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A Major Public Health Issue: The High Incidence of Falls During Pregnancy

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Abstract The objectives of this population based cohort study of 3997 women was to determine the incidence of falling and risk factors related to falls during pregnancy. Birth certificate data identified women who had delivered a child within the previous 2 months. Subjects were reached either by phone, internet or mailed surveys. The women were asked about health issues and activities at the time of the fall. Of the 3997 participants, 1070 reported falling at least once (27%) during their pregnancy. Of those 1070 35% fell two or more times, 20% sought medical care and 21% had two or more days of restricted activity. Women aged 20–24 years had an almost two fold risk of falling more than those over 35 years (odds ratio 1.9; 95% confidence interval 1.4, 2.7). Characteristics of falls included: indoors (56%), on stairs (39%) and falling from a height greater than three feet (9%) (not mutually exclusive). Though 27% of women fell while pregnant, 10% experienced two or more falls. Pregnant women should be aware of the risk factors of and situations related to falls. There is an urgent need for primary prevention in this high risk group.

Keywords Fall · Injury · Pregnancy · Intervention

Introduction

Falls are the most common cause of minor injury during pregnancy and are estimated to cause 17–39% of trauma associated with emergency department visits and hospital admissions, second only to motor vehicle crashes [1–11]. Falls during pregnancy may result in injury to the mother including fractures, sprains/strains, head injury, rupture of internal organs, abruptio placentae, rupture of the uterus and membranes, and occasionally maternal or fetal death [3, 10, 12–14]. The overall rate, risk factors, and characteristics of falls during pregnancy in the general population are unknown, however, making prevention difficult. To address these gaps, a population based cohort study of new mothers who had recently given birth was undertaken.

Methods

Study Population and Recruitment of Subjects

Women were considered eligible if they had delivered within 8 weeks at one of six hospitals located in the Greater Cincinnati area, were residents of the tristate area (Ohio, Kentucky or Indiana) and were at least 20 years old. Public record birth certificate data from December 1999 through July 2000 identified 6217 eligible women who were mailed a letter describing the study and asking them to complete a telephone or internet survey. Names and addresses were matched to telephone numbers for 2810 (45.2%) women. Telephone interviewing began five days after initial letters were sent and at least eight attempts on

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different days and times were made to contact subjects. Women who completed the 15 min phone or internet survey received five dollars. Those not responding by phone were then sent another letter and a four page mail survey including a two dollar bill. After this mailing, in 2 week intervals, a reminder postcard was sent followed by a letter including another mail survey. This study was approved by the University of Cincinnati Institutional Review Board and informed consent was obtained from all participants. Informed consent procedures for phone were verbal and for mail were written. For internet participants, the first screen explained the study and to consent they inserted a confidential unique identifier that had been supplied in a letter.

Definitions of Falls

To determine if a fall had occurred during pregnancy, subjects were asked: "During this last pregnancy, did you experience any loss of balance, resulting in a fall where some part of your body—other than your feet—touched the ground?"

For participants with multiple falls, the most severe fall was analyzed defined by requiring medical attention or resulting in injury or restricted activity. For participants with multiple falls without medical attention, injury, or restricted activity, the fall that occurred later in gestations was chosen.

Telephone, Internet and Mailed Surveys

A fall and injury survey was developed with questions selected from other instruments [15–17] and received outside review from recognized injury experts. All instruments were pilot tested and silent monitoring was performed on 20% of phone interviewing conducted by experienced trained interviewers. The phone and internet surveys were identical. In order to maximize participation, the mail survey was limited to four pages and, therefore, included a subset of questions from the phone and internet questionnaire.

All surveys (phone, internet and mail) asked about demographics and social factors (often referred to as predisposing factors) including maternal age, race, presence of a permanent partner, problem with balance or vision prior to pregnancy, diagnosis of diabetes (mellitus and gestational), and employment status during pregnancy. Additional predisposing factors collected only from *phone and internet surveys* included maternal height, weight gain during pregnancy, number of toddlers age three and under cared for during pregnancy, exercise patterns prior to pregnancy, number of previous live births, desire to become pregnant, and the baby's weight and gestational age at delivery.

For those women reporting a fall during pregnancy, *all surveys (phone, internet and mail)* asked questions to estimate severity based on medical attention, injury and restricted activity. Medical attention included: none, doctor visit, emergency room visit or hospital admission. Injuries due to the fall included none, bruise, cut, turned ankle, sprain/strain, broken bone or other. Restricted activity (in days) included: 0, 1, 2–5, 6–10, >10.

