

INTRODUCTION

Frailty is theoretically defined as a clinically recognizable state of increased vulnerability resulting from aging-associated decline in reserve and function across multiple physiologic systems such that the ability to cope with everyday or acute stressors is comprised. In the absence of a gold standard, frailty has been operationally defined by Fried et al. as meeting three out of five phenotypic criteria indicating compromised energetics: low grip strength, exhaustion, slowed walking speed, low energy expenditure, and/or unintentional weight loss (1) (Table 1). A pre-frail stage, in which one or two criteria are present, identifies a subset at high risk of progressing to frailty. Various adaptations of Fried's clinical phenotype have emerged in the literature, which were often motivated by available measures in specific studies rather than meaningful conceptual differences.

The clinical phenotype of frailty was first proposed and validated in the Cardiovascular Health Study (CHS). The CHS criteria were later adapted to the Women's Health and Aging Study (WHAS) sample at baseline, given the measures available in WHAS. The WHAS criteria have strong internal validity *vis à vis* stated theory characterizing frailty as a medical syndrome, and predictive validity for IADL and ADL disability, institutionalization and death (2). The major differences lie in three items: weight loss, exhaustion, and low energy expenditure. Starting with *weight loss* criterion, in CHS, participants were asked whether they had unintentionally lost more than 10 pounds in the last year. No such question was asked of WHAS participants; rather, weight at age 60 was self-reported. We assigned a frailty-eligible weight loss if a woman's weight as measured at baseline represented a decrease of at least 10% relative to weight at age 60.

Questions relating to *exhaustion* differed in the two studies, as summarized in Table 1.

Exhaustion was defined in WHAS as an indicative response to at least one of three relevant questions regarding self-perceived low energy level and frequent tiredness and weakness. The two questions used in the CHS for measuring exhaustion were selected from the Center for Epidemiologic Studies Depression Scale (CES-D).

To measure *energy expenditure*, WHAS utilized a subset of the Minnesota Leisure Time Activities Questionnaire (MLTAQ) utilized in CHS, condensed from the original 18 activities to assess participation in six: walking, doing strenuous household chores, doing strenuous outdoor chores (e.g. gardening, mowing), dancing, bowling and exercise. Therefore, we set the WHAS threshold for defining low energy expenditure at 1/3 of the CHS kilocalorie threshold. This choice is disputable for two reasons: Firstly, the activities excluded from the WHAS assessment were those deemed least frequently subscribed to by disabled older women, thus tending to require greater energy expenditure. Secondly, some of the original MLTAQ activities were merged into single question responses in WHAS (for example, various specific modes of exercise into a combined “exercise” question). However, a recent unpublished study found that this shorten/condensed version of physical activity questionnaire is a good surrogate for determining physical activity status in an older adult population similar to the CHS. The surrogate corresponds well with the original criterion and the cross-validation using data from the CHS provides evidence to support its continued application as means to ease participant burden and speed frailty assessment.

Grip strength was measured using the same protocol in WHAS and CHS; the definition for low grip strength was identical in both studies. *Walking Speed* in WHAS was based on a four-meter measured walk at usual pace rather than 15 feet as in CHS. The slowness criterion used in WHAS merely rescaled the CHS criterion to apply to the new distance.

The Frailty Assessment Tool currently uses the WHAS criteria by default, as it is anticipated that its briefer extent will be considered preferable by many users in light of the available validation data. But users will be given the option to opt out to CHS if desired when initiating a new project.

References

1. Fried LP, Tangen CM, Walston J, Newman AB, Hirsch C, Gottdiener J, Seeman T, Tracy R, Kop WJ, Burke G, McBurnie MA; Cardiovascular Health Study Collaborative Research Group. Frailty in older adults: evidence for a phenotype. *J Gerontol A Biol Sci Med Sci*. 2001 Mar;56(3):M146-56. PMID: 11253156
2. Bandeen-Roche K, Xue QL, Ferrucci L, Walston J, Guralnik JM, Chaves P, Zeger SL, Fried LP. Phenotype of frailty: characterization in the women's health and aging studies. *J Gerontol A Biol Sci Med Sci*. 2006 Mar;61(3):262-6. PMID: 16567375

Table 1. Frailty-defining criteria: Women’s Health and Aging Studies (WHAS) versus Cardiovascular Health Study (CHS)

Characteristics	WHAS	CHS
1. Weight loss	<p>Baseline: Either of: i) $(\text{weight at age 60} - \text{weight at exam}) / (\text{weight at age 60}) \geq 0.1$ ii) BMI at exam < 18.5.</p> <p>Follow-up: Either of : i) BMI at exam < 18.5 ii) $(\text{weight in previous year} - \text{current weight}) / (\text{weight in previous year}) \geq 0.05$ and the loss was unintentional</p>	<p>Baseline: Lost > 10 pounds unintentionally in last year</p> <p>Follow-up: $(\text{weight in previous year} - \text{current weight}) / (\text{weight in previous year}) \geq 0.05$ and the loss was unintentional</p>
2. Exhaustion	<p>Self report of any of: i) low usual energy level¹ (≤ 3, range 0-10) ii) felt unusually tired in last month² iii) felt unusually weak in the past month²</p>	<p>Self report of either of: i) felt that everything I did was an effort in the last week ii) could not get going in the last week</p>
3. Low Energy Expenditure	<p>Women: Kcal <90 on activity scale (6 items) Men: Kcal <128 on activity scale (6 items)</p>	<p>Women: Kcal <270 on activity scale (18 items) Men: Kcal <383 on activity scale (18 items)</p>
4. Slowness	<p>Usual pace walking 4m Women: speed $\leq 4.57/7$ for height ≤ 159 cm speed $\leq 4.57/6$ for height > 159 cm Men: speed $\leq 4.57/7$ for height ≤ 173 cm speed $\leq 4.57/6$ for height > 173 cm</p>	<p>Usual pace walking 15 feet (4.57m) Women: time ≥ 7 for height ≤ 159 cm time ≥ 6 for height > 159 cm Men: time ≥ 7 for height ≤ 173 cm time ≥ 6 for height > 173 cm</p>
5. Weakness	<p>Grip strength: Same as in CHS</p>	<p>Grip strength Men: ≤ 29 for BMI ≤ 24 ≤ 30 for BMI 24.1 - 26 ≤ 30 for BMI 26.1 - 28 ≤ 32 for BMI > 28 Women: ≤ 17 for BMI ≤ 23 ≤ 17.3 for BMI 23.1 - 26 ≤ 18 for BMI 26.1 - 29 ≤ 21 for BMI > 29</p>

¹ Rated on 0-10 scale, where 0 = “no energy” and 10 = “the most energy that you have ever had.”

² If yes, there followed questioning “how much of the time” the feeling persisted; responses “most” or “all” of the time were considered indicative of exhaustion.