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Obesity and its Bone, Muscle and Kinematic Falls Related Associations among High Age Community Dwellers: Umbrella Review of Salient Peer Reviewed Research Observations

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Abstract

Obesity, a health state and one increasing rapidly among older populations usually deemed to be frail rather than not has many health implications including disabling falls associated with numerous dire orthopedic consequences. This brief specifically examines whether obese adults are at increased risk for injurious falls and possible bone fractures requiring timely and insightful prevention oriented services and response directives, and if so, what preventive approaches other than pharmacologic approaches would be safely recommended. It also examines if an obese state jeopardizes bone reparative surgical outcomes. Covering the 2010-2026 time periods and using the search terms: *biology, biomechanics, bone, falls, fractures, kinematics, muscle, obesity and intervention* among others, data revealed: 1) A possible increased risk of falling as well as fracturing a bone such as the hip bone in older obese adults with poor bone health. 2) Fractures can occur even if weight is duly lost. 3) Muscle abnormalities may pose a possible potent unrecognized risk factor for bone fractures in the face of osteosarcopenic obesity. 4) Minimizing excess body weight in a tempered manner, controlling any tendency to adopt a sedentary lifestyle, as well as advocating for muscle strengthening and vitamin D supplements where indicated will likely reduce overall health costs and suffering attributable to injurious as well as recurrent falls among the older obese population, especially if thoughtfully and comprehensively delivered.

Keywords: Aging, Bone, Falls, Fractures, Gait, Muscle, Obesity, Prevention, Osteosarcopenic Obesity, Weight Control

Introduction

It appears beyond dispute that falls defined as a loss of balance from a stable state due to one or more often unanticipated or unrecognized extrinsic or intrinsic factors, or as a result of tripping or a slip incident occur readily and with innumerable severe consequences in the older population. Inducing highly adverse late life impacts and unwanted potentially highly injurious bone fractures, falls may impact as well as engender one or more physical, anthropmetric, social, multisensory, psychological, mobility and functional challenges and impairments that rarely diminish without due consideration. At the same time, inattention to the degree to which obesity as defined by an excess of body fat mass - an immense escalating global health concern and one that can affect bone and muscle structure as well as gait kinematics and overall health status, including the onset and perpetuation of osteosarcopenia [age associated bone and muscle mass losses] – can collectively heighten many life negating situations, including secondary falls and fractures, other fall related injuries, plus suboptimal post fracture treatment outcomes regardless of its anabolic impact on bone mineral density [1-10]. Indeed in the face of either a single or recurrent falls events sustained by the older obese adult this may necessitate the use of many costly health resources, including the risk of an increasing need for multiple medications as the years unfold, plus possible institutionalization. At the same time, this scenario is juxtaposed by the scarcity of effective visible community wide falls prevention efforts, the possible failure to administer bone building protective drugs and therapy to the obese aging adult [2], a belief the obese incur better bone protection than the non obese [5, 10], alongside increasingly vocal demands by aging adults for more autonomy as well as efficacious efforts to extend their years of healthy life as well as maximize their life quality.

In a society with high numbers of aging overweight adults, however, simply failing to address the ramifications of obesity such as bone fractures may predictably induce many costly degrading health situations for many that could be prevented [1, 2].

Unfortunately, not only does the ability to effectively reduce the persistently high prevalence of falls among the elderly as a vulnerable population remain limited in its own right, but many misconceptions prevail about the role of obesity in mediating fractures in the event of a fall [5, 10-15].

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Added to this possible remediable cycle of adverse obesity states and outcomes is the seeming lack of motivation to develop one or more sound non pharmacologic solutions for mitigating many high age health challenges, such as environmentally or behaviorally derived obesity manifestations and erroneous beliefs, as well as its biomechanical ramifications that can potentially heighten late life falls associated fracture risks unexpectedly [2, 10]. Rather, it appears what could be done in this regard is rarely contemplated, translated, initiated or enacted effectively at either the secondary ot tertiary prevention levels or clinically speaking in the realm of rehabilitation. For example, in addition to possible misuse of single and especially multiple medications, including their under or over usage, the deterministic proven role of physical inactivity, knee extensor muscle quality declines, poor diet, deficient postural control, cognitive and sleep problems, are rarely embraced in mainstream medicine health promotion realms despite almost 20 years of acquired clinically applicable related understandings [13].