In order to address fall prevention, detailed information regarding falls was collected (often referred to as situational factors). *All surveys (phone, internet and mail) asked about* month of gestation at the time of the fall, location, and whether the fall was associated with a slippery floor, uneven or sloped ground, bathtub/shower, stairs or a cluttered or poorly lit area. Type of shoe worn at the time of the fall was ascertained including heel height and if the shoes were slick, worn, loose, or backless. *Phone and internet surveys* asked about additional situational factors including: obstructed view, carrying an object or child, hurrying, falling >3 feet or pushed/struck (by accident or on purpose). In addition, during the *phone/internet survey,* the subject was also asked if she had experienced illness (including hypoglycemia, dizzy, and extreme vomiting or diarrhea) the day prior to the fall.

Assessment of Reliability, Validity and Participation Bias

Approximately 4 weeks after completion of the initial survey, a test–retest reliability study was undertaken on a 10% random sample of participants. Respondents were asked questions related to the occurrence and location of falls during their pregnancy. Validation of injury needing medical attention was attempted by requesting authorization to review medical records regarding the fall. Finally, in order to assess non-participation bias, women who did not participate in the phone, internet or mail survey were sent a self addressed stamped double serrated postcard asking if they had fallen during their pregnancy. In addition, birth certificate data was used to compare age (as a continuous variable) and birth hospital (public or private) between participants and non-participants.

Missing Data

The percents of missing data for each independent variable were less than five percent and evenly distributed across methods, except for race, which was missing in 4.0%, 2.0%, and 6.7% of the telephone, internet, and mail datasets, respectively. Imputation of missing data was done prior to regression analyses by supplying the mean or mode value for continuous or dichotomous factors, respectively. Missing values for race were replaced by a predicted value

that was most probable by using the SPLUS function TRANSCAN [18].

Data Management and Analysis

Telephone and internet data were entered directly into computer files. Mail survey data were computer entered using 100% keystroke double entry with 10% comparison against hardcopy. Responses were standardized and coded and a system of checks and compare programs were applied as quality control measures.

Descriptive statistics examined the distribution of each variable. Univariate analyses using chi square, unadjusted odds ratios, and 95% confidence intervals determined variables marginally associated with a fall. Logistic regression was conducted using the phone and internet participants because they provided more information compared to the mail survey. Model building proceeded by first entering variables at least marginally associated ($P < 0.25$) with the outcome; those significant at $P < 0.05$ were retained for the final model. Assumption of linearity was assessed and evidence of confounding and effect modification were examined by association between dependent and independent variables through stratified and logistic regression analyses. All statistical analyses were performed using SAS (Cary, North Carolina), version 8.1 and SPLUS 2000.

Results

Study Sample

Of the 6217 eligible women, 3997 (64.3%) participated (resulting in 1639 phone, 506 Internet, and 1852 mail completions), 144 (2.3%) refused, 151 (2.4%) had no viable address or phone number, and 1925 (31.0%) did not respond. The 2220 non participants were characterized by birth certificate data analysis as being younger ($P < .0001$) and more likely to have given birth at a public hospital ($P < .0001$) compared to the 3997 participants. The average age of the participants was 29.9 years; 83.4% were Caucasian and 51.8% had graduated from college. Over 70% had been employed during their pregnancy. Table 1 shows participant characteristics by whether they fell during pregnancy.

Falls During Pregnancy by Survey Method

Of the 3997 participants, 26.8% ($n = 1070$) reported falling during pregnancy. The fall rate for those responding by telephone (23.6%) were significantly lower ($P < .01$) from those responding by internet and mail surveys with fall rates of 28.9% and 29.0%, respectively. There were 380 women who did not participate in the phone, internet or mail survey but replied to the non-participant postcard asking if they had fallen during their pregnancy. These "non-participants" reported the highest incidence of falling during pregnancy at 30.8% which suggests that falls were not over reported by the survey participants.

Table 1 Characteristics of women by whether they fell during pregnancy ($n = 3997$)

	Fall	
	Yes	No
Mean age**	29.4 (5.3)	30.1 (5.1)
Race**		
Caucasian	842 (78.7)	2493 (85.2)
African American	88 (8.2)	264 (9.0)
Other	26 (2.4)	154 (5.3)
Refuse/missing	114 (10.7)	16 (0.5)
Education**		
≤12 years	354 (33.1)	658 (22.5)
>12 years	715 (66.8)	2265 (77.4)
Refuse/missing	1 (0.09)	4 (0.1)
Employed during pregnancy	757 (70.7)	2090 (71.4)
Permanent partner**	910 (85.0)	2757 (94.2)
Balance or vision problem before pregnancy	41 (3.8)	126 (4.3)
Diabetes mellitus	15 (1.4)	63 (2.2)
Gestational diabetes	92 (8.6)	215 (7.3)
Survey method*		
Phone	387 (36.2)	1252 (42.8)
Internet	146 (13.6)	359 (12.3)
Mail	537 (50.2)	1315 (44.9)

Data are presented as n (%) or mean ± standard deviation. Statistically significant differences between fall (yes, no): * $P < .05$, ** $P < .01$

Timing and Factors Associated with Falls

As shown in Fig. 1, almost two-thirds (61.3%) fell during gestational months six through eight with month seven being the worst. Of the 1070 women who fell, over a third (35.3%) reported falling two or more times during the pregnancy.

