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Review

The association between decreased hand grip strength and hip fracture in older people: A systematic review

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ABSTRACT

Hip fractures are a global concern, resulting in poor outcomes and high health care costs. They mostly affect people > 80 years. Hip fractures are influenced by various (modifiable) risk factors. Emerging evidence suggests hand grip strength (HGS) to be one of several useful tools to identify hip fracture risk. This is the first systematic review that aims to assess the evidence underlying the relationship between hip fracture incidence and HGS.

Eleven studies were selected for this review (six case-control and five cohort studies), comprising 21,197 participants. Where reported, HGS was significantly decreased in individuals with a hip fracture near the time of injury as compared to controls ($p < 0.001$); HGS was associated with increased hip fracture risk in all included studies. Meta-analysis was not possible.

All studies included in this systematic review confirmed a relationship between decreased HGS and hip fracture incidence. We were not able to quantify the strength of this relationship, due to the heterogeneity of the included studies. HGS merits further investigation as a useful tool for identifying individuals that might be at elevated risk for sustaining a hip fracture.

1. Introduction

Low impact fractures of the proximal femur (hip fractures) are a major worldwide public health concern (Hernlund et al., 2013; Kanis et al., 2012; The World Bank, 2015). They mostly occur in people older than 80 years (Kistler et al., 2015).

As the population ages, hip fractures are predicted to increase by 35% between 2012 and 2022; the annual cost will rise to $1.27 billion in Australia alone (Watts et al., 2013). The current annual hospital cost of hip fractures in the UK has been estimated at £1.1 billion (Leal et al., 2016).

Thus, it is vital to further improve fracture prevention strategies, not only to decrease health care costs, but also to reduce devastating outcomes such as morbidity, disability, dependency, and poor quality of life (Griffin et al., 2015; Parker, 2016).

Many, often modifiable, risk factors need to be considered for hip fracture prevention. Osteoporosis (Kanis, 1994) and falls (Jarvinen et al., 2008) are recognized risk factors for sustaining a hip fracture. Other factors include, but are not limited to, sarcopenia (Oliveira and Vaz, 2015), muscle weakness, physical inactivity, impaired cognition, impaired vision, and chronic health conditions (Marks, 2010).

The current gold standard screening tool to assist in identifying those most at risk of hip fracture is the Fracture Risk Assessment Tool (FRAX®). FRAX is based on 12 variables: age, sex, weight, height, previous fracture, parent fractured hip, current smoking, glucocorticoids, rheumatoid arthritis, secondary osteoporosis, alcohol (three or more units/day), and femoral neck bone mineral density (BMD) (The University of Sheffield, 2011). Low BMD, the cardinal sign of osteoporosis, was established as the number one risk factor for sustaining a hip fracture more than two decades ago (Kanis, 1994). However, only between 10% and 44% of fractures occur in people with osteoporosis (Jarvinen et al., 2015; Stone et al., 2003). Hence the value and benefit of FRAX have become a subject of debate. General validity and reliability appear to be higher in women than in men (Sandhu et al., 2010). When used without BMD, FRAX does not perform any better than only screening for age and previous fracture incidence (Rubin et al., 2013; Sambrook et al., 2011). FRAX does not include variables like activity level, muscle strength and mass, or falls history, and does not differentiate between different types of previous fractures (number, site, severity) (Silverman and Calderon, 2010).

Investigating other aspects of hip fracture prevention seems therefore critical when striving for an inclusive evidence based approach.

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This review focused on the relationship between hip fracture and hand grip strength (HGS), with the latter being an indicator for overall muscle strength (Hirschfeld et al., 2017; Rantanen et al., 2003) and an important measure for frailty (Syddall et al., 2003), sarcopenia (Chen et al., 2014; Cruz-Jentoft et al., 2010) and osteoporosis (Cheung et al., 2012; Kritz-Silverstein and Barrett-Connor, 1994).

1.1. Hip fracture, hand grip strength, and frailty

It is well recognized that hip fractures affect individuals aged 65 and over, with the majority being older than 80 years (Auais et al., 2013; Kistler et al., 2015). As people age, the likelihood of developing chronic diseases or geriatric syndromes increases. Two of those aging related conditions are osteoporosis and sarcopenia. They have similar risk factors and often occur simultaneously, then referred to as osteosarcopenia (Hirschfeld et al., 2017).

Osteoporosis is an undisputed major risk factor for sustaining a hip fracture. Decreased BMD makes the proximal femur susceptible to breaking, with no or minimal impact involved (Kanis, 1994). There is somewhat conflicting but mostly positive evidence for a relationship between HGS and systemic BMD (Dixon et al., 2005).

Sarcopenia is a recognized factor in hip fracture risk (Ho et al., 2016; Oliveira and Vaz, 2015; Tarantino et al., 2015). Progressive, generalized loss of muscle strength and mass lead to an increased risk of falls (impaired neuromuscular function) and decreased bone strength (lack of mechanical forces) (Cederholm et al., 2013).

The clinical diagnosis of sarcopenia is based on three criteria: decreased muscle mass, poor physical performance (gait speed), and decreased muscle strength (HGS) (Chen et al., 2014; Cruz-Jentoft et al., 2010).