As a result, emergent states of age related osteosarcopenic status may be exacerbated thus inducing a potential exaggerated risk of bone fragility, poor bone protection, recurrent falls, fractures and falls mediated injuries and mobility losses [1, 3, 6, 14-19] even if not fully supported by all [10, 19].

However, it increasingly appears the link between obesity and bone is not at all a linear unidirectional favorable one, but may involve a variety of mechanisms, including alterations in bone fat volume, bone formation/resorption ratios, proinflammatory cytokine release, and bone marrow microenvironmental alterations. These in turn, depend on on diversified factors, such as the extent of ongoing or sudden mechanical loading, obesity degree, location, and gender, age, bone sites implicated in a traumatic fall, as well as the degree of circulating bone derived cytokines [16].

Added to this, may be poor overall health and joint biomechanics responses, longer lies after a fall, extensive soft tissue damage, pain, and a host of progressive degrading functional and health problems, including possible excess sarcopenia and/or sarcopenic obesity, muscle strength and contractile declines, as well as a deficient motivation to move that does not occur to the same degree in the healthy weight older adult [4].

At the same time, those subjected to recurrent falls or injuries may experience a variety of cumulative disabling psychological and social impairments that ultimately heighten the chances of a severe disabling life trajectory and outcome than desired especially if they sustain one or more bone fractures that require surgical interventions [9]. Indeed, sufficient data reveal, it is not uncommon to observe those older adults who have fallen once or repeatedly, may not only go on to develop excessive reactive fears of future falls or pervasive immobilizing falls concerns termed kinesiophobia, known to be especially harmful to the cardiovascular and musculoskeletal systems of the aging adult, but the likely impact of bone mineral density losses due to increases in bone located fat deposits rather than a state that can counter bone fragility.

In this regard, since bones that are fragile fracture at low rates as well as high rates of impact, many obese older adults may indeed suffer intently for years to come, even from a minor falls if excess body fat located externally as well as internally is considered solely to represent a protective state against bone fractures in our estimation [10]. In turn, this scenario may have unwanted parallel impacts on bone metabolism [5] that may directly or indirectly affect trabecular bone volume and numbers.

In addition, recent epidemiologic and clinical studies suggest that a high level of body fat may be a risk factor for osteoporosis and bone fragility in its own right, challenging the long-held belief that obesity is protective against bone loss and disabling life threatening fractures and adverse skeletal outcomes [6]. Adipose tissue that is not dealt with can indeed act as an active endocrine organ that secretes various adipokines, molecules implicated in bone remodeling, energy homeostasis, and inflammation.

Unsurprisingly, the association between obesity and fracture risk is presently deemed a complex one that appears somewhat site-dependent but regardless can disrupt bone remodeling processes, to the detriment of bone formation and potentially increases bone fragility and fracture risk [24].

As a result, whereas the '*favorable fat mass*' theory is not deemed generalizable or one that can be relied upon universally, in the event of a fall, those diagnosed as being obese may have less than expected bone protection especially if they have excess muscle property losses, are excessively weak, and have slow reaction times plus possible high states of bone resorption rather than deposition. Untreated, they may not only incur secondary falls and fractures, but may not heal at desired rates post surgical fracture repair interventions, they may display heightened systemic inflammatory responses, as well as possible extremely limited functional mobility in the case of those who adopt sedentary fear evoked behaviors especially in those with a pre existing impairment in dynamic postural control, gait, neuromotor and reflex responses [5, 20-22, 47].

There is in fact no argument that this cycle of cascading events is highly probable and one likely to be extremely challenging to reverse or mitigate successfully in the absence of effective public health efforts to minimize falls as well as obesity-defined as the presence of excess body fat, plus periodic related health assessments, early efforts to advance bone and overall health, and the implementation of cross cutting related interventions that can advance rather than impede the subject's actual or more underlying obesity associated condition[s], plus their ability to function independently, safely, confidently, and socially without a fear of falling [20-24].

In this regard, while most researchers favor exercise as an adjunct to sound nutrition practices and glycolic control plus elimination of harmful drugs where indicated, intervention when offered has tended to rely largely on one or more pharmacologic or surgical strategies that may in essence encourage osteosarcopenia - a possible parallel and powerful falls injury mediator and obesity correlate. Moreover, these actions may not obviate those adiposity derived interactions that may engender unwanted neuromotor functions, such as deficiencies in balance control, alongside falls and falling fears, inflammation, pain, muscle fiber type losses, strength and bone health declines, balance confidence losses, and subnormal gait/joint biomechanics [20, 47].

