

Pathways from physical frailty to activity limitation in older people: Identifying moderators and mediators in the English Longitudinal Study of Ageing[☆]



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ABSTRACT

Physical frailty increases the risk of future activity limitation, which in turn, compromises independent living of older people and limits their healthspan. Thus, we seek to identify moderators and mediators of the effect of physical frailty on activity limitation change in older people, including gender- and age-specific effects. In a longitudinal study using data from waves 2, 4, and 6 of the English Longitudinal Study of Ageing, unique physical frailty factor scores of 4638 respondents aged 65 to 89 years are obtained from confirmatory factor analysis of physical frailty, which is specified by three indicators, namely slowness, weakness, and exhaustion. Using a series of autoregressive cross-lagged models, we estimate the effect of physical frailty factor score on activity limitation change, including its moderation by social conditions, and indirect effects through physical and psychological conditions. We find that the effect of physical frailty on activity limitation change is significantly stronger with older age, while it has significant indirect effects through low physical activity, depressive symptoms, and cognitive impairment. In turn, indirect effects of physical frailty through low physical activity and cognitive impairment are stronger with older age. Sensitivity analyses suggest that these effects vary in their robustness to unmeasured confounding. We conclude that low physical activity, depressive symptoms, and cognitive impairment are potentially modifiable mediators on pathways from physical frailty to activity limitation in older people, including those who are very old. This evidence offers support for population-level interventions that target these conditions, to mitigate the effect of physical frailty on activity limitation, and thereby enhance healthspan.

1. Introduction

Frailty is widely regarded as the multidimensional loss of an individual's body system reserves which results in vulnerability to developing adverse health-related outcomes (Espinoza and Walston, 2005; Lally and Crome, 2007; Pel-Littel et al., 2009), such as death, disability, falls, hospitalization, and institutionalization (Daniels et al., 2012; Ensrud et al., 2009; Ensrud et al., 2008; Jones et al., 2005; Kiely et al., 2009; Pilotto et al., 2012; Woo et al., 2012). Across a spectrum of definitions applied, the prevalence of frailty is estimated to be about 10% among people aged 65 years or older (Collard et al., 2012). The potential adverse outcomes of frailty and its size of problem combine to create significant health and social impact for ageing populations. Consequently, frailty plays a central role in influencing the well-being

of older people and holds major public health importance (Woo et al., 2006).

As an adverse outcome of frailty, functional disability reduces the quality of life in older people (Murphy et al., 2007; Walker and Lowenstein, 2009). The latest WHO classification of disability defined three levels of functioning. They are impairment, activity limitation, and participation restriction (ICF, 2002). Typically, activity limitation is measured in terms of needing assistance in basic and instrumental activities of daily living (BADL and IADL). BADL items include bathing, dressing, toileting, transferring, feeding and walking (Katz et al., 1963). Activity limitation exerts a negative impact on older people. Those with increasing levels of activity limitation have lower levels of well-being, which manifests as higher prevalence of depression, less life satisfaction, poorer quality of life, and more loneliness, even after stratifying

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for age (Demakakos et al., 2010). Moreover, activity limitation compromises healthspan, which is measured by length of healthy life (Crimmins, 2015), and is equally if not more important than lifespan for many older people.

Frailty and functional disability, represented by activity limitation, are considered distinct entities with some degree of overlap (Fried et al., 2004). More importantly, frailty indicators predict future activity limitation in terms of BADL and IADL dependence among community-dwelling older people (Avila-Funes et al., 2008; Gobbens et al., 2012b; Romero-Ortuno et al., 2011; Vermeulen et al., 2011). However, the precise mechanisms by which frailty exerts this effect are less clear. There is sparse knowledge on pathways from frailty to eventual activity limitation. Better understanding of these pathways including the identification of moderators and mediators on them can inform public health and social policy with respect to organizing effective population-level interventions that could potentially minimize the impact of frailty where it already occurs. This may in turn slow down or even delay the onset of activity limitation in older people.

To conceptualize pathways from frailty to activity limitation, a good starting point is the working framework proposed by the Canadian Initiative on Frailty and Aging (Bergman et al., 2004) which is simplified and has its relevant portion shown in Fig. 1. Biological, psychological, social, and societal assets and deficits are represented as moderators on pathways to adverse outcomes which include disability. These assets and deficits represent potential target conditions for intervention to reduce the negative impact of frailty. More recently, the integral concept of frailty (Gobbens et al., 2010b) incorporated a similar set of frailty pathways adapted from those of the Canadian working framework. Other frailty pathways have also been proposed, but are largely restricted to the biological sphere, and are therefore less suitable for a broader investigation of the effects of frailty. Thus, the Canadian working framework offers a useful foundation on which to build a conceptual model for pathways from frailty to activity limitation.