Not surprisingly, Huo et al. (2015) demonstrated gait velocity and HGS to be reduced in patients with osteosarcopenia ($p > 0.001$), and Yoo et al. (2018) found that 28.7% of their 324 hip fracture patients had osteosarcopenia.

Relationships between HGS and postoperative complications, length of hospital stay, discharge destination, disability, multi-morbidity, chronic disease, cognition, mortality, fractures, poor physical performance, and decreased mobility have also been demonstrated (Bohannon, 2008; Cheung et al., 2013; Cheung et al., 2012; Keevil et al., 2013; Lloyd et al., 2009; Rijk et al., 2016; Roberts et al., 2012).

A causal link between HGS and all the aforementioned conditions and outcomes is considered unlikely. Bohannon (2008) suggested the linking factor to be frailty.

An operational definition of frailty has not yet been established, (Rodriguez-Manas et al., 2013) but it is generally accepted that genetic and environmental factors of aging are potentially reducing the physiological reserve in several body systems. Together with decreased physical activity and poor nutrition, this leads to increased vulnerability to poor resolution of homeostasis after a stressor event, which causes increased risk of adverse outcomes (Clegg et al., 2013). Sarcopenia, osteoporosis, and osteosarcopenia can be considered part of frailty (Hirschfeld et al., 2017). Frailty is associated with chronological age (Bassey and Harries, 1993), but Syddall et al. (2003) demonstrated an even stronger association between frailty and (decreased) age and gender stratified HGS. They hence suggested that HGS could possibly be used as a single marker for frailty. Several instruments and scores for diagnosing and monitoring frailty have been developed, and many of them include HGS measures (Buta et al., 2016; de Vries et al., 2011). An example is the currently most cited score, Fried's Phenotype (Fried et al., 2001). It includes HGS as one of two objective measures, together with gait speed, the same criteria as used for diagnosing sarcopenia (Chen et al., 2014; Cruz-Jentoft et al., 2010).

Frailty measures appear to aid in the prediction of: early complications post hip fracture surgery (Kistler et al., 2015; Kua et al., 2016), adverse outcomes in older inpatients (Hubbard et al., 2017), nursing home placement (Kojima, 2018), falls risk, fracture risk, mortality, length of hospital stay (Ensrud et al., 2007; Khandelwal et al., 2012; Kistler et al., 2015), disability (Vermeulen et al., 2011), and cognitive decline (Godin et al., 2017).

Evidence based cut-off points for identifying low HGS are available from current literature. Dodds et al. (2014) published very well informed normative, age and gender stratified HGS data and suggested cut-off points at 32 kg for men and 19 kg for women (based on a T-score of −2 or below), measured with a dynamometer. They later conducted a systematic review and meta-analysis to investigate differences in grip strength by world region, which supported the use of their cut-off points across developed regions (Dodds et al., 2016).

The European Working Group on Sarcopenia in Older People (EWGSOP) recommended generic cut-off points at 30 kg for men and 20 kg for women; they then suggested differentiating further depending on a person's body mass index (BMI) (Cruz-Jentoft et al., 2010).

The Asian Working Group for Sarcopenia (AWGS) provided two sets of cut-off points. Base on Japanese data: 30.3 kg for men and 19.3 kg for women; base on the recommendations by the EWGSOP, adjusted according to Asian data: > 22.4 kg for men and > 14.3 kg for women (Chen et al., 2014).

Many epidemiological studies investigating HGS and its relationship to various parameters have been published over the past few decades. Several systematic reviews have been conducted to summarize this evidence:

Bohannon (2008) looked at HGS as a prognostic tool for negative health outcomes; Norman et al. (2011) established HGS as a marker for nutritional status; den Ouden et al. (2011) related HGS to disability in later life; and Rijk et al. (2016) looked more broadly at the prognostic value of HGS in older individuals.

To our knowledge, no previous review has looked specifically at the relationship between decreased HGS and hip fracture incidence. We believe that HGS is a simple, inexpensive measure that has potential to aid in the identification of individuals at risk of hip fracture. It may support hip fracture prevention strategies and thus help older people to maintain their independence.

1.2. Aim of this review

This paper systematically reviewed the literature about HGS in relation to individuals with hip fracture, pre-injury or at acute presentation, and assessed the strength of the evidence for a relationship between HGS and hip fracture.

2. Methods

2.1. Search strategy

A systematic review of current literature was conducted (PROSPERO Registration number: CRD42014010080). The reporting of this paper conforms to the process outlined in the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) statement (Liberati et al., 2009; Moher et al., 2009). A comprehensive computerized database search was performed in Ovid MEDLINE(R), PubMed, Embase, CINAHL, Scopus, and Cochrane Library (both controlled trials and reviews) from each database's earliest inception data to January 2018. The initial search was performed in Ovid MEDLINE(R), using Medical Subject Headings (MeSH terms), explode functions (brackets to break a string into an array), keyword searching, truncations (to retrieve all alternative terms), adjacency (to narrow search) and Boolean operators (connectors AND/OR). The key words of HGS and proximal femur fracture were combined to conduct the search. The full search strategy can be found in Appendix 1. References of included papers were hand-searched for further relevant studies.