Problem Statement

Although fractures clearly pose a major threat to an older person's life quality, most articles on this topic do not strongly attribute an injurious fall in later life to the presence of excess body fat. In particular, in the realm of obesity and its ramifications in later life, most falls related preventive approaches do not target this group specifically despite their proven high falls risk. This is despite evidence that older fallers with hip fractures for example may be overweight rather than simply underweight and emerging evidence that bone is not always protected from impacts in the obese. This gap in efforts to avert late life bone fractures is further impacted by low rates of osteoporosis preventive care in the obese and as a result this lack of effort surely yields societal health costs that are incalculable. In particular, failing to expose aging adults to periodic related screenings for any physiological body and bone composition changes can undoubtedly heighten their falls risk, as well as their increasing gait challenges [25-30].

Moreover, even if the risk factors for falls are similar in the obese to the non obese [31], the additional impact of excess fat mass on muscle, as well as postural sway and a reduced ability to get up off the ground following a fall tends to favor a poor prognosis for recovery among those affected [26, 31].

Rationale

Along with obesity, falls represent one of the most common potentially preventable geriatric syndromes encountered in primary care settings and others and thereby impose a growing incalculable burden on many aging individuals, their families, and healthcare systems, often inadvertently. This situation is compounded in those with concomitant osteosarcopenia, even though this may not be recognized or inevitable, but rather measurable and largely preventable [25-35]. However, this cycle of modifiable events is commonly ignored until it is pressing, or alternately, is under-recognized, poorly understood, or treated non-holistically, or only in one dimension, not others. Indeed, from the multi factorial nature of obesity as well as falls in the elderly, it appears most of their specific causes can be traced to one or more health behaviors including some that provoke osteoporosis and other chronic conditions such as type 2 diabetes, plus its often devastating neuromuscular associations. Additionally, the impact of polypharmacy status that can reduce bone quality and heighten fracture risk, alongside various nutrition factors that can possibly be mitigated or managed more effectively, for example by eating low glycemic content foods and those rich in vitamin D and calcium may play a key disadvantageous bone health role in later life. While an upstream view that aims at preventing obesity in the first place is the most obvious solution here, recommended approaches in this regard are often ignored, or enacted too late. In addition, incorrect misconceptions may prevail that drive health decisions, and may thereby exacerbate rather than attenuate any excess weight associated falls risks, forthcoming fracture severity, and the ability to recover from fracture surgery if needed that can evolve over time [36-46].

Those older adults who fall and require immediate emergency responses may be poorly served however, if they cannot access care or rise from a fall in a timely way and provide challenges to first responders and others, for example if they are morbidly obese.

Review Aim

In this brief we aimed to examine and elucidate upon what appears to have emerged as regards the specific risk factors occurring in the older obese adult over time as this may impact bone fractures and injurious falls risks, especially in the realm of a possible interactive impact of excess fat mass or adiposity state on muscle and bone health.

In particular, based on an understanding of the risk factors for falling in general, plus those that are specific to those suffering from obesity or excess adiposity, we sought to identify how providers in health settings can help to avert or reduce future falls and falls injuries, as well as secondary bone fractures, often a lethal state in this growing older adult population.

Hypothesis

Untreated obese older adult fallers whose bone and muscle mass may yet deteriorate unduly are especially likely to incur one or more injurious falls, and fragility fractures if they fall repeatedly that may pose an immense personal degree of suffering alongside immense public health costs among those who survive.

Methodology and Approach

To gain some perspective on the state of knowledge and its application in this regard and to establish if more can be done to reduce the burden of falls injuries among older adults suffering from an excess fat mass and diagnosed as having an obese profile, if anything, we conducted a comprehensive albeit selective review of related articles housed in the PUBMED CENTRAL, GOOGLE SCHOLAR, and PUBMED computerized databases over an extended time frame using the key words: *adiposity, bone, falls, muscle, older adults, obesity, prevention, sarcopenia, and vitamin D*. In terms of the data collected, only those sources related to obese community-dwelling elders were considered. Excluded were studies that took place in hospitals, nursing homes or those that discussed pharmacologic management approaches, or genetic and biochemical mechanisms of pathology and intervention implications. Data were summarized solely in a narrative format.

