

Osteoarthritis and Frailty: Associations, Relevance, and Counter Solutions

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Abstract

Background

Many older adults, including those who have acquired painful disabling osteoarthritis of one or more joints may be frail rather than obese as is often reported. Those older adults who are frail may acquire osteoarthritis in turn if they encounter excess joint stresses and injury.

Aims

This report sought to examine what has been published to date on both of these debilitating health states, namely osteoarthritis and frailty.

Methods

Reviewed were relevant articles published in ACADEMIC SEARCH COMPLETE, PUBMED, WEB OF SCIENCE, SCOPUS and GOOGLE SCHOLAR regardless of time period but that focused on osteoarthritis and frailty related topics. The focus was on ascertaining how these two conditions might interact among community-dwelling older adults and whether more should be done specifically to mitigate any potentially preventable 'frailty' induced negative health impact among this group.

Results

Older adults with osteoarthritis living in the community may suffer from both osteoarthritis and frailty. Those that do are at high risk for disability and injury and should be targeted more effectively.

Conclusion

Timely and concerted efforts are needed to

offset frailty correlates as well as excess osteoarthritis disability among community dwelling older adults.

Background

Osteoarthritis, the most common form of arthritis is a widespread destructive and functionally disabling joint disease that commonly affects the ability of many older adults to function physically and independently [1-3] and that is expected to rise sharply in the coming decade [4]. A disease of unknown etiology, but one associated with varying degrees of pain, stiffness, bone deformity, inflammation, and functional declines, and currently affecting millions of older adults worldwide, many aspects of this disease, while heavily researched, remain fragmented or severely limited in explaining the nature of the disease and its varying manifestations, plus rates of progression and severity, as well as in advancing features of the disease that may be preventable or ameliorated [5]. In this regard, while many articles portray a key role for biology, immunology, and genetics [6], as well as clinical features of obesity and overweight in the disease trajectory [7] the possible role played by frailty, a very common often fatal situation affecting older adults [8-10] and one that heightens vulnerability for other adverse health conditions [11], is quite rarely alluded to by comparison, even though frailty and pre frailty is found to be associated with the presence of osteoarthritis in older adults when examined [12]. Defined as a lack of physiological reserves and the inability to adequately respond to external stressors, frailty may be more common than expected in older patients with advanced stage degenerative arthritis [13].

On the other hand, frailty itself may ensue not only as a result of age but due to the possible negative interaction of the most common attributes of osteoarthritis such as inflammation, obesity, metabolic syndrome, and pain [2, 4, 8, 9, 14, 15], which in turn may impact multiple physiological systems adversely, while increasing vulnerability to injury [9], a strong osteoarthritis determinant [15] and one that strongly predicts progressive joint damage [16], even though this is

not well recognized [5]. In addition, it is possible that features of osteoarthritis that are not well understood such as those implicating the gastro-intestinal microbiome in the development of osteoarthritis symptoms and structural damage [5] may also contribute indirectly to biological ageing in its own right as well as disability and pain [17]. Parallel alterations in health status, especially muscle and bone attrition in frailty situations may in turn impact joint health significantly and adversely [18].

Indeed, it appears safe to propose that in absence of a total understanding of the disease among the older adult population in particular, it appears shortsighted to omit the study of frailty from this body of current research [eg 15], especially in view of the impact of being sedentary on the risk of physical frailty [19], a state that can result from the presence of excess pain, fear, instability, and depression among other osteoarthritis correlates. Moreover, not only does the prevalence of frailty among the community-dwelling population increase with age, as does osteoarthritis, but frailty occurs at especially high rates among octogenarians, where osteoarthritis is likely to be highly manifest. In addition, research reveals several correlates of frailty clearly align with those of osteoarthritis, such as a prevailing age-associated decline in muscle mass and muscle strength, declines in endurance capacity, balance, walking performance, and the ability to pursue multiple physical activities safely and independently [20, 21]. Unsurprisingly, older adults requiring total hip joint replacement surgery for purposes of alleviating their end stage osteoarthritis burden may also exhibit one or more frailty attributes that appears to impair their rate of recovery quite readily [22]. Other common factors associated with both frailty and osteoarthritis and that imply there may be considerable overlap between these syndromes in a fair percentage of older adults are the use of multiple medications, high pain levels, and a high comorbidity burden [23].

In light of the limited progress made in securing a consistently high life quality among older adults with

intractable painful osteoarthritis, and the fact many older adults thus tend to experience declining levels of physical function over time, this exploratory review was designed to provide current information as to whether the prevalence of osteoarthritis is linked to frailty in some way, and if so, whether the presence of these two conditions or their progressively disabling trajectories has any prognostic significance and thus merits further study.

