Pregnancy as a Risk Factor for Ambulatory Limitation in Later Life: Evidence from the Hispanic Established Population for Epidemiologic Studies of the Elderly

Abstract

Objectives: We investigate the relationship between gravidity (the number of times a woman has been pregnant) and walking difficulty in later life.

Methods: Data come from the Hispanic-EPESE, a representative population-based cohort of Mexican-Americans age 65+, residing in five southwestern states. Walking difficulty was measured using two items from the performance-oriented mobility assessments (POMAs): the timed walk and seated chair-rise.

Results: 44.9% and 27% of women in the study were unable to perform or performed poorly in the seated chair-rise and timed walk respectively. Significantly higher rates of ambulatory limitation were observed among women with 6 or more pregnancies than among women with 4 or fewer pregnancies. Ordinal logistic regression models show that gravidity predicts level of performance in both mobility tasks, and that higher gravidity is associated with worse performance, even after adjustment for both age and chronic disease.

Conclusions: Extending previous work linking high fertility with poor health outcomes, we present new evidence that gravidity is a risk factor for ambulatory limitation in old age. Our findings support a life-course approach to reproduction in public health research and practice.

Introduction

In the United States today, approximately 1 in 4 adults aged 65 and older experience ambulatory limitation (1). From the age of 45 onwards, the prevalence of walking difficulty rises rapidly (2), and is accompanied by an increased risk of falls. The consequences of such falls can be costly to both physical and mental health, often resulting in further declines in independent mobility (3), (4). Public health interventions designed to reduce walking difficulty in later life typically involve a rehabilitative approach, seeking improvement in ability through conventional athletic enhancement (5). Yet these therapeutic methods, despite benefitting overall health, demonstrate limited progress in individual functional capacity (6), (7), (8). Prevention of walking difficulty in older age, and prolongation of functional independence, are therefore key concerns for public health researchers, practitioners and advocates.

Across global populations as diverse as Japan, Sweden, and Nigeria, the prevalence of walking difficulty is higher among older women than older men (9), (10), (11). Indeed, this phenomenon has consistently been found in studies worldwide. In a recent U.S. population-health survey, women of age 65 and older were almost 20% more likely than men to experience walking difficulty (2), a fact that is reflected in their rates of fractures and joint problems (12).

Explanation of the high prevalence of walking difficulty in women has so far focused on variation by gender in the prevalence of chronic diseases that accompany aging (13), (14).

In this study, we hypothesize that such risk factors, although important, cannot explain all of the observed variation in walking difficulty among women, nor can they fully explain why such limitation is more prevalent among women than men. In light of the well-known association between high fertility and poor health status (15), we examine gravidity (the number of times a woman has been pregnant) as a gender-specific risk factor for walking difficulty.

The Hispanic Established Populations for Epidemiologic Studies of the Elderly (H-EPESE) cohort represents a prime opportunity to formally test gravidity as a risk factor. The cohort consists of Mexican-American men and women, aged 65 years and older at baseline, for which measures of activity limitation, family size, pregnancy history, and various chronic diseases were ascertained. High fertility is a feature of the H-EPESE cohort, affording us a greater range over which to test our hypothesis. Using a panel of established risk factors, we evaluate the contribution of high gravidity to walking difficulty among elderly women.

Methods

The H-EPESE is a 15-year panel study of older Mexican-Americans residing in one of 5 Southwestern states (Arizona, California, Colorado, New Mexico, and Texas), who were first interviewed in 1993-94. The sample and detailed characteristics of the H-EPESEs have been described elsewhere (16). Our cross-sectional analytic sample consists of 1,408 men (n = 541) and women (n = 867) who were interviewed at Wave IV (2000-01), about their socio-demographic characteristics, performance-based mobility, physical health, including the

presence of specific chronic diseases. Tests of walking ability, namely the seated chair-rise and timed walk, were also performed. At Wave II (1995-96), the female respondents in our sample were also interviewed retrospectively about their reproductive and maternity history.