Overview of Findings

The aforementioned extensive search, while not necessarily inclusive of all related data sources and perspectives, revealed a considerable number of related papers over the years that not only describe falls in older adults, but more specifically their underlying causes. In contrast to early studies, a high number now detail a specific role for osteosarcopenic obesity and its ramifications. Many also stress or focus on both the negative outcomes of this linkage, rather than a historic favorable one. They uniformly provide a strong call for solutions to minimize falls risk, as well as osteosarcopenic obesity among the elderly as a result [17-19]. Several too provide potentially impactful insights into the link between obesity and associated bone health plus a need for customized physical activity and behavioral based interventions rather than a reliance on passive weight loss methods [9, 10]. Others focus on identifying risk factors for falls among the older adult population, which turn out to be numerous, but largely and essentially modifiable or preventable and associated with with or engendering excess weight gain as well as functional disability.

In this respect, whereas obesity, characterized by excessive fat accumulation, and traditionally associated with the induction of a higher bone mineral density than not, does not confer adequate fracture prevention in all cases [9, 16]. The risk of fractures in an older adult with high muscle, bone, and regional fat deposits may well vary depending on the skeletal site impacted as well as the fall related biomechanics and degree of impact, thus it is hard to arrive or derive universal generalizations [31].

In addition, adipose tissue elicited systemic inflammation, especially observed with the presence of abdominal obesity may exert multiple negative effects on bone that are not well understood, including bone mineral density, even after adjusting for age, sex, and body mass index. Moreover, weight loss interventions, including drugs, a restricted diet and bariatric surgery can yet lead to bone loss over time as well as post operative fracture repair surgery challenges [9].

Indeed, the pervasive false belief that obesity has little impact on fracture occurrences may not only lead to a failure to act preemptively, but may lead to irreversible functional deficits that exacerbate the individual's falls risks [33-38]. This is owing to the possible excess infiltration of fat into muscle [22], a related chronic pro inflammatory status, and a generally reduced degree of mobility [22-30].

Additional Findings

Crivelli et al. [39] note that when viewed as a whole, it seems both visceral and subcutaneous fat may be detrimental rather than supportive

of bone health, and where severe may increase the risk for incurring an incident severe fracture as well as a subsequent fracture and possible poorer than desirable fracture healing and bariatric surgery trajectories thereafter [43], especially in those with a high fat muscle ratio [40] and age, vitamin D insufficiency, and obesity and vitamin D related osteo-sarcopenia [41, 42].

Obesity is also associated with a high likelihood of multiple muscle function and structural deficits, as well as defective bone metabolism and possibly thereby with a high secondary fracture risk and damage to both the bone itself and/or the surrounding soft tissue especially if accompanied by proprioception declines at the knee [31, 45, 47, 48].

The degree to which excess body weight is a risk factor for falling as well as future fractures among many elderly, not always appreciated by all, may indeed be especially exacerbated in those with excess abdominal fat who display a heightened sway area and sway range, plus a lower complexity of anterior-posterior center of pressure responses when walking and that may impact dynamic balance adversely, especially if ignored [46, 48, 53, 76]. Similarly, the replacement of muscle and bone mass by fat, plus generalized pain, deficient vitamin D, neuropathy, excessive fat mass derived oxidative stresses, and diabetic linked foot ulcers may induce unwanted gait imbalances and deficient reflex responses that engender or provoke single or multiple injurious falls [5, 7, 44, 49, 51-55] as well as a cycle of progressive degrees of bone marrow and muscle fat increases, muscle strength declines, bone vascular and remodeling alterations, as well as adverse bone inflammatory responses [5, 7, 44, 49, 51, 54, 56-59].

Moreover, in those who remain untreated, the allied influence on bone of continuous over nutrition, poor nutrition, possible fears of falling, and a possible ongoing state of limited mobility may well engender the aforementioned web of negative associations and excess debility including skeletal muscle atrophy and dysfunction and possible pervasive adverse immobilizing cognitions [44, 51, 53, 54, 59]. Also reported are possible gene biology mutations relative to appetite and energy dynamics, and an accelerated senescence in stromal stem cells that may impact adiposity as well as bone status adversely in the absence of.

