American Journal of Epidemiology

Vol. 186, No. 6

Research Letter

EXTERNAL VALIDATION OF THE CLAIMS-BASED FRAILTY INDEX IN THE NATIONAL HEALTH AND AGING TRENDS STUDY COHORT

Fried et al. (1) operationalized a frailty phenotype that can be reproducibly identified with standardized measures. The 5 measures that define the phenotype are unintentional weight loss, self-reported exhaustion, weakness as measured with grip strength, slow walking speed, and low physical activity. Individuals with this phenotype, however, cannot be easily identified in data that do not have these performance measures. Given the ubiquity of claims data, we recently developed a tool that we operationalized using claims data alone (2).

In developing this tool, we considered the Fried frailty phenotype to be the reference standard and developed a parsimonious model using Medicare data linked to data from the Cardiovascular Health Study (CHS) to approximate the frailty phenotype (3). The model had a cross-validated area under the receiver operating characteristic curve of 0.75 to concurrently predict a frailty phenotype. We sought to validate this Claims-Based Frailty Index (CFI) in a large, nationally representative cohort of older adults in order to demonstrate that the CFI can sensitively and specifically identify phenotypically frail individuals and predict outcomes.

METHODS

The National Health and Aging Trends Study (NHATS) is a cohort of older adult Medicare beneficiaries living in the United States (https://www.nhats.org/). Only persons living in the community in 2010 were included in the present analyses ($n = 7{,}197$), representing 91.7% of the Medicare population aged 65 years or older (weighted percentage). The NHATS investigators linked their interview data to the Medicare claims of the participants from the time of their Medicare enrollment.

We used data from the beneficiaries who had continuous coverage with Medicare Parts A and B for the 6 months prior to the month of their NHATS Round 1 interview (4,582 participants). Using the CFI variables and β coefficients from logistic regression previously derived in the CHS data, we generated a predicted probability of frailty for each individual (Web Tables 1 and 2, available at https://academic.oup.com/aje).

Because the NHATS data include performance assessments at cohort entry, the frailty phenotype was previously determined for each participant (4). A phenotype status of "frail" was assigned to the individual if 3 of the 5 frailty criteria were met. We used a cutoff of 0.2 to classify individuals as frail (as in the derivation cohort) and calculated the test characteristics of the CFI.

We operationalized outcomes of interest using claims or interview data 3 years after cohort entry (5). We calculated hazard ratios or odds ratios for events using Cox proportional hazards models or logistic regression, respectively, for individuals classified as frail or not with the CFI, with weighting to account for the survey design. Analyses were not adjusted for age and sex because these are included in the CFI calculation and are highly collinear with the CFI (2). Hazard ratios and odds ratios were similarly calculated for individuals classified as frail or not with the phenotypic measure. These outcomes were plotted and compared visually to the outcome measures for those classified with the CFI.

RESULTS

The included individuals (community-dwelling, with continuous coverage) differed minimally from the whole cohort (Table 1). The mean age was 75.2 years at enrollment, ranging from 66–106 years. The weighted population was 56% women and 84% white. For comparison, in the CHS cohort, the participants also had an average age of 75.2 years at enrollment (ranging from 65 to 100 years), 58% were women, and 84% were white.

The mean predicted probability of frailty in this population, from the CFI algorithm, was 0.10 (95% confidence interval (CI): 0.10, 0.11). Using a cutoff of 0.2, as in the derivation cohort, 11.5% of the weighted population was classified as frail. The κ coefficient, reflecting agreement between the CFI and the frailty phenotypic measure, was 0.27. (The κ coefficient in the derivation cohort was 0.25.) With the cutoff of 0.2, the sensitivity of the CFI for identifying frailty in this cohort is 33% (95% CI: 29, 36) and the specificity is 92% (95% CI: 91, 93), with positive and negative predictive values of 39% (95% CI: 36, 43) and 90% (95% CI: 88, 91), respectively.