The outcomes of interest—performance in the seated chair-rise and timed walk—are elements of the standard clinical "performance-oriented mobility assessments" (POMAs) (17), which together test the essential elements of walking ability. The seated chair-rise involves rising from the seated position, and measures balance and lower body strength, both of which strongly predict walking ability. The timed walk involves walking 10 feet, and assesses gait. Participants were asked to perform the tests, and interviewers trained by physicians were asked to assess performance as "Best," "Good," "Moderate," "Poor," or "Unable to do," according to time taken. The use of these objective measures helps us to avoid the potential methodological biases of self-reported assessments of mobility (18), (19).

The key independent variable under study, gravidity, was measured by asking female participants to state the number of times they had been pregnant (range 0-27). In our dataset, we winsorize the sole observation of 27 to 20. Winsorising is a statistical transformation technique used to limit extreme values, thus tempering the effect of outliers. Gravidity is a continuous variable in our regression models, however, we partitioned it into lower, middle, and upper terciles, to examine the association of each with performance in the seated chair-rise and timed-walk, before regression analyses were conducted. Both female and male participants were also asked to state the number of living children they had (range 0-18).

In our analyses we control for a key set of variables that are known to increase the risk of walking difficulty. Established risk factors include age, hysterectomy, chronic diseases known to affect walking ability (20), and incontinence, which has been strongly associated with functional limitation (21), (22). Participants were asked to state their age, and whether they had ever received a medical diagnosis of diabetes, arthritis, stroke, osteoporosis or cardiac failure. In our analyses, age is standardized, and positive diagnoses of diabetes, arthritis, stroke, osteoporosis and cardiac failure are included as dummy variables. We accounted for a history of hysterectomy, coded as a dummy variable, because it is a major surgical procedure carrying a risk of urinary incontinence (23).

We also control for self-reported incontinence, which is based on a 5-item ordinal scale: "4: All of the time," "3: Most of the time," "2: Some of the time," "1: Hardly ever," and "0: Never". We constructed four dummy variables D1-D4 to represent these categories of severity. Dummy variable Dj was coded 1 if the participant selected category j, or any more severe category. In this way the coefficient associated with each dummy represents the marginal effect on the dependent variable of a participant's falling into category j, compared to category j-1. For example, a participant who chose "4: All of the time" would be coded as 1 for all four dummy variables.

Previous research has shown that socioeconomic variables predict health outcomes (24), yet H-EPESE cohort is relatively homogeneous with respect to such factors, with nearly all members having low income, and the vast majority lacking private health insurance. To avoid consequent standard error inflation, these variables are not included in the model.

Educational attainment is associated with both gravidity and mobility limitation (25), (26), and our model includes a dummy variable representing those respondents with greater than a high school education.

A key difference among cohort members is nativity status, in that some are first-generation immigrants born in Mexico, while others were born in the United States. Several demographic factors associated with nativity may affect walking ability (27), and any differences in fertility trends and early life-experiences between Mexican immigrants and US-born Mexican Americans must also be taken into account (28), (29). For this reason, we use birthplace information to create a dummy variable representing those respondents born in the U.S. rather than in Mexico.

Using ordinal logistic regression models**,** we estimate variation in both seated chair-rise and timed walk performance by number of pregnancies (for females only), controlling for other contributing factors. Because pregnancy is a gender-specific factor, we also perform a control analysis substituting number of children as the key independent variable. Friedlander and colleagues (1996) found that lifetime reproductive intensity lessened the survivorship of women, while having no effect on men (30). To test the impact of lifetime reproductive intensity (i.e. the number of offspring one has), we perform ordinal logistic regression models separately for men and women using number of children as a predictor of performance in the timed walk and seated chair-rise.

All regression coefficients are denoted as changes in log-odds, and all statistical analyses were performed using the R statistical software package.

Results

<<Insert Table 1>>

The demographic, reproductive, and chronic disease characteristics of the H-EPESE sample are shown in Table 1. Consistent with known gender-differences in chronic disease rates, and with current trends in Hispanic health data, women in the sample had significantly higher rates than men of diabetes (28.7% versus 22.9%), arthritis (59.9% versus 45.8%), and osteoporosis (14.4% versus 1.9%). There were no statistically significant differences between men and women in the rates of stroke, urinary incontinence, and cardiac failure.

Our sample reflects the well-established fact that aging women are more likely than aging men to have difficulty walking. Women were significantly more likely than men to be unable to perform the timed walk (18.0% versus 12.0%) or the seated chair-rise (22.3% versus 17.0%). Among those able to perform these tasks, women were significantly more likely to be poor performers of the seated chair-rise (22.6 % versus 17.0 %).