- Salient periodic screening, preventive, and remedial protocols
- Advanced fat mass assessments alongside bone and gait biomechanics
- Structured low fat mealtimes and exercise action plans
- Health education and falls prevention adjunctive interventions.

Moreover, osteoporosis as often experienced by the elderly and that increases the risk of fractures may not be treated early on to the same degree as the non obese [17]. The use of multiple medications, including diabetic drugs, the presence of excess abdominal fat deposits, muscle weakness, and a possible vitamin D deficit are also red flags that should be examined even if the literature is not yet conclusive [60].

Based on emerging data, the role of a high er fat mass, particularly visceral adiposity, appears to correlate with lower bone quality and increased fracture risk, independent of bone mineral density. In addition, it appears unrelenting obesity can likely trigger inflammatory imbalances that can impair bone formation and heighten bone resorption activities [5, 7, 20, 31, 43, 44, 60].

At the same time, the lack of awareness of obesity/falls/falls injury linkages that persists can may play a role [36, 44, 60] along with the subject's knowledge, attitude and perception related to the need for any falls and fracture prevention counter efforts [30, 35, 45].

In particular, the possible exacerbation of the presence of age associated sarcopenia, as this effects muscle mass adversely, as well as muscle force capacity, along with possible muscle conductivity, walking speed and endurance in those who are largely sedentary may have the additional effect of disturbing as well as delaying inherent protective motor functions in the event of an unanticipated falls risk [59, 62-65, 71].

Added to this may be harmful eating practices such as a diet high in sugary contents and low in micronutrients that can impact muscle fat mass encroachment, poor muscle based postural control mechanisms plus desirable movement mechanism and behaviors that impact bone health [23, 60, 61, 67, 68], pain and distress, as well as aerobic capacity, muscle strength, compensatory and dynamic balance skills [21, 42, 61, 69-75]. Possible excess use of impairing medications and their falls linkages [35, 77], especially in cases with signs of neuropathy [78], cognitive deficits [79], plus vitamin D deficits may jeopardize overall life quality [80].

Conversely, older at risk adults diagnosed promptly and followed up accordingly will likely be more successful in accomplishing their life's goals than those who are not.

Discussion

This current overview tends to affirm falls among the elderly obese are likely to prevail for some time to come and their dual impact on fracture risk demands prompt actionable and timely preventive and intervention services, and others, in efforts to avert further injurious falls, and possible fat mass gain especially in the face of evident substantive osteosarcopenia, plus gait disturbances, sleep problems, high waist to hip measures and central adiposity [22, 44]. While it is agreed the association between bone and obesity is complex, little consensus prevails, thus evidence to guide secondary prevention in this population with any degree of certitude is lacking. As a result, rather than acting promptly, the need here may well be overlooked quite readily and especially by a consistent failure to follow up obese fallers who report 'no falls injury' [21] or researchers who note an ambiguous association, but fail to pursue any follow up insightful research remedy. The methods of acquiring data as well as subjects in reported studies, data sets that rely on interpretation or memory, and reliance on the body mass index and grip strength to define obesity and osteosarcopenia presence alone examined retrospectively through medical records may account for the varied conclusions that have been reported as well as the documented persistence of a failure to prevent late life fractures in general among the overweight older adult subgroup. Moreover, the specific determinants of future falls and fractures are often not studied to any concerted degree, nor discussed, and are assumed comparable to those in the non obese aging adult population.

There are also many misconceptions in this regard and a strong belief in current pharmacologic interventions to minimize weight in isolation and to thereby restore health, or the view obesity has no clinically significant bearing on osteoporosis or fracture risk [10, 53] or that obesity heightens falls risk, but not injury extent [19].

Thus despite many years of study, falls among the older obese adult who may represent up to a third of older adult populations in the West as well as increasingly in former less well developed nations remains a major public health concern among all aging populations especially in the face of concurrent rises in osteosarcopenia, a prevalent health state in later life for many [29]. Particularly noticeable in this regard is the failure of pharmacologic methods of obesity management to address many of the key determinants of falls in this population, such as a

possible diminished proprioception sense, declining muscle activation mechanisms, poor walking balance, and movement accuracy [14, 47]. Bone protective medications may also be offered or advocated less often than not to the obese adult [2].