Rationale

Aging is often associated with states of declining muscle strength and endurance that renders the aging joint susceptible to joint damage in the face of excess stresses imparted to the joint by weak muscles and excess stiffness among other factors [24]. In addition, research and practice-based evidence generally shows excess sedentary behavior and possible excess systemic inflammation that may ensue can be expected to heighten rather than reduce weakness, and possible frailty. In turn, the presence of increasing pain as is found in osteoarthritis can undoubtedly engender associated fears of movement, as well as muscle atrophy, fatigue, and declines in function that tend to increase, rather than decrease osteoarthritis disability, as well as frailty risk or excess frailty, and an associated proclivity for falling, falls injuries, fractures, pain, and progressive joint destruction [25, 26].

On the other hand, even if hard to define precisely [27], frailty, the most common age-related musculoskeletal conditions is likely to be implicated in the onset and development of multiple health challenges such as osteoporosis, osteoarthritis, and spinal conditions. Beyond that, frailty can impact nutrition and energy supply and intake, while producing debilitating psychological and emotional health states. However, despite a growing recognition of the role of frailty in mediating or moderating aging health outcomes, there is still a clear lack of focus on frailty as opposed to obesity in the context of osteoarthritis. Confusion also exists because obesity has been deemed to be linked to frailty as a result

of its impact on muscle and bone attrition, thus more clarity in this regard would undoubtedly be of utmost value in efforts to prevent excess joint degradation, injury, inflammatory responses, and their combined negative outcomes [8].

Indeed, although osteoarthritis is not deemed to be readily reversible, it is yet possible that efforts to avert any trend towards frailty, which is said to be a dynamic state, rather than a fixed state, may help to reduce some of the osteoarthritis burden [28]. At the same time, more focused treatments that can be advanced to reduce the rate and severity of any underlying osteoarthritic pathology may help to prevent or minimize the risk for frailty [9].

Working Hypothesis

This report that is based largely on the available English language literature and the past work of the author, hypothesizes that there is sufficient evidence to support the idea of their being a clinically relevant bi directional or reciprocal association between osteoarthritis and frailty in sizeable numbers of older adults, especially those with end-stage osteoarthritis as observed by Meessen et al. [28]. That is, the processes of aging that can foster frailty, coupled with those that are associated with osteoarthritis and where they exist concurrently would be found to potentially lead to heightened frailty, for example as a result of pain [29], vulnerability to stressors [30], and multisystem dysfunctions [30] as well as overall disability as depicted in Figure 1.

Methods and Procedures

To examine the above premises and to garner information on the topic of frailty as related to osteoarthritis disability, and its palliation, we examined the ACADEMIC SEARCH COMPLETE, PUBMED, WEB OF SCIENCE, SCOPUS, and GOOGLE SCHOLAR data bases for related data using the key words: osteoarthritis and frailty or frailty syndrome. All possible articles related to osteoarthritis and frailty and that were deemed eligible were scrutinized, regardless of year of publication,

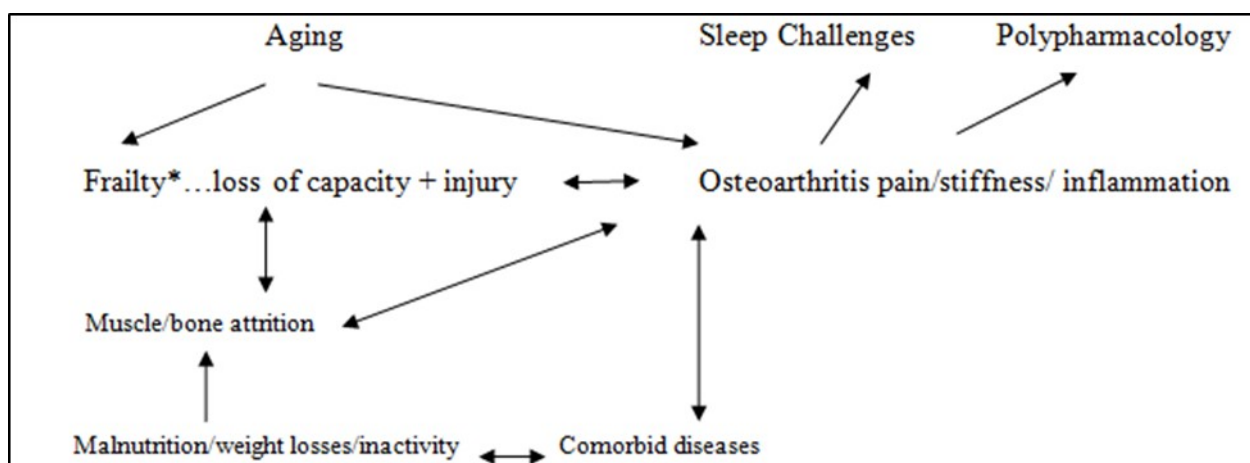


Figure 1. Possible interactions of frailty and osteoarthritis that may induce multiple adverse health outcomes among the elderly and implying a strong need for integrated multi level, interdisciplinary interventions [18, 19, 31-38].