Mean gravidity in our sample was 5.9 pregnancies per woman. Upon analyzing performance in both the seated chair-rise and timed walk within each tercile of gravidity (0-4, 5-7, 8+), we find that the women in our sample are non-randomly distributed between performance categories according to each tercile (Pearson's Chi-squared test = 19.42, p = .013). Moving

from the lowest to the highest tercile, women are more likely to have worse performance in the seated chair-rise and timed walk. A much higher percentage of women in the highest tercile are in the "poor" or "unable to do" categories compared to the middle and lowest terciles, and a lower percentage are in the "best" or "good" categories (models not shown).

<<Insert Table 2 >>

Table 2 shows the control analyses comparing performance in the seated chair-rise and timed walk by number of children, for women and men separately. These models clearly show that a higher number of children predicts worse performance in both the seated chair-rise and timed walk for women, but not for men. For women, each additional child increased the log odds of poor performance in both the chair rise and the timed walk by 5%. Ancillary analyses (models not shown) reveal that women who were never pregnant or had no children appeared to be protected from poor performance in the seated chair rise (41%) and the timed walk (22%).

<<Insert Tables 3 & 4>>

Tables 3 and 4 show the formal testing of the association between gravidity and ambulatory limitation. Using five models, we allow the sensitivity of the relationship between number of pregnancies and performance in the seated chair-rise (Table 2) and timed walk (Table 3) to be tested against a successively increasing panel of control variables.

Model 1, a simple regression model, shows that a higher number of pregnancies predicts a worse outcome in both the seated chair-rise and the timed walk. Model 2 accounts

for the marginal impacts of incontinence severity. In all studies of ambulatory limitation, incontinence is the strongest predictor of chair rise and timed walk performance. The "always incontinent" and "always, most, or sometimes incontinent" categories are both significantly associated with a poor performance. In Model 2, number of pregnancies remains a significant predictor of poor performance in the seated chair-rise and the timed walk.

History of hysterectomy is added to Model 3, controlling for the potential adverse effects of this common gynecological procedure. We find that the negative effect of a high number of pregnancies remains unchanged for the timed walk and seated chair-rise. Interestingly, hysterectomy is significantly associated with better performance in the seated chair-rise, although we did not observe an effect for the timed walk.

Model 4 adjusts for the influence of age, nativity, and education on the association between number of pregnancies and performance in the timed walk and seated chair-rise. Results show that adding these variables does not change the relationship between number of pregnancies and performance in either task. In this model, incontinence remains a significant predictor of poor performance, while hysterectomy continues to predict better performance. We elected to use nativity to test potential differences between U.S.-born and foreign-born Mexican -American women. Interestingly, there was no effect of nativity on poor performance, once other factors were taken into account.

The final model, Model 5, accounts for the contributions of five major chronic diseases associated with walking difficulty: diabetes, stroke, arthritis, osteoporosis, and cardiac failure. Number of pregnancies continues to predict poor performance in both the seated chair-rise and timed walk. For every additional pregnancy, the odds of having a worse

performance in the seated chair-rise increase by 4% ($p < .01$) and the odds of having a worse performance in the timed walk increase by 3% ($p < .05$). The association between number of pregnancies and poor ambulatory performance remains statistically significant after adjustment for proximal risk factors such as advanced age, incontinence, and chronic diseases such as diabetes or cardiac failure.

In summary, we find that high gravidity is associated with worse performance in both the timed walk and seated chair- rise, and that this relationship is robust, retaining the direction, magnitude, and statistical significance of its effect across all five models. Both predictor variables, number of children and number of pregnancies, showed the same association for women, indicating that they can be used interchangeably in this analysis.

Discussion

In this study, we focus on Mexican-Americans, the largest Hispanic ethnic group in the US, with a life expectancy advantage at birth of 2.5 years over the non-Hispanic white population, and 7.7 years over the non-Hispanic black population (31). A complex interaction of socioeconomic and biological risk factors puts Mexican-Americans at high risk of experiencing walking difficulty in later life. Vulnerability to diabetes, osteoporosis, and obesity play an important role (we conducted a latent analysis that included BMI in the model as a measure of obesity, and found that it did not alter the magnitude or significance of the correlation between pregnancy and performance in either task). Our results suggest that the high gravidity experienced by Mexican-American females during the reproductive years is also a contributing factor to walking difficulty in later life.