Indeed, whereas falls and their potentially disabling consequences in older populations have been discussed for many many years, the reasons for trying to do more to avert falls and their consequences in this population is that its association has far reaching costly public health and personally linked impacts including multiple falls, falls injuries and fractures, especially secondary fragility fractures that remain strongly associated with obesity as defined by the body mass index ≥ 30 kg/m^2, a common numerical measure and very widely employed [14, 22].

In addition, even though it appears fracture injuries are increasing in parallel with population wide obesity increases [57], it appears the increasing use of various forms of pharma ftomherapy may yet contribute to the elevated risk of fragility fractures often seen unexpectedly in older individuals suffering from obesity,. In addition to that the lack of consensus here as to whether obesity is harmful to bone or protective surely drives the inadequacy of sound preventive practices as well as beliefs [22], the importance of lifestyle in weight control, and resistance exercise training [30, 32, 35]. As in other realms of chronic health research shortcomings noted above and others may be failing many older adults [8, 53, 63, 72], especially because many studies continue to rely on self-reported and secondary data estimates evaluated largely in cross-sectional designs or aggregate studies of non representative segregated or widely heterogeneous samples [10, 53] that cannot establish causation or a role for reverse causation or report on actual outcomes [8, 14].

Alternately, erroneous beliefs that nothing needs to be done, or the notion that nothing can be done even of the face in remediable falls mediators such as walking balance, walking difficulty, possible deficits in joint kinesthesia, plus emergent states of kinesiophobia, neuropathy, dizziness, hyperglycemia or hypoglycemia and poor overall health may play a role in jeopardizing the wellbeing of many [71, 80].

Recently too, it is shown that obese adults who lose weight via pharmacologic interventions may also lose muscle mass, and thus a strong likelihood remains for them of being at risk for recurrent falls and possible heightened bone damage on any unexpected bone impact. Indeed, a lack of attention in this regard, and especially in light of the emergence of a possible drug induced frail type of obesity they may predictably remain at risk for multiple fractures [23]. Deficient knowledge as to why this subgroup may tend to fall backwards and sideways, unlike healthy weight elders, as well as excessively [79] may also jeopardize preventive efforts from attaining optimal results [22].

At the same time, factors that may add to this burden are rarely addressed, for example, a role for deficient environmental safety, access to care, and if needed to nutritional sources, stressful life events, a lack of exercise options, and appropriately construed cognitive and emotional interventions [29, 60]. Conversely, as in other realms of elder care, strongly indicated here is a comprehensive tailored approach to treating the obese older adult more proactively and continuously, including helping them make investments in lifestyle modifications, weight management, as well as falls prevention strategies, and if indicated falls and pharmacological intervention safety measures [15, 17, 35, 50, 80]. A sound clinical role for considering a fracture mediating role in an obese older adult due to: a) suboptimal cognitions and health behaviors, b) food insecurity, c) medication interactions, d) insensitive fragility bone measures e) complex alterations in joint biomechanics, gait kinematics and f) poor postural control and falls fears is especially indicated in our view [26, 48, 50, 60, 74, 76, 80].

In the interim, we strongly assert obesity should no longer be overlooked as a possible fracture mediator and is one where emergent osteosarcopenic obesity – a syndrome recently identified as a condition encompassing osteopenia/osteoporosis, as well as altered gait kinematics that implicate slower walking speeds and higher energy expenditure, particularly affecting weight-bearing tasks such as walking, stair climbing, and chair rise ability are evidenced when body mass index levels exceed 35 kg.m^{-2} [74].

In this regard, we propose, sarcopenia and obesity should perhaps be assumed to be present if not a leading future falls and fragility fracture risk factor in those whose body mass indices exceed 30 kg.m^{-2} and who have not received balance training or bone building medications [17, 47] and especially those with abdominal obesity who may be fracture prone [62]. Moreover, it can be assumed carrying a degree of excess body fat can indeed not only mediate an exaggerated falls risk, but the mode of a fall, the ability to get up off the ground after a fall [26] and the magnitude of energy applied to the underlying aging bone including the hip – thought to be 'safe' but not necessarily so among women with body mass ≥ 25 kg.m^{-2}, where a 5% increase in this index was associated with a 26% increase in the risk of incurring a hip fracture [74]. Also noteworthy here is the possible added disadvantage of excess obesity derived distal motor system muscle mass deficits, poor exercise tolerance, muscle coordination deficits, alongside associated bone mass structural alterations and possible detrimental fracture healing impacts as well as fracture severity [43]. In addition, obesity can engender increases in absolute ground reaction forces and joint loads because the joint articulating surfaces in the lower limbs do not scale significantly with body size. Subjects may also demonstrate altered joint biomechanics during movement, including a decreased capacity for forward flexion, abnormal joint rotation, and increased knee joint stresses plus gait adaptations, such as an increase in their support base and stride width that can foster abnormal ground reaction forces and pain [76], especially in the morbidly obese [75, 80].