research design and methods applied. The term frailty was used to describe those key attributes of weight loss, vulnerability to stresses and injury, declines in health status, and physical activity commonly heightened in the context of a high percentage of older adults. All modes of assessing whether study subjects were identified as being frail or not were accepted.

Results

Despite a dedicated search, only a limited number of topical articles were found published and posted on any of the websites surveyed, with most overlapping across the websites, and appearing to be published largely within the last five years and not before with few exceptions. In addition to the low volume of citations, the available body of directly related information concerning osteoarthritis and frailty associations was found to be both highly fragmented and diverse, to embody few longitudinal studies, and consistent sampling procedures Moreover, most articles discussed osteoarthritis and frailty from multiple rather than uniform perspectives, using differing instrumentation approaches and statistical approaches. As well, even though osteoarthritis may occur readily

between the ages of 60-64 years of age, most samples studied were reportedly 65 years and older. Similarly, although frailty is often more prevalent in adults of advanced age, few articles included samples where older age groups 90 years and older were included. Additionally, few focused on institutionalized adults, forms of osteoarthritis other than the knee and hip, and with the exception of pain, most failed to both study and clearly report whether certain other aspects of osteoarthritis pathology are of specific salience to explaining the presence, absence, or proclivity towards the development of frailty in selected cases of osteoarthritis. Some relevant data that do exist accordingly suggest however, that this is a clearly a most promising topic to explore in more depth. Some of these observations that warrant further study are described below according to their representative themes, including some overall general findings.

General Findings

Despite limited data on this current topic of interest, if compared to the vast number of publications on osteoarthritis and frailty when considered independently,

and the fact both conditions have multiple parallel determinants and consequences, most available evidence points to the possible value of uncovering how frailty and osteoarthritis may interact or be associated and in what respect. In general, and in this regard, it appears fair to say a growing body of documentation indicated osteoarthritis cases may not always be obese, but in fact a proportion may be deemed frail and underweight. Moreover, those deemed to be non frail may yet develop incident osteoarthritis, and those with osteoarthritis may become frail over time. In addition, those osteoarthritis cases who succumb to frailty, as well as frail elders who develop osteoarthritis, appear to experience worse health outcomes when viewed concurrently, and compared to their individual impacts on health.

As well, current data indicate a possible bidirectional association between osteoarthritis and frailty in a sizeable proportion of older adults with interactions that stem from possible underlying health determinants such as a heightened susceptibility to oxidative stresses, systemic inflammation, adverse immune responses, polypharmacology, sleep problems, and a heightened vulnerability to stresses [4, 33, 35]. In particular, even if osteoarthritis cases do not appear frail at the outset, the persistent presence of unrelenting chronic pain may well be expected to induce a variety of physiological responses that may hasten the onset of a progressive state of frailty, and with this a high susceptibility to low magnitude bone stresses and ensuing injurious joint outcomes, as well as less than optimal outcomes if surgery is needed [39]. As well, a combination of osteoarthritis and frailty can be expected to foster the possible onset or worsening of multiple chronic health conditions, a rapid decline in muscle strength, endurance, and muscle mass, bone mineralization and physical abilities as well as cognitive abilities [40, 41]. However, while the importance of considering these highly deleterious possible clinical associations in the context of osteoarthritis is thus being stressed by some [12], screening alone, while useful, may not be sufficient in

cases where clear frail states are not evident, for example if the older adult has a mesomorphic body frame or is in a pre-frail state but does not match criteria for detection. Indeed, frailty presence assays for example that are based solely on checklists designed to demote grip strength, walking speed, and activity parameters [33] may make it possible for the elderly adult with hand pain, who walks slowly due to joint instability or diabetes, but not frailty to be classified as frail. Alternately, an older adult with osteoporosis, who is active, and has a normal hip to waist ratio, weak lower limb muscles, but adequate grip strength, may be deemed non frail, inadvertently, but erroneously. In addition, the instruments used to classify both osteoarthritis as well as frailty may not be equally sensitive across studies as discussed by Wang et al. [13] and Pulik et al. [39]. Additionally, there is a frequent lack of agreement between frailty assessment approaches [42], imperfect predictability, and limited data on community based versus hospital based samples [43]. At the same time, it cannot be assumed that check lists can be readily applied in real life situations where older adults may not all be literate or have intact vision and hand writing skills, for example in the context of a 25 item frailty associated survey sent to the older adult [35]. Moreover, in addition to the possible exclusion of salient older adults being examined in community based settings, for multiple reasons, including limited literacy and vision, evaluations conducted within the constraints of a research context may not truly represent the characteristics of the general population at all adequately and may well underestimate or overestimate the importance of frailty in the midst of osteoarthritis disability, in particular, if such efforts fail to address the subject's overall medical history, and perceived self-efficacy for managing their health, among other factors .