Measurement of the impact of early/middle-life events on late-life health has long been a key concept in population health research—the consistent link between low educational attainment and earlier age of onset of Alzheimer's disease (32)**,** and the accelerated osteoporosis experienced by children who survived the Dutch Famine of 1944 (33). In recent years, life-course women's health research has slowly begun to shift its focus from the proximal to the more distal health consequences of child-bearing, moving from the short-term effects on health and socioeconomic status, to the long-term physical and mental effects of early and high parity (34). Several studies have found that high parity increases the risk of mortality (35), (36), and a few have also linked high parity to poor self-reported physical health and increased self-reported activity limitation in older age (37), (38). The notable strength of our investigation is that the timed walk and seated chair-rise are objective measures of ambulatory limitation. This provides an advantage over subjective measures of limitation, where potential methodological bias may arise due to more frequent self-reporting of such limitation among women (39), (40).

Because it occurs early in the life-course compared to the time at which walking difficulty becomes prevalent, reproductive history is a factor rarely considered by gerontologists and public health experts studying ambulatory limitation. Yet it has consequences for both research and practice. Our study suggests that public health and aging practitioners should consider including gravidity in epidemiological models of ambulatory limitation. Additionally, management of high gravidity as a risk factor is also a possibility, both proximally, in terms of contraception, and further downstream, after pregnancies have already occurred. For example, policies designed to increase access to effective, affordable methods of contraception for Hispanic women of all income levels and immigration statuses (a particular problem in states such as Texas at present), may have the potential to delay

ambulatory limitation in old age. Additionally, women over a certain age who have had a certain number of pregnancies might be advised about pelvic floor exercises, or other lower-body muscle strengthening regimens to lower the risk of ambulatory limitation in later life.

Despite the advantages offered by our dataset, there are several limitations. Data on number of pregnancies, number of children, and diagnosis of chronic conditions rely on self-reporting, and the cross-sectional nature of the analyses means that we can provide only a snap-shot of walking ability and chronic disease status, and that we must treat consecutive pregnancies as if they happened simultaneously. These issues merit further attention and should be addressed where possible in future studies. Although some attrition occurred over time in the H-EPESE cohort, ancillary analyses comparing the characteristics of those who exited the cohort between baseline and Wave IV with those who remained reveal no concerning bias.

Perhaps the most important limitation is the lack of ability in this cohort to explore the association between high gravidity and ambulatory limitation in its environmental context. Environmental factors and contextual influences affect our full understanding of functional limitation, and of the disablement process generally, (41), (42), and future studies should aim to include such analysis. Additionally, the women in our sample were all Mexican-American, and some experienced a very high number of pregnancies. Proportionally more women experienced walking limitation at the middle and highest terciles than at the lowest tercile of gravidity, but because not all populations experience such fertility variation, these results merit further investigation in other cohorts, before wider generalizations can be made.

Distinguishing between number of pregnancies and number of children is an important conceptual piece of our analysis. Gravidity has the advantage of being precisely measured in the cohort, whereas measurement of parity relies on number of children. We also suspect that a high number of pregnancies may have a related, but distinct, role to that of parity in ambulatory limitation. By comparing the results of gender-specific models, our analysis suggests that there is a biological mechanism underlying the relationship between gravidity and walking difficulty. While the nature of this mechanism cannot be determined from our study, the well-recognized effects of pregnancy on the female anatomy offer some insight. Incomplete uterine involution following each pregnancy may lead to an enlarged, bulky uterus that persists over the rest of the life-course. As our results suggest, the association between hysterectomy and better and performance in the seated-chair rise lends initial support to this observation. Additionally, cumulative stress to the pelvic floor musculature occurring over multiple pregnancies often leads to damage of the vulnerable pelvic neural plexus during the childbearing years. This damage may then be unmasked by subsequent age-related declines in pelvic neural integrity, eventually leading to the emergence of walking difficulty.

