)	
White	124 (49.6%)
Black	49 (19.6%)
Hispanic	38 (15.2%)
Asian/Pacific Islander	35 (14.0%)
Other/Unknown	4 (1.6%)
Currently smoking, n (%)	4 (1.6%)
BMI in kg/m^2, mean (SD)	28.0 (5.2)
Systolic BP in mm Hg, mean (SD)*	133.1 (14.2)
Diastolic BP in mm Hg, mean (SD)*	69.4 (9.8)
Orthostatic hypotension, n (%)**	50 (20.0%)
Antihypertensive medication classes, n (%)	
0	13 (5.2%)
1	89 (35.6%)
2	96 (38.4%)
3 or more	52 (20.8%)
Diabetes mellitus, n (%)	71 (28.4%)
Arthritis, n (%)	130 (52.0%)
Coronary heart disease, n (%)	41 (16.4%)
Heart failure, n (%)	12 (4.8%)
Depression, n (%)	40 (16.0%)
Self-reported falls in the year prior to baseline, n (%)	
0	154 (61.6%)
1	50 (20.0%)
2 or more	42 (16.8%)
Short physical performance battery (SPPB)	
Balance, (range 0-4), mean (SD)	3.7 (0.7)
Chair stands, (range 0-4), mean (SD)	2.2 (1.2)
Gait speed, (range 0-4), mean (SD)	3.6 (0.7)
Total score (range 0-12), mean (SD)	9.5 (1.9)
Life-space mobility, composite score (range 0-120), mean (SD)	88.2 (23.2)

SD = standard deviation, BMI = body mass index, BP = blood pressure,
*Average of six seated BP measurements, 3 on each arm
**Defined as a decline of ≥20 mm Hg in SBP or ≥10 mm Hg in DBP after 1 or 3 minutes of standing

Table 2. Fall rates before and during the COVID-19 pandemic for two separate calendar periods.*										
	Before the pandemic (2019-2020)				During the pandemic (2020-2021)				During vs. Before	
Calendar period	**N**	**Falls**	**Person months**	**Fall rate (95% CI) per 100 person-months**	**N**	**Falls**	**Person months**	**Fall rate (95% CI) per 100 person-months**	**Rate Ratio (95% CI)**	**p-value**
Aug, Sept, Oct	76	18	168	10.7 (6.4, 16.9)	187	97	502	19.3 (15.7, 23.6)	1.8 (1.1, 2.9)	0.02
Nov, Dec, Jan	160	81	407	19.9 (15.8, 24.7)	166	41	380	10.8 (7.7, 14.6)	0.5 (0.4, 0.8)	<0.001

*Three-month time periods were chosen to provide a larger sample of participants and a more stable estimate of fall rates to compare during versus before the pandemic. Excluding March, the month in which the pandemic began, August, September, October, November, December and January were the only months for which we had available data before and during the pandemic. These months were grouped to best correspond to the fall 2020 phased re-opening and subsequent winter 2020 surge.

LEGENDS

Figure 1. Monthly fall rates (95% confidence intervals) per 100 calendar months (solid line and right axis) among AMBROSIA participants and daily COVID-19 cases in Los Angeles County (histogram and left axis) from August 2019 through March 2021.