Table 2 shows the injury, medical attention and situational factors related to falls. Of those who fell, 630 (58.9%) reported an injury, 210 (19.6%) received medical attention and one in five experienced restricted activity for two or more days. In addition, 16 (1.5%) reported premature labor or delivery due to fall.

The two factors accounting for 72.5% of the falls were stairs and slippery surfaces. Of those falling on stairs over half reported not using available handrails and of the 720

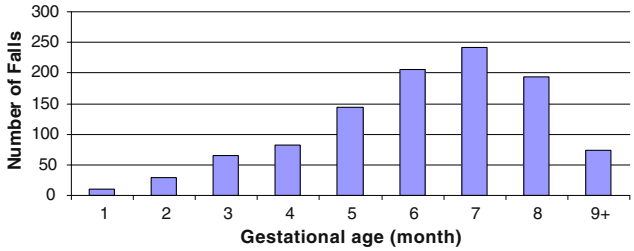

Fig. 1 Falls by gestational age. Each subject is represented once; if a woman reported they fell >1 time during pregnancy, their "most serious fall" was used ($n = 1046$ due to 24 were unable to remember the gestational month of fall)

women wearing shoes when falling, 31.0% reported their shoes were loose, backless, or slick and/or their shoes had a heel height of least one inch or higher (15%) (data not shown). The women at highest risk for fall were those <24 years old (Table 3); these younger women experienced an almost two fold higher risk of falling compared to women >34 years old (odds ratio of 1.9; 95% confidence interval of 1.4, 2.7).

Reliability and Validity

A test retest reliability assessment for fall and fall with any injury was completed on a 10% sample of the participants (415/3997). Kappa values were excellent for fall ($k = .85$) and good for any injury ($k = .58$), with percent agreement of 92.8% and 84.6%, respectively. Of the 210 women who reported obtaining medical attention due to a fall, only 14.3% ($n = 30$) provided written authorization to review their medical record and all were validated.

Discussion

Even though physicians presumably advise women on inevitable instability during pregnancy due to changes in center of gravity and loosening of joints, one in four fall, and one in ten fall two or more times over just a 9 month gestation. Further, these falls caused 10.0% to seek obtain medical attention which further increases obstetrical costs. These are astounding numbers as this public health problem is completely preventable. Most falls were associated with slippery floors, wearing inappropriate shoes and using insufficient safety measures such as holding on to stair hand rails. Further, carrying additional loads was a factor in 28.7% of falls as pregnancy in itself already compromises vision of the feet and floors. The fact that most of these falls occurred during the last trimester supports this concern. Two recent longitudinal studies showed increases in postural sway during second and third trimesters, indicating additional instability [19, 20].

Table 2 Characteristics of falls including number, injury, medical attention and situational factors

Number of falls ($n = 1070$)	
1	692 (64.7)
2	242 (22.6)
≥3	136 (12.7)
Injury ($n = 630$)	
Bruise	229 (36.3)
Cut	114 (18.1)
Turned ankle	72 (11.4)
Sprain/strain	157 (24.9)
Broken bone	23 (3.7)
Other	35 (5.6)
Medical attention obtained ($n = 210$)	
Visit to physician office	113 (53.8)
Emergency room visit	74 (35.2)
Hospital admission	23 (11.0)
Restricted activity ($n = 227$)	
2–5 days	138 (60.8)
6–10 days	43 (18.9)
>10 days	46 (20.3)
Situational factors ($n = 1070$ or 533*)	
Indoors	595 (55.6)
Stairs	419 (39.2)
Slippery floor	357 (33.4)
Snow	157 (14.7)
Water	153 (14.3)
Uneven/sloped ground	272 (25.4)
Poor lighting	182 (17.1)
Cluttered area	75 (7.0)
Bathtub/shower	47 (4.4)
Pushed/struck by accident	43 (4.0)
Pushed/struck on purpose	8 (0.7)
Hurrying*	161 (30.2)
Carrying object or child*	153 (28.7)
Obstructed view*	57 (10.7)
Getting up/down*	33 (6.2)
Fell > 3 feet*	50 (9.4)
Feeling ill day of fall*	93 (17.4)

Data presented as n (%). * These questions were in the phone and internet surveys only, therefore, the denominator is 533

These findings regarding falls agree with previous research showing younger women are at higher risk for injury due to trauma during pregnancy [1, 21–23]. Younger women may be more likely to be active than those over 35 years, which would contribute to the higher incidence of falls.