In addition, research strongly suggests that obesity not only increases the risk of falls in later life, but possibly the ability to recover from one or more falls [24, 48, 74], as well as increasing the risk of possible fragility fractures [57]. Moreover, even though generally reversible, non tailored falls prevention approaches that do not account for the complex array of obesity related ramifications whether primary or secondary may prove ineffective, unsafe, or undesirable. In addition, recommendations that are poorly aligned with the clients' personally desired life goals, falls self-efficacy status, outcome expectation beliefs, their degree of multimorbidity, and any altered gait patterns, standing postural features, and functionality are bound to fail [74, 79].

Those who may benefit from insightfully planned intervention may however be those at highest risk, and include women older than 75 years of age, morbidly obese men, those with signs of frequent dizziness, proprioception and muscle strength losses, high degrees of central adiposity, low falls prevention efficacy and poor posture, pain, and stability [62, 74, 80]. Others needing preemptive activated falls prevention attention are those subject to possible bone mass depletion in the face of sudden excess weight losses, or medications that engender bone attrition and confusion [33, 37, 38, 53]. In addition, those employing psychotropic drugs and diabetes medications that induce hypoglycemia, especially those categorized as having a polypharmacologic history may be at high risk for single falls as well as recurrent injurious future falls if unrecognized [2, 9, 71]. Conversely, those less likely to fall and sustain a fracture are those with a higher appreciation of their falls risk, a higher degree of balance control, a more optimal gait strategy, and body weight than not, and adequate rather than deficient leg muscle strength [32, 80]. In addition, those who are active, exercise as indicated, and who receive

and carry out relevant instructions including those that address muscle, as well as bone health, may reap considerable life affirming functional benefits [71, 75, 77].

To achieve success, more intense and visible continuous community wide efforts towards preventing the well described costly obesity and falls epidemics alongside osteoporosis prevention are strongly indicated, however. Hospital policies and resources to address these overlapping issues as well as their mitigation including clear fact sheets may also prove helpful.

Additionally, clinicians can help by stressing the importance of attaining a healthy weight in the context of falls prevention as well as bone health and mobility as this is not well understood. To assist here we propose the following as well:

i. Periodic bone structural attrition assessments/referrals as indicated.

ii. Personalized rather than generic community wide falls prevention interventions.

iii. Multidimensional/sensory integrated non fatiguing exercise programs [7, 80]**.**

iv. Nutritional oriented education/resource support.

v. Periodic medication reviews [61].

vi. Efforts to reduce distress, falls fears, anxiety and depression [12].

Efforts to reduce distress, falls fears, anxiety and depression [12].Here, physical therapies known to improve proprioception, muscle strength, balance, and walking kinematics ability, as well as counter or avoid pain appear especially warranted. Physical therapy health providers are also well positioned to organize any needed parallel cognitive therapies that can moderate or eliminate mindless eating, harmful repetitive behaviors and beliefs, sleep challenges and immobilizing fears of falling, often not associated with obesity. They can help encourage their client's abilities to self-monitor and adopt consistent moderate physical activity levels and healthy eating regimens. They can likely help foster the gradual attainment of more optimal muscle power, energy, and physical function states of being as well as independence [7] and possible more desired post surgical outcomes if employed [9]. They and other service providers can also collectively formulate an actionable therapeutic program that is mindful of the possible anthropometric and functional consequences of associated obesity impacts such as chronic pain that may impose limitations on the ability of the obese older adult to perform timely well modulated compensatory stepping responses following large postural disturbances or encourage fears of falling and weightbearing activities [7, 9, 74]. Additionally, they can identify and address those aspects of nutritional health deemed crucial for preventing obesity as well as muscle atrophy in this group and their individual and collective personal, communal, national and global multiple negative projected impacts [6, 7 12, 64].