With the basis for a conceptual model of frailty pathways available, the challenge is then to identify a frailty specification which is suitable for investigation of these pathways. In his seminal work, Strawbridge

recognized the multidimensional nature of frailty and conceptualized frailty as involving problems in at least two from among physical, nutritive, cognitive, and sensory domains (Strawbridge et al., 1998). More recently, the view of frailty being multidimensional has been expressed in part through the development of frailty identifiers that measure deficits across more than a single domain (Bielderma et al., 2013; Gobbens et al., 2010b; Rockwood, 2005). However, some of these multidimensional elements in these frailty specifications, including those components in the Canadian working framework in Fig. 1, are also hypothesized to be key conditions on pathways from frailty to its adverse outcomes. Having these elements as part and parcel of the frailty specification complicates the task of teasing out the relationship between frailty and these key deficits. As an alternative, the integral concept of frailty explicitly specifies frailty as having three distinct domains namely physical, psychological, and social (Gobbens et al., 2010a). Being able to specify frailty on the basis of a single domain facilitates its disentanglement from conditions related to the other two domains. This in turn facilitates less constrained exploration of the relationship of frailty with multidimensional conditions which may turn out to be mediators or moderators on its effect.

Among these three frailty domains, physical frailty offers the most promising choice as a frailty specification for the investigation of related pathways. There are a number of reasons for this. Firstly, physical frailty is far better understood than psychological or social frailty. Secondly, physical frailty contributes most to prediction of disability among the three frailty domains (Gobbens et al., 2012a). Finally, there exists an excellent prototype for physical frailty in the CHS frailty phenotype (Fried et al., 2001). It conceptualizes physical frailty as having five indicators, which are slow walking speed, weak grip strength, self-reported exhaustion, unintentional weight loss, and low physical activity level. However, exercise as a counter of low physical activity, is a modifier of frailty's effect (Daniels et al., 2008). Thus, given that low physical activity is a lifestyle condition on pathways from frailty to its adverse outcomes, it may be argued that it should be excluded from the set of indicators for a physical frailty specification implemented for examining its relationship with activity limitation. On the other hand, the other four indicators are either symptoms or physical measurements that are not considered to be conditions on frailty pathways which need to be excluded from being a physical frailty indicator. Indeed, our previous work argues that specifying physical frailty with three of the five indicators, namely slow walking speed, weak grip strength, and exhaustion retains face and content validity. In addition, we demonstrate construct and concurrent validity for this physical frailty specification. Weight loss did not enhance these aspects of validity, and can therefore be omitted from the final set of indicators (Ding, 2016). In the light of these points, physical frailty specified by these three indicators holds promise for the investigation of pathways from frailty to activity limitation.

Our conceptual model for investigating the relationship of physical frailty with activity limitation is shown in Fig. 2. In this model, indirect

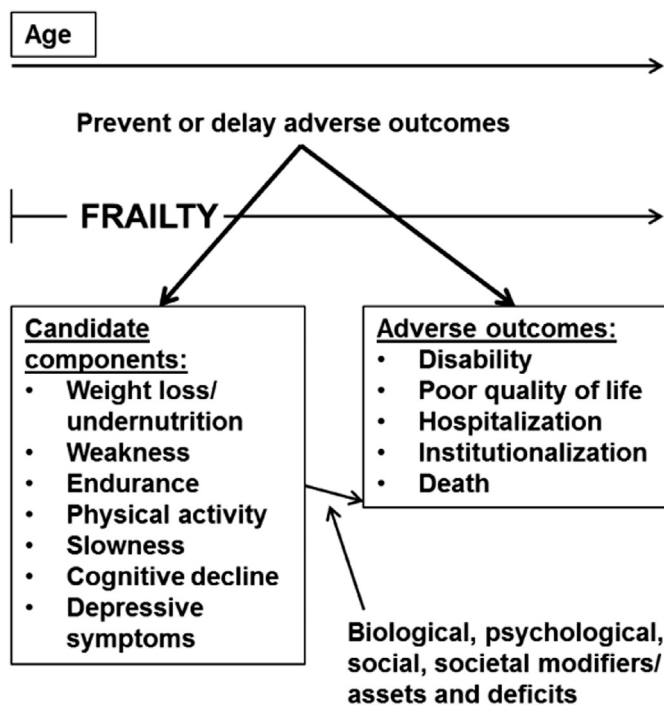


Fig. 1. Working framework of the Canadian Initiative for Frailty and Aging: frailty to its adverse outcomes (adapted from Bergman et al., 2004 with modifications).

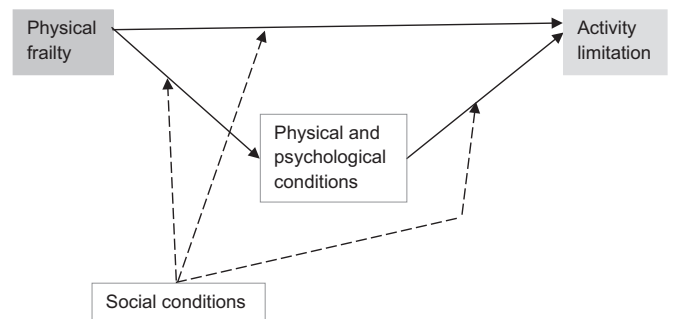


Fig. 2. Conceptual model for investigation of pathways from physical frailty to activity limitation.

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