Our data show that fall rates for pregnant women are similar to those of elderly persons living in the community, estimated at 25% for those 70 years of age and 35% for those over 75 [24]. Fracture rates of 5% among those who

Table 3 Logistical regression for fall for phone and internet participants ($n = 2145$)

	Fall during pregnancy Number (%)	Adjusted odds ratio (95% confidence interval)
Age in years (number)		
20–24 (261)	92 (35.3)	1.9 (1.4, 2.7)
25–29 (578)	146 (25.3)	1.2 (0.9, 1.6)
30–34 (832)	187 (22.5)	1.0 (0.8, 1.3)
>35 (474)	108 (22.8)	1.0 (reference)
Race		
African American (155)	43 (27.7)	1.0 (0.7, 1.5)
Other (66)	7 (10.6)	0.3 (0.2, 0.8)
Caucasian (1924)	483 (25.1)	1.0 (reference)
Diabetes		
Mellitus (17)	4 (23.5)	1.1 (0.4, 3.4)
Gestational (128)	41 (32.0)	1.5 (1.0*, 2.3)
Neither (2000)	488 (24.4)	1.0 (reference)
Survey method		
Phone (1639)	387 (23.6)	1.0 (reference)
Internet (506)	146 (28.9)	1.4 (1.1, 1.7)
Number of toddlers cared for during pregnancy		
>1 (223)	64 (28.7)	1.4 (1.0, 1.9)
1 (875)	229 (26.2)	1.2 (1.0, 1.5)
0 (1044)	240 (23.0)	1.0 (reference)

Initial model consisted of unadjusted factors with $P < 0.25$ among phone and internet participants including: maternal age, race, number of toddlers cared for during pregnancy, diabetes, survey method, and employment during pregnancy (unemployed, employed full time, employed part time)

fell also are similar in our sample compared to the elderly [25]. This comparison is important as seldom is it recognized that pregnant women should receive the same cautionary warnings e.g. wearing flat rubber soled shoes that the elderly receive.

Rates of reported emergency department visits due to a fall in our participants aged 20–24 years were 4826 per 100,000 compared with 2337 per 100,000 for age matched women [26]. Hospital admission rates due to a fall are 9–28 times larger (depending on age) during pregnancy compared to all women aged 20–39 in the same county [26]. This observed difference may be due to a higher rate of serious falls in pregnant women or a tendency to admit them in order to evaluate fetal status; nonetheless, these events increase medical care costs.

Falls due to reported physical violence were minimal; of the 1070 women who fell, only eight (0.7%) women reported their fall was associated with being "purposefully pushed or struck". Prevalence of violence during pregnancy has been shown to range from 0.9 to 20% [27]. The survey used in this study only asked about violence associated with the fall, therefore cannot be compared to direct rates of overall violence during pregnancy. There are no studies that have investigated falls due to violence during pregnancy. One explanation for this lower reporting of violence may be that women who were physically assaulted were more likely to be non respondents or did not report the violence.

Although obvious strengths of this study include the population based study design and relatively large sample size, there are limitations such as possible recall or participation bias. To minimize recall bias, women were contacted within 8 weeks of giving birth. We believe participation bias is also minimal because the fall rate among women who did not complete the full survey but did complete the non participant postcard survey was 30.8% vs. 26.8% among participants. Further, fall rates did not decrease from the early responders (phone and internet) to the later responders (first and second mailing). Because subjects were identified through birth certificates, falls resulting in fatalities to mother or child, estimated at 0.1 per 100,000 live births [22] are not available but are rare events. Authorization to review medical records for validation of medical attention was limited, but this has been shown to occur even in long term prospective studies due to privacy concerns [28]. Finally, it is possible that medical attention sought due to a fall was dependent on insurance but this information was not collected.

In conclusion, the public health importance of loss of balance and falls during pregnancy is obvious as one in four women fell during pregnancy. This study should be used as a basis for developing in-depth intervention for pregnancy regarding risk factors for falls and good fall prevention strategies. Based on this study, specific tips that may help decrease falls during pregnancy include: avoid slippery floors; when walking on stairs, hold on to the rail

and do not carry items or children; wear shoes that are flat, rubber soled and not loose; try not to hurry; be careful when carrying children, walking on unlevel surfaces (e.g. grass) or when performing any activity that obstructs your view. A pamphlet in the physician waiting area with fall prevention tips may be beneficial. Physicians may want to target higher risk women including those <30 years old and women with gestational diabetes.

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