Nonetheless, and until more robust research is conducted, it is concluded that attempts to identify frailty or frailty correlates in clinical osteoarthritis contexts as optimally and accurately as possible, coupled with subsequent efforts towards addressing any preventable

and observed probable determinants of frailty at the earliest point in time may not only prove efficacious for offsetting frailty, but quite helpful for averting those osteoarthritis mediators such as falls injuries and others, as well as surgeries due to poor nutrition, depression, excess disability and a failure to address modifiable health attributes such as bone mass [44, 45]. It may also be a wise approach given that frailty as assessed by the Frailty Staging System was found to significantly predict mortality in both osteoarthritis as well as disease free cases over time, but more so in those with osteoarthritis [46, 47]. Those who might be at most risk and might be targeted accordingly are likely to be those who are depressed, those taking multiple medicines, those with chronic conditions, high pain levels, and low levels of education [10, 11, 48, 49].

Specific Findings

Osteoarthritis and Frailty

Although data in the context of evidence to support a possible important clinically relevant association between the presence of frailty in the context of osteoarthritis that might indicate its presence as a possible and highly relevant subtype of osteoarthritis is sparse, Castell et al. [12] who conducted a longitudinal study in the context of an elderly population of diverse European cohorts using baseline data and first follow-up waves, from 2,455 individuals aged 65-85 years found frailty was indeed present in 10.2 % of those subjects deemed to have osteoarthritis, while 51% were deemed to exhibit signs of pre-frailty. The data further revealed that odds of frailty was 2.96 and that of pre-frailty was 1.54 higher among osteoarthritis individuals compared to those without the disease, thus providing some evidence that a modest proportion of older adults who are deemed to have osteoarthritis of one or more joints may also be categorized as being frail or at risk for frailty.

As confirmed by Motta et al. [9], given the co occurring similarity in underlying disease and frailty status factors, it is unsurprising that frailty is found to be quite prevalent in adults affected by rheumatic diseases, including those diagnosed as having osteoarthritis when

compared to the rates observed among healthy controls. At the same time this group argue that frail adults with an arthritic condition can be expected to be more vulnerable and more difficult to treat, due to the risk of side effects, and thus every effort to identify such cases early on is imperative. This can help in particular to identify those patients who will be less likely to tolerate potentially toxic medications or certain surgeries and that might rather benefit from more conservative regimens.

Miguel et al. [50] who set out to characterize and examine aspects of the frailty syndrome in a cross sectional sub study that examined the attributes of 58 community-dwelling elderly Brazilians diagnosed with either knee and/or hip osteoarthritis, found that those 22.4 percent of the elderly cases who exhibited both osteoarthritis and frailty signs were those who tended to use more medications, and to be more obese and depressed than the non frail (29.3 percent) or pre frail cases (48 percent). They were also characterized as having a poorer perception of their own health and lower activity levels as time progressed. They also had worse fall-related self-efficacy beliefs, and worse levels of physical function. It was unclear if over time, if any effort had been made to impact the attributes of either frailty or osteoarthritis uncovered at baseline, or whether the presence of both conditions can be expected to simply decline over time and heighten vulnerability of both in selected cases.

Osteoarthritis and its Impact on Frailty

In regards to the question of whether cases with osteoarthritis can not only exhibit frailty, but whether those who have osteoarthritis, and do not appear to fit the criteria for frailty at the outset can become frail, a revealing study by Bindawas et al. [51] who examined the longitudinal association between knee pain, the most symptom of knee joint osteoarthritis and frailty, found that after adjusting for age, sex, race, education, marital status, smoking status, comorbidities, and body mass index, unilateral knee pain at baseline was associated with an increased 1.14 odds of developing pre frailty and a 1.89 odds ratio for developing frailty. Bilateral knee pain at

baseline was also associated with an increased risk of pre frailty and frailty over time in comparison to those with no knee pain. It was concluded that knee pain (particularly bilateral knee pain) is associated with an increased risk of developing pre frailty and frailty over time. However, although data from five clinical venues located in the United States and 3,053 non frail participants aged 45-79 years were studied to enhance generalizability of the findings, the subjects studied did not however appear to have definitive osteoarthritis at baseline, hence the link to this disease could not be verified.

