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Original Study

How Many Older People Are Frail? Using Multiple Imputation to Investigate Frailty in the Population

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A B S T R A C T

Objectives: The objective of this study was to establish the extent to which frailty was associated with attrition and then compare estimates of frailty prevalence and progression estimated from the observed data to those estimated after imputation.
Design: Population-based cohort study.
Setting: The Health in Men Study (HIMS) with frailty estimated at Wave 2 (2001/2004) and Wave 3 (2008) and mortality follow-up to 2010.
Participants: Participants were 10,305 community-dwelling men aged 70 and older, followed for up to 10 years.
Measurements: Participants completed an extensive questionnaire covering functional activities and illnesses. Frailty was assessed using the FRAIL Scale and a 32-item Frailty Index.
Results: Nonresponders at Wave 3 were more likely to have been frail at Wave 2. Imputed estimates of frailty prevalence were 8% to 10% higher than those derived from the observed data.
Conclusion: Epidemiological surveys may substantially underestimate the levels of frailty among older people in the general population. This selective nonresponse results in an overoptimistic view of aging populations, particularly for the very old.

Advancing age is associated with increased susceptibility to progressive functional decline and clinical syndromes, such as delirium and falls.[1] This underlying susceptibility is commonly known as frailty. Frail people have reached the limits of their physiological reserve in 1 or more of the major homoeostatic systems.[1] Such individuals cannot adequately manage relatively minor endogenous or exogenous changes, which produce a cascade of symptoms and health events.

Although frailty inevitably occurs in all people as they age, the level of frailty can vary substantially between individuals of the same age, as can its rate of progression. Consequently, epidemiological studies that can explain this variation have the potential to identify groups within the population that could benefit from early intervention.[2] To this end, several different measures of frailty have been developed,[3–5] but regardless of how frailty is defined, higher levels of frailty are associated with increased mortality and disability.[3,6–8]

Cohort studies would seem ideally suited to the task of investigating frailty in older populations, because they can assess levels of

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frailty at regular intervals and directly observe frailty progression. However, cohort studies invariably lose participants during follow-up either because of nonparticipation or death, and this is a critical issue in aging cohorts in which mortality is high and in which age, ill health, and frailty are all associated with attrition.[9,10] A strong association between frailty and attrition would therefore selectively remove the frailest individuals from the cohort, leading to underestimation of both the prevalence of frailty at a given age and the rate of progression of frailty with age. In this case, any factors found to be associated with either the presence or progression of frailty would have limited validity, as frailty estimates may be biased.

Multiple imputation[11] may offer a solution to this problem. As a cohort is followed over time, if all deaths are known, then missing data due to attrition can be imputed from the previously acquired data of those individuals lost to follow-up. In this study, we first established the extent to which frailty was associated with attrition and then compared estimates of frailty prevalence and progression derived from an analysis of the observed data to those found after multiple imputation. We hypothesized that the imputed estimates of frailty prevalence would be substantially greater than those derived from the observed data.

Methods

Data Sources

We used data from the Health in Men Study (HIMS), a population-based longitudinal study of aging that was formed by the 12,203 men who were screened for abdominal aortic aneurysm in a randomized controlled trial conducted in Perth, Western Australia (WA), in 1996.[12] The men recruited into this trial were community-dwelling residents of Perth, aged 65 to 83 years, and the data collected during the trial became the baseline data (Wave 1) of the HIMS cohort. Further data were collected from these men between October 2001 and August 2004 (Wave 2) and again in October 2008 (Wave 3). The date and cause of death of cohort participants was obtained by linking to mortality data held by the WA Data Linkage Service, established to facilitate health-related research in WA.[13]

The data collected in both Waves 2 and 3 allowed us to use 2 different measures of frailty that represent 2 main approaches that have been taken to defining frailty: the FRAIL Scale,[7] a short, 5-item scale that accesses frailty according to a specific phenotype, and the Frailty Index,[14] which defines frailty as the accumulation of deficits.

Ethical Approval

The human research ethics committee of the University of Western Australia approved the protocol for the HIMS, and all men gave written informed consent before entering any part of the study.