However, although exercise can prevent many adverse bone impacts in the face of a high fat diet [77] it can be argued adherence to any of the above often attempted recommendations will only be beneficial, if delivered using a progressive long term multidimensional approach that may help build bone, as well as confidence and muscle mass. As well, an approach that addresses both excess general as well as abdominal fat deposits as potentially harmful to bone but does not scare the older adult may foster a subject's willingness to do all they can to reduce their falls and bone fragility risks.

In the interim, research shows older obese fallers do greatly welcome advice from physical therapists and others on how to improve their safety and overcome fears of mobility and repeat falls, especially those due to poor muscle strength and endurance and bone structural declines. In addition, if a fall occurs they can undertake efforts towards identifying and removing the reasons for the fall as far as possible, including the lack fall prevention education and resources. Currently, however, many fall risk assessments and falls prevention intervention strategies are not well targeted to account for the immense impacts of obesity even if anti-obesity medical interventions or diet based approaches that foster excess weight reduction are forthcoming. The role of weight loss in fostering bone attrition and frailty fracture risk is also rarely discussed [33]. Therefore, the 'at risk' older adult may rarely identify the possible impacts of their individual obesity state on their bone safety as well as their falls risk. They may also have received conflicting messages or misinformation, hence remain uncertain about their role and possible obligation to carry out nutritional, exercise, and any safety recommendations.

In this regard, Cho et al. [21] suggest central obesity be assessed periodically in efforts to ward off an excess older adults' fall and fracture risk. Other attributes that need oversight are the presence of moderate or severe pain, the negative effects of both excessive as well as limited activity participation, gait disturbances, unhealthful lifestyles, and often poor glycemic control, as indicated [30, 69].

Conclusions

On the basis of the literature presently explored we confidently conclude:

- Older obese adults will continue to fall at high rates if no major advancements or robust translatable conclusions about their many modifiable antecedents can be reached in a timely manner.
- Early well conceived screenings and ongoing monitoring of falls and fracture risks, followed by case specific preventive strategies and action plans that aim at enhancing physical activity, balance control, muscle and weight bearing functions are likely to reduce much harm and undue older adulthood distress, and overall suffering costs [69].
- Those obese cases in the higher age ranges who are frail, have multiple health distress provoking challenges, and exhibit mobility limitations as well as central obesity, pain, deficient balance control, and low vitamin D levels should be specifically targeted to avert the sizeable risk of one or more falls and possible severe poorly healing bone fractures in the future, plus the onset or exacerbation of co-morbidities including obesity, and the use of multiple medications [33, 43, 69].
- By helping to bridge the gap between lifestyle medicine and fall prevention offerings and conducting salient physical assessments and follow ups, comprehensive medication therapy management [61], and multi factorial collaborative holistically oriented interventions, physical therapist and others are well placed as well as encouraged to be key players in arresting this abovementioned cycle of functional declines and possible premature death spirals that are actually largely preventable.

To optimize much needed clinical preventive efforts in this regard, research samples studied should aim to include high age adults while accounting for survival biases as this may impact the obese population of elders more severely than healthy aging adults. Both men and women,

and their 'actual' voices, rather than data extracted from population based surveys assessing subjective response attributes based on memory and applied in regression analyses are essential. As well, in addition to universally agreed upon validated data collection procedures, plus clearly defined inclusion and exclusion criteria of representative samples, well tested agreed upon obesity assessments are imperative. More attention to long term obesity impacts on falls and fracture incidence and degree of overall disablement alongside actual physiological measures as well as mobility indicators, and lifestyle issues will be especially advantageous in all likelihood [53, 69, 78].

Final Thoughts

Obesity as well as osteosarcopenia may be magnified in the community dwelling older adult population especially in the face of any misconceived risk oversight regarding their probable heightened injurious falls propensity and risk, and thereby ensuring some fractures in the elderly will remain a leading cause of age associated disability, even if weight is lost rapidly rather than progressively.

To help prevent falls and secondary fractures in older people [even if disputed as salient by some], factors such as dynapenic abdominal obesity should be sought routinely and taken seriously in our view, and corresponding intervention counter measures such as lifestyle modifications and muscle building should be implemented accordingly [10, 12, 25, 45, 78].

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