Veronese et al. [29] however, concluded that pain does appear to increase the risk of developing frailty in older adults who are diagnosed as having osteoarthritis. To this end this group conducted a population-based prospective cohort study with a follow-up of 4.4 years and that included 1,775 older men and women with osteoarthritis enrolled in another study. Results of a fully-adjusted logistic regression analysis demonstrated that lower limb osteoarthritis-related pain was associated with an increased risk of developing frailty compared with people with osteoarthritis and no pain. Hence, pain related to osteoarthritis appeared to be a highly salient factor influencing the relationship between the presence of lower limb osteoarthritis and the development of frailty.

Frailty can Lead to or Exacerbate Osteoarthritis

In addition to the probable highly relevant data reported above, McAlindon et al. [52] in addressing the question of whether frailty can lead to osteoarthritis further note that in their opinion the presence of skeletal fragility, a widespread aging correlate, can possibly account for findings of increasing severity of the severely impairing condition known as erosive hand osteoarthritis. In this regard, frailty also appears to predict worse outcomes of reconstructive surgery for advanced osteoarthritis, possibly due to its negative impact on both bone and muscle. Wang et al. [13] for example who undertook a prospective, observational, pilot study of patients 65 years or older awaiting elective knee or hip replacement surgery for disabling arthritis found between 5% and 10% of these patients were deemed frail and

hence at risk of possible adverse outcomes. Pulik et al. [39] support this idea and found those deemed frail before surgery had poorer outcomes than the non frail. As well, frailty delayed neuro cognitive recovery in a similar surgical sample [44].

Frailty Transitions and Associated Factors.

In terms of further frailty implications in the context of osteoarthritis, Blanco-Reina et al. [48] who examined the prevalence of frailty among 582 older community dwelling Spanish adults and who found signs of frailty in 24.1% of the study sample named osteoarticular pathology as one of the key determinants in this regard. An even higher frailty rate was observed by Sharma et al. [10] who examined the presence of frailty among older adults aged ≥ 80 years, where the presence of poor physical performance ability, depression, and chronic joint pain, as occurs in osteoarthritis were key predictors.

Lee et al. [11] who attempted to examine the nature of frailty transitions and their associated factors among 3018 Chinese community-living adults 65 years or older found that at baseline 850 (48.7%) men and 884 (52.6%) women were pre frail, and that while among these cases deemed at risk for frailty, including 23.4% men and 26.6% women these cases tended to improve after 2 years; while 11.1% of men and 6.6% of women tended to worsen. Hospitalizations, older age, previous stroke, lower cognition, and osteoarthritis were listed as being among the key risk factors for any observed decline among the pre frail participants.

Trevisan et al. [53] who similarly elected to investigate frailty state transitions in a cohort of older Italian adults in the context of a population-based longitudinal study with mean follow-up of 4.4 years, found 1,114 (38.1%) subjects retained their baseline frailty status, 1,066 (36.4%) had a transition in frailty status, and the remainder of the sample died. Older age, female sex, obesity, cardiovascular disease, osteoarthritis, smoking, loss of vision, low levels of self-sufficiency and physical performance, cognitive impairment, hypovitaminosis D, hyperuricemia, and polypharmacy were associated with

increasing frailty and greater mortality. Conversely, overweight, low to moderate drinking, high educational level, and living alone were associated with decreasing frailty. It was concluded that frailty is a dynamic syndrome, with socioeconomic and clinical factors that could be targets of preventive actions influencing transitions to better or worse frailty status. As per Zhobina et al. [54] these targets might include efforts to prevent osteoporosis, sarcopenia, and the presence of joint hypomobility, a common functional feature of osteoarthritis pathology.

Pérez-Sousa et al. [34] found that along with probable sarcopenia, individuals who are physically inactive, have diabetes, arthritis, or osteoarthritis do tend to have a higher prevalence of probable sarcopenia that could foster frailty and lower the threshold to injury and excess joint destruction. It could also render efforts to curtail osteoarthritis pain more challenging as certain anti-inflammatory drugs have been cited as harmful in the presence of frailty [55]. Pre-existing frailty may also impact knee joint replacement surgeries negatively and significantly as far as impacting rehabilitation trajectories, prolonging the use of walking aids, heightening the risk of post-operative complications and surgical efficacy [56].

