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Osteoarthritis Depressive, Loneliness and Social Isolation in Later Life and the Robotic Companion

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Abstract

Background: Older adults with disabling osteoarthritis may be severely impacted by negative emotions and pain, especially if they feel isolated.

Review Aims*:* 1) To summarize the research base concerning the presence of depression in older adults suffering from osteoarthritis; 2) To examine the degree to which mitigating loneliness is desirable in this regard and may be helped by one of the many emergent robotic social devices offering companionship; and 3) To provide directives for professionals who work or are likely to work with this population in the future.

Methods*:* Reviewed were current publications detailing some aspect of osteoarthritis in the older adult, depression, emergent loneliness and social isolation, and the role and impact of robotic personal 'friends' in this realm.

Results*:* Collectively, these data reveal efforts to reduce and mitigate different degrees of depression in older adult osteoarthritis cases are needed and that social robots may help quell isolation.

Implication*:* Those older adults with osteoarthritis suffering from depression and emergent loneliness and social isolation may benefit from robotic human or pet like contacts and interactions regardless of cause and overall health status, but the key is still loneliness prevention.

Introduction

Osteoarthritis, a chronic health condition affecting one or more of the freely moving joints of the body of many older adults induces enormous bouts of pain and functional disability that is projected to reach epidemic proportions by 2050. With few remediable intervention options a high proportion of older adults may well endure progressive and oftentimes widespread cumulative pathological features of joint pain and derangement. As time evolves, and especially if more than one joint site is painful [1] mental health may gradually wane and functional challenges may be difficult to obviate or reverse thus leading to possible dejection and declining motivation to cope in at least 20 percent [2] or up to 55 percent of cases [3] .

At the same time, many cases may suffer from multiple medical conditions that stem from or foster symptoms of depression and related declines in the motivation to move and the ability of the older impaired adult to undertake life affirming social activities. According to Mahmoudi et al. [4] the high prevalence of depression among older adults with osteoarthritis highlights the need for routine depression screening and management so as to maximize treatment outcomes and quality, including surgical outcomes [5].

In either case, those who are neglected or overlooked may suffer increasing pain and isolation and with this persistent feelings of sadness, a loss of interest and pleasure in daily activities, feelings of hopelessness, and low self-worth. Even in the absence of osteoarthritis, older adults and others suffering from various degrees of depression may experience poor sleep patterns, fatigue, excessive catastrophic thinking, and appetite losses or weight control impairments [6]. They may experience related elevated pain levels and poor self-efficacy as well as an impaired body image, a loss of resilience and life quality, especially if care giving is sporadic and they strongly believe they have an irreversible, rather than a potentially modifiable condition and degree of disability, including loneliness, a chronic disease mediator or moderator and one that can impact osteoarthritis adversely [7] even after surgery if ignored [8].

In this regard, it is apparent that social robots are increasingly being deployed to address social isolation and loneliness, particularly among older adults, in a wide sphere of health concerns that may reflect a deficit in social support coupled with a sense of invalidation [8]. Clips on social media attest that individuals availing themselves of this option are pleased with their robot companions. Yet, some people find the use of social robots to meet fundamental human emotional needs disturbing [9-11].

To this end, this review describes: what is observed as regards depressive symptoms in the older adult affected by osteoarthritis, and which may occur independently as a separate longstanding health condition, or in reaction to the persistent presence of other illnesses, adverse life events and losses, social and self-care and mobility losses. Accordingly, this discussion focuses on:

1. Some key features of the predicament of older adults with osteoarthritis.
2. Findings concerning associated osteoarthritis and depression features such