Pregnancy, however, is not the only process causing cumulative pelvic floor injury. While its effect is large, there are other activities associated with pelvic floor trauma that could create a similar risk profile for men. For example, there is a newly emerging medical literature on repeated pelvic floor trauma among bicycle racers (43). To detect other sources of cumulative pelvic floor stress, new data collection efforts should consider improved measurement of occupation and recreational activities in addition to obstetrical details.

Our study provides initial evidence that gravidity influences walking difficulty among older females. A higher number of pregnancies predicts a greater likelihood of walking difficulty, even when other well-established risk factors are taken into account. This finding contributes to our understanding of the consequences of high fertility for women, and the life-course risk factors associated with ambulatory limitation. In light of emerging global trends in aging, a framework for the prevention of ambulatory limitation that includes consideration of reproductive health policy deserves serious attention.

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TABLE 1—Sample Characteristics by Sex, 2000-01

	Males (n=541)	Females (n=867)
Demographics and Socioeconomic Status		
Age (mean)	78.9	79.4
Nativity (% foreign born)	45.5	39.6
Education (% high school or less)	89.3	90.9
Chronic Conditions and Disability (in percentages)		
Diabetes	22.9	28.7*
Stroke	4.6	3.5
Arthritis	45.8	59.9***
Incontinence "All of the time"	3.0	3.9
Incontinence "All" "Most' or "Some" of the time	19.0	22.8
Osteoporosis	1.9	14.4***
Cardiac failure	19.9	19.7
Reproductive History (in percentages)		
Gravidity by tercile[a]		
0-4	--	42.6
5-7		24.8
8-20		32.6
Number of Children by tercile[a]		
0-3	--	43.0
4-5		24.3
6-18		32.4
Hysterectomy[a]	--	30.3
Physical Function (in percentages)		
Best Performance in the Seated Chair-rise	30.3	21.3***
Poor Performance in the Seated Chair-rise	17.2	22.6*
Unable to Perform the Seated Chair-rise	17.0	22.3*
Best Performance in the Timed Walk	27.7	19.6***
Poor Performance in the Timed Walk	6.1	9.0
Unable to Perform the Timed Walk	12.8	18.0*

[a=] Data from Wave II of the H-EPESE (1995-96)

* statistically significant t-test/chi-squared difference of means test at $p \leq .05$

** statistically significant t-test/chi-squared difference of means test at $p \leq .01$

*** statistically significant t-test/chi-squared difference of means test at $p \leq .001$

TABLE 2—Ordinal Logistic Regressions of Performance in the Seated Chair-Rise and Timed-Walk on Number of Children, by Sex, 2000-01

	Seated Chair Rise		Timed Walk	
	Females (n=867)	**Males (n=541)**	**Females (n=867)**	**Males (n=541)**
No. of Children[a]	0.05**	-0.02	0.04*	-0.02
	(0.02)	(0.02)	(0.02)	(0.02)
Always, Most, or Sometimes Incontinent	0.24	0.65**	0.24	0.37
	(0.16)	(0.22)	(0.16)	(0.22)
Always Incontinent	1.77***	0.51	1.92***	0.33
	(0.42)	(0.55)	(0.42)	(0.58)
Age	0.48***	0.26**	0.50***	0.48***
	(0.07)	(0.09)	(0.07)	(0.09)
Nativity	0.12	-0.13	0.01	0.28
	(0.13)	(0.16)	(0.12)	(0.16)
Education	-0.06	-0.36	-0.96*	-0.45
	(0.44)	(0.43)	(0.47)	(0.46)
Diabetes	0.33*	0.70***	0.40*	0.87***
	(0.14)	(0.19)	(0.14)	(0.19)
Stroke	0.24	0.76	0.37	0.96*
	(0.35)	(0.43)	(0.36)	(0.41)
Arthritis	0.13	0.23	0.27	0.06
	(0.13)	(0.16)	(0.13)	(0.16)
Osteoporosis	0.28	1.01	0.51**	1.54**
	(0.19)	(0.61)	(0.18)	(0.59)
Cardiac Failure	0.38*	0.48*	0.32*	0.25
	(0.17)	(0.20)	(0.16)	(0.20)

Standard errors in parentheses

[a]Data from Wave II of the H-EPESE (1995-96)