Ritt et al. [38] noted those patients of theirs that were deemed to be frail also had an increased risk for adverse clinical outcomes, such as mortality, readmission to hospital, institutionalization and falls. This association between frailty and adverse clinical was independent of several major potential confounder factors, such as age, sex, race, comorbidities and disabilities and was found to occur as well in younger patients, a fact not often recognized. At the same time, other data imply more attention to offset frailty at all ages is not only desirable, but essential in consideration of its impact on older adults. This is because frailty is not only found to significantly predict a high risk for fracturing one or more bones [26, 31], but severe insomnia symptoms [35], and increased mortality rates in both subjects with and without osteoarthritis, but especially those with osteoarthritis [47, 26, 28, 31]. Factors to consider here

other than older age are being female, obese, having cardiovascular disease, osteoarthritis, a loss of vision, having lower education levels, low levels of self-efficacy and physical performance, plus cognitive impairments, poor health perceptions, hypovitaminosis D, hyperuricemia, and polypharmacy [53, 57].

Lee et al. [11] further imply that among the factors that foster frailty are the presence of diabetes, and a previous cancer history, the presence of any chronic lung disease, and stroke. According to de Villiers [58] frailty is a state of 'weakness' associated with cognitive impairment, depression, social isolation, multiple health issues such as osteoarthritis, medication side-effects, low levels of physical activity, and a high tendency to falls, functional declines, and increasing frailty. In accord with these aforementioned findings, Li et al. [56] argued in favour of early recognition and identification of frailty in the context of any rehabilitation clinic or hospital and that might help physicians to provide appropriate counselling to at risk patients and their families. Song et al. [19] further suggest interventions that promote reductions in sedentary behaviors in addition to increases in physical activity may be especially helpful for decreasing physical frailty onset and progression, as may efforts to increase energy expenditure, and to avoid restrictive diets [58].

A summary of key observations extracted from the literature that may offer some important clinical insights in this regard is listed below in Table 1.

In sum, as identified by Salaffi et al. [63], frailty represents an important construct that can be avoided, or at least needs to be identified by those who seek to reduce the vulnerability of older adults to excessive degrees of suffering and highly unfavourable health outcomes, especially among those challenged by painful osteoarthritis of one or more joints. This argument accords with that of O'Brien et al. [18] who argued that frailty may not only drive osteoarthritis development by creating an inflammatory environment that can interfere with normal tissue health, but also high disability rates. The molecular and biochemical changes associated with prevailing or emergent osteoarthritis may in turn

Table 1. General findings linking osteoarthritis and frailty and supporting the hypothesis that an association that has clinical implications appears valid

Authors	Findings
Blanco-Reina et al. [48]	The high prevalence of frailty among community-dwelling older adults may be associated with many preventable or modifiable factors, especially in cases with depressive symptoms, and in the presence of osteoarthritis, plus the use of multiple medications.
Misra et al. [59]	Knee osteoarthritis and frailty as well as frailty risk are related, hence could provide targets for improved intervention options and should be studied further.
Bindawas et al. [51]	Knee pain, especially bilateral knee pain is associated with an increased risk of developing pre frailty and frailty over time.
Cook et al. [60]	Adults with osteoarthritis are at risk for being frail or becoming frail, especially if they have common comorbidities such as diabetes.
Miguel et al. [50]	Older adults with osteoarthritis and frailty use more medications, are more obese and depressed, have a poorer perception of their own health and of their level of activity as compared with that of the previous year, have a worse fall-related self-efficacy, and worse physical function.
McAlindon et al. [52]	Erosive hand osteoarthritis is more common in older women and is strongly associated with severity of articular structural damage and its progression. Individuals who develop this disease have thinner bones, suggesting that this condition is a disorder of skeletal frailty.
Wanaratna et al. [61]	There is a high prevalence of frailty and pre-frailty in cases with knee osteoarthritis especially among those in higher age ranges, those with severe knee symptoms, those suffering from malnutrition, and functional dependence.
Wise et al. [62]	Hip osteoarthritis in men is associated with frailty that should be addressed.
Song et al. [19]	There is a strong relationship between the amount of time spent in sedentary activities and the development of physical frailty. Interventions that reduce sedentary behaviors in addition to increases in physical activity may help decrease physical frailty onset.
Veronese et al. [32]	Osteoarthritis of the lower limb increases the risk of developing frailty. Osteoarthritis pain appears to be an important factor influencing the development of frailty in this group.

exacerbate or foster frailty among those exhibiting pre frailty as well as non frail states, thus producing an inexorable deterioration of the affected osteoarthritic joint, and possible high frequency of falls and depression [45].