The frail individuals, classified with the CFI, were at high risk of outcomes relative to nonfrail individuals: The odds ratio for death was 5.7 (95% CI: 4.7, 7.0), for falls was 2.4 (95% CI: 1.8, 3.2), and for hip fracture was 3.7 (95% CI: 2.3, 6.1). This frail population had an elevated risk of intensification of services, with an odds ratio for hospitalization of 3.7 (95% CI: 3.1, 4.4) and for nursing home admission of 4.4 (95% CI: 3.7, 5.3) relative to nonfrail individuals. These odds ratios were very similar to those for individuals with phenotypic frailty (Web Figure 1). Additionally, for those classified as frail relative to nonfrail, the odds ratio for needing help with self-care was 7.6 (95% CI: 6.2, 9.3), the odds of needing help with mobility were 8.7 (95% CI: 7.0, 11), and the odds of needing help with housework were 5.5 (95% CI: 4.3, 6.9).

DISCUSSION

The test characteristics of the CFI in the NHATS sample are very similar to those in the derivation cohort. Members of the CHS cohort had a similar mean age (75 years) to those in the NHATS cohort and a comparable prevalence of phenotypic frailty (11%). The remarkable similarity of predictive characteristics of the CFI between the CHS and the

Table 1. Characteristics of Community-Dwelling Participants in the National Health and Aging Trend Study, United States, 2011[a]

Variable	Participants in National Health and Aging Cohort Round 1 Interview			
	Entire Cohort (n = 7,197)		Subset With Continuous Medicare Part A and B Coverage (n = 4,582)	
	No. of Participants	Weighted %	No. of Participants	Weighted %
Sex				
Male	3,050	44	1,956	44
Female	4,147	56	2,626	56
Race/ethnicity from survey interview				
White, non-Hispanic	4,861	81	3,251	84
Black, non-Hispanic	1,598	8.4	942	7.6
Other	209	3.6	122	3.3
Hispanic	445	7.1	211	5.1
Education				
Less than high school	1,947	22	1,191	21
High school or beyond	5,166	78	3,339	79
Marital status				
Married	3,562	57	2,241	56
Living with a partner	148	2.4	98	2.6
Separated	120	1.4	65	1.1
Divorced	754	11	461	10
Widowed	2,341	26	1,546	27
Never married	265	3.3	168	3.2
Age from survey interview	74.8 (0.1)		75.2 (0.1)	

[a] Values are presented to 2 significant digits. Age values are expressed as weighted means and standard errors.

NHATS provides evidence for the generalizability of CFI to older adults in the United States.

In the derivation cohort (CHS), the area under the receiver operating characteristic curve was 0.75, and the positive and negative predictive values for the CFI (with a cutoff of 0.2) were 35% and 92%, similar to those in this NHATS cohort. In the derivation cohort, the CFI-predicted hazards of outcomes over 5 years were similar to those predicted by the frailty phenotype, with neither measure predicting an increase in fractures. In the NHATS cohort, the CFI predicted outcomes similarly to the frailty phenotype, including fracture.

This study gives further confidence in the use of the CFI for identification of frail individuals and, equally important, for identification of nonfrail individuals. This index should be valuable as an effect modifier in epidemiologic studies and in the investigation of treatment effectiveness where differences in treatment-response due to frailty are expected (6). This may be valuable for analyses of trial or cohort study data where the risk-benefit balance may differ by frailty status (7). A claims-based index may also be valuable for population health planning, such as directing high-intensity management services.

Acknowledgments

This is work was supported by the National Institute on Aging (grants R21AG048494-01 and U01AG032947) and the Johns Hopkins University Claude D. Pepper Older Americans Independence Center, supported by the National Institute on Aging (grant P30AG021334), which provided partial support for the frailty related research of R.V. and J.H.

Conflict of interest: none declared.

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DOI: 10.1093/aje/kwx257; Advance Access publication: August 23, 2017