The FRAIL Scale

The FRAIL Scale was based on deficits in 5 domains: fatigue, resistance (ability to climb a single flight of stairs), ambulation (ability to walk 1 block), illnesses (>5), and loss of weight >5%.[5,7] Measures of fatigue, resistance, and ambulation were derived from items in the SF-36 Health Survey.[15] Fatigue was assessed using the responses to the questions “Did you feel worn out?” “Did you feel tired?” and “Did you have a lot of energy?” Participants scored positive for fatigue if they responded “all of the time,” “most of the time,” or “a good bit of the time” to either of the first 2 questions or “some of the time,” “a little of the time,” or “none of the time” to the last question. Similarly, participants scored positive for resistance if they reported that they were “limited a lot” or “limited a little” in their ability to climb 1 flight of stairs and positive for ambulation if they reported that they were “limited a lot” or “limited a little” in their ability to walk 100 m.

Participants scored positive for illness if they reported more than 5 of the following 14 conditions: arthritis (including osteoarthritis and rheumatoid arthritis), diabetes, angina or heart attack, hypertension, stroke, asthma, chronic bronchitis, emphysema, osteoporosis, colorectal cancer, skin cancer, depression or an anxiety disorder, Alzheimer disease or other dementia, or leg ulcers. Finally, participants scored positive for loss of weight if their self-reported weight decreased by more than 5% between successive data collection waves.

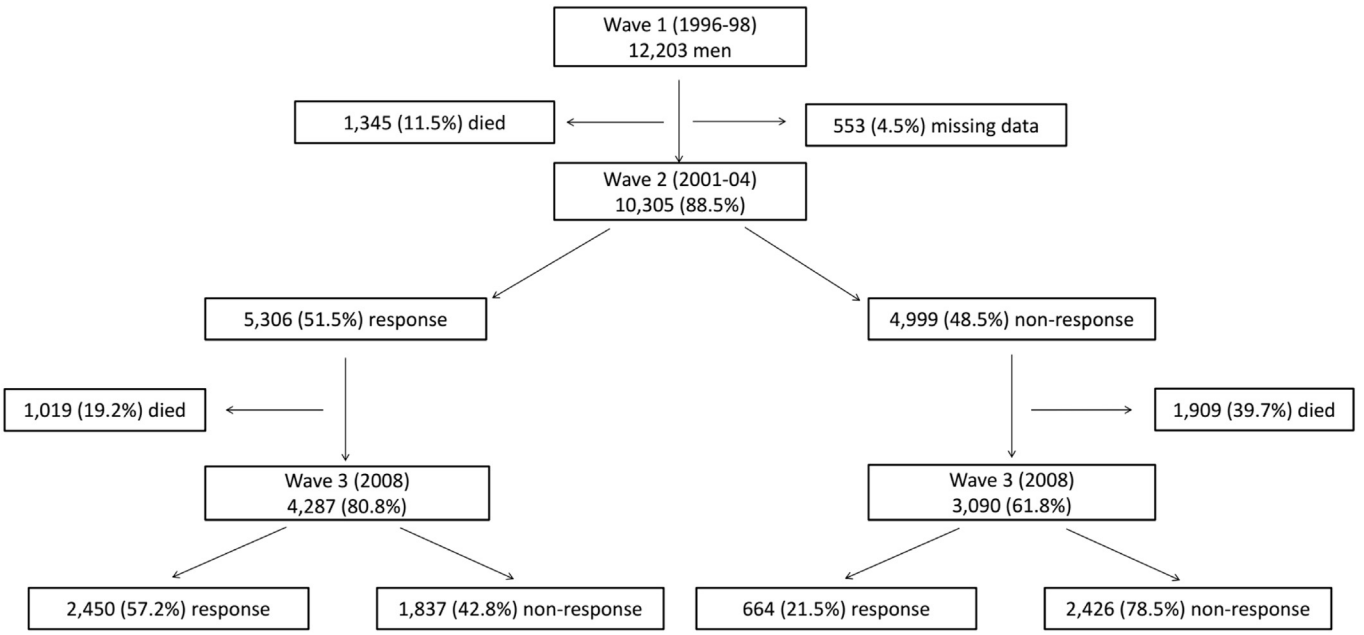

Fig. 1. Attrition and mortality at Wave 2 and Wave 3.