In this regard, research conducted by Wanaratna et al. [61] found physical frailty as well as the presence of cognitive frailty to heighten the risk for adverse outcomes among older people in general, as well as those diagnosed as having osteoarthritis of the knee and who are living in the community, and who are presumably healthier than those residing in nursing homes who have been less well represented in the available literature. In fact, increasing evidence shows frailty is not uncommon among older community dwelling adults who have advanced end stage osteoarthritis requiring surgery, although the extent to which frailty heightens surgical risk is implied but not well examined [64] and may depend on the adoption of healthy lifestyles and life affirming environments. As per Wanaranta et al. [61] the prevalence of frailty and pre-frailty is indeed found to be quite high in cases with knee osteoarthritis, regardless of age, especially among those suffering from malnutrition, and those exhibiting excess functional dependence, and cognitive frailty. It is also associated with the presence of co morbidity [60] and less than optimal outcomes among elders deemed frail and who undergo primary hip joint replacement surgery [39], as well being associated with the presence of severe pain [17, 65], persistent signs of local or systemic inflammation [17], excess sedentary practices [19], as well as a lower than desirable muscle mass, plus a higher muscle fat mass [66, 67].

Discussion

As societies age, efforts to maximize older adults well being must surely become paramount not only due to its collective impact on fiscal costs, but in consideration of enormous associated human costs. In this regard, the widespread chronic joint disease known as osteoarthritis alongside one of the most significant geriatric syndromes known as frailty is emerging as a topic of high salience.

Indeed, although we did not examine frailty as it occurs in the nursing home or long term care setting, there can be no dispute that many older adults may well succumb to either of these conditions quite readily, and that where both these conditions prevail, their independent negative health impacts are likely to tend to worsen and become associated with multiple costly debilitating irreversible health outcomes. In this regard, this current report elected to focus on identifying if either: 1) a sizeable proportion of older frail adults may be found to have osteoarthritis of one or more joints 2) if frailty and pre-frailty as it occurs among older adults can lead to osteoarthritis, for example, in the presence of injury and high rates of comorbid diseases such as diabetes. In the case of having a dual diagnosis, regardless of origin, this overview further sought to uncover if worse outcomes could be expected even in the instance of generally highly successful joint replacement surgery if these health correlates manifest simultaneously and especially if this situation is not addressed or recognized as being associated in a timely way [13]. As outlined by Wang et al. [13] this idea appears important to consider, given, the overall prevalence of clinical osteoarthritis at any site which was 30.4%; in their study and was found to parallel the presence of frailty in 10.2% of cases and pre-frailty in 51.0 % of cases. While the diagnosis of frailty is usually made clinically and based on specific criteria that may sometimes prove inconsistent [63], preventing frailty is not only of high general clinical importance owing to its link to increased morbidity and mortality [62], but because as noted by Negm et al. [20] frail older adults who have to undergo surgery are said to not only be more challenging to operate on, but they also tend to be more vulnerable to peri-operative stressors, a high risk of post-operative complications, increased lengths of hospital stays, and discharge to assisted living facilities. Moreover, as noted by Perez-Souza et al. [34] almost half of all their elderly sample had probable sarcopenia, a frailty determinant, as well as a determinant that could provoke osteoarthritis pain and disability as well as overall declines in functional reserve and bone health. Frailty is also strongly associated with the onset of a

declining locomotor function or locomotive syndrome, where both overloading as well as underloading the joints may foster cartilage, bone and muscle degeneration [68]. The presence of frailty may also adversely impact perceived health status, blood pressure and cardiovascular health [69], plus both adherence to, as well as the efficacy of exercise interventions designed to reduce joint pain [46, 70] and that could compromise surgery as well as overall well being. In turn, the presence of pain leading to sleep challenges as well as sarcopenia can also be expected to be a strong frailty and ensuing disability correlate in its own right [35], as may obesity, even if this is not intuitive [71].

Thus these aforementioned data and others that are emerging, while yet somewhat fragmented, are not only noteworthy, but generally consistent with findings of Ninomiya et al. [22] who examined the presence of frailty as denoted by weakness, weight loss, low activity and low energy levels, and slow gait, among 518 cases who had undergone hip joint arthroplasty surgery and where 11.4% or 51% were frail or pre-frail respectively. Moreover, these data plus those additional observations highlighted in Table 1 must surely warrant attention as far as their possible translation into standardized clinical geriatric practices are concerned, especially in light of the numbers of older adults predicted to live to a higher age in the future, but who if frail, are more likely than not to be susceptible to injurious falls, muscle mass and strength losses, poor functional ability, osteoarthritis, and low life quality plus immense suffering and functional declines [58].