* $p \leq .05$ ** $p \leq .01$ *** $p \leq .001$

Cut-points for performance in the seated chair-rise:

Females:Best|Good -1.03 Good|Moderate -0.11 Moderate|Poor 0.59 Poor|Unable 1.78 Cox-Snell Pseudo R^2: 0.14

Males: Best|Good -1.33 Good|Moderate -0.49 Moderate|Poor 0.26 Poor|Unable 1.29 Cox-Snell Pseudo R^2: 0.08

Cut-points for performance in the timed walk:

Females:Best|Good -1.20 Good|Moderate 0.18 Moderate|Poor 1.44 Poor|Unable 2.03 Cox-Snell Pseudo R^2: 0.16

Males: Best|Good -1.63 Good|Moderate -0.19 Moderate|Poor 1.00 Poor|Unable 1.51 Cox-Snell Pseudo R^2: 0.09

TABLE 3—Ordinal Logistic Regressions of Performance in the Seated Chair-Rise on Gravidity and Covariates, 2000-01 (Females Only)

	Model 1	Model 2	Model 3	Model 4	Model 5
Gravidity[a]	0.04* (0.02)	0.04* (0.02)	0.04* (0.02)	0.04** (0.02)	0.04** (0.02)
Always, Most or Sometimes Incontinent		0.33* (0.16)	0.35* (0.16)	0.41** (0.16)	0.24 (0.16)
Always Incontinent		1.86*** (0.4)	1.81*** (0.41)	1.67*** (0.41)	1.69*** (0.42)
Hysterectomy[a]			-0.32* (0.13)	-0.27* (0.13)	-0.32* (0.14)
Age				0.47*** (0.06)	0.47*** (0.07)
Nativity				0.12 (0.13)	0.15 (0.13)
Education				0.16 (0.45)	0.04 (0.45)
Diabetes					0.35* (0.15)
Stroke					0.18 (0.36)
Arthritis					0.15 (0.13)
Osteoporosis					0.31 (0.19)
Cardiac Failure					0.41* (0.17)

Note. The sample size was n=867
Standard errors in parentheses
[a] Data from Wave II of the H-EPESE (1995-96)
* $p \leq .05$ ** $p \leq .01$ *** $p \leq .001$
For Model 5:
Cut-points for performance in the seated chair-rise: Best|Good -1.20 Good|Moderate -0.28, Moderate|Poor 0.42, Poor|Unable to do 1.60.
Residual Deviance: 2636.9; AIC: 2670.9 (smallest of all 5 models); Cox-Snell Pseudo R^2: 0.14

TABLE 4—Ordinal Logistic Regressions of Performance in the Timed Walk on Gravidity and Covariates, 2000-01 (Females Only)

	Model 1	Model 2	Model 3	Model 4	Model 5
Gravidity[a]	0.03* (0.02)	0.03* (0.02)	0.03* (0.02)	0.03* (0.02)	0.03* (0.02)
Always, Most or Sometimes Incontinent		0.39* (0.16)	0.35* (0.16)	0.46** (0.16)	0.23 (0.16)
Always Incontinent		2.0*** (0.4)	1.98*** (0.41)	1.77*** (0.41)	1.83*** (0.42)
Hysterectomy[a]			-0.17 (0.13)	-0.11 (0.13)	-0.15 (0.14)
Age				0.49*** (0.06)	0.49*** (0.07)
Nativity				0.08 (0.13)	0.12 (0.13)
Education				-0.73 (0.47)	-0.94* (0.47)
Diabetes					0.41** (0.14)
Stroke					-0.50 (0.37)
Arthritis					0.27 (0.13)
Osteoporosis					0.53** (0.18)
Cardiac Failure					0.33* (0.16)

Note. The sample size was n=867
Standard errors in parentheses
[a] Data from Wave II of the H-EPESE (1995-96)
* $p \leq .05$ ** $p \leq .01$ *** $p \leq .001$
For Model 5:
Cut-points for performance in the seated chair-rise: Best|Good -1.23 Good|Moderate 0.15 Moderate|Poor 1.40 Poor|Unable to do 2.0.
Residual Deviance: 2530.5; AIC: 2564.5 (smallest of all 5 models); Cox-Snell Pseudo R^2: 0.16