In particular, since both health conditions are strongly associated with sedentary life styles, losses of muscle strength, muscle mass, malnutrition, losses of cognitive and active functional ability, sensory losses, and possibly even obesity [71], it appears tackling these challenging albeit common underlying health conditions sooner rather than later on in life would be highly advantageous as well as essential as intimated by de Villiers [58]. To this end, more concerted and integrated efforts to identify who is most at risk early on, plus routine

follow up frailty assessments, and efforts to intervene and rehabilitate the individual older adult after any acute injurious incident, regardless of health status, appears especially important to consider.

In the interim, and in consideration of the immense burden of osteoarthritis and its possible link in many instances to pre frailty or frailty, and until more research is forthcoming, encouraging modest levels of activity participation, weight training, and following a healthy diet and sound nutrition at all ages appears well founded. In addition, efforts to foster early diagnosis and timely tailored integrated management approaches known to allay physical activity declines as well as efficacious non pharmacologic strategies to offset pain, any lack of confidence, and distress along with osteoarthritis symptoms that can impact frailty on an ongoing basis among a sizeable number of vulnerable older adults where even minor stresses can lead to immense negative health repercussions [48, 58] are especially likely to help avert considerable suffering and predictable functional life threatening declines and need for institutionalization among this cohort [72, 73]. In addition, until more clear evidence for evidence-based individual and health-system interventions to manage frailty are forthcoming [72], approaches other than those above that may prove beneficial are: 1) various socially-supportive interventions and the provision of financial resources; 2) the application of joint sparing techniques, appropriate footwear and assistive devices; 3) the adoption of appropriate home and personal safety measures; 4) the use of varied relaxation/stress reduction approaches; 5) the alleviation of any signs of excess inflammation, depression and anxiety; 6) the enhancement of the older adult's self-efficacy; 7) the prevention of infections, stress, and jarring movements; 8) the prevention and optimal treatment of co occurring comorbid health conditions and sleep disturbances; 9) frequent medication, medical, and vision checks; and 10) falls prevention education [19, 30, 36, 42, 45, 58, 72].

At the same time, it appears improved understandings of ageing-related mechanisms that

underlie both osteoarthritis and frailty and examining whether sarcopenic frailty is a specific phenotype of osteoarthritis [74], as well as studies on inflammation, and how obesity can lead to frailty, could lead to the discovery of new targets or therapies that might effectively retard or mitigate the progression of both these chronic and disabling conditions and that clearly heighten morbidity and excess mortality [66, 67, 72]. Alternately, if ignored, overlooked, unrecognized, or treated suboptimally or unsightfully, the probable emergence of the existence of both osteoarthritis and frailty in many aging adults along with other comorbid health conditions will undoubtedly be strengthened and with this a possible public health crisis of immense proportion in the future that could possibly overwhelm usage of available health care resources, while fostering widespread suffering. Moreover, a failure to screen for frailty, as well as a failure to encompass the probable importance of social factors in general [75], and frailty in the context of routine osteoarthritis care, in particular [9], along with efforts to update or reshape any obsolete health care premises and systems may be expected to readily engender one or more of those current frailty criteria of unintentional weight loss, poor walking ability, excess fatigue, cognitive impairments, a variety of comorbid health conditions, and severe pain and polypharmacology.

To avert this possible tsunami, and in light of the growing aging global populace living to higher ages, and that information and telecommunication technologies are not indicated for intervening on frailty in aging adults with or without osteoarthritis [76], more insightful current, as well as future collective efforts by academicians, health personnel, economists, social scientists, policy makers, psychologists, and researchers, along with efforts to develop and agree upon more universally applicable and valid frailty diagnostic criteria, are strongly urged and encouraged to address the knowledge and practice gap in this regard, as well as to address any possible unmet needs and desirable innovations in practice as well as in community based settings. A life course approach that does not omit social factor influences in this regard, may

be one way forward that may greatly help to identify therapeutic targets more aptly, before these deterministic conditions multiply and manifest incrementally and adversely [66, 67, 75]. Another may be efforts to address chronic pain in its own right [77].

Conclusion

The current status of the literature and science leads us to conclude:

Osteoarthritis a widespread painful joint disease especially among the older population that continues to unabatedly induce immense adverse impacts on life quality, and functional ability, may be associated in some instances with frailty rather than obesity.

In turn, frailty, an age associated health 'weakness' related syndrome can induce osteoarthritis or worsen its outcomes.

To advance this generally uncharted realm of clinical study and practice and to reduce its immense burden, high quality studies that apply validated tools, cut-off points, multiple measures, and careful selection criteria and follow-up strategies are strongly warranted in this regard.

More timely routine outreach and screening efforts, as well as valid efforts to correctly classify who is frail or non frail and who has definitive osteoarthritis versus joint pain and how frailty manifests over time in association with osteoarthritis disease progression are also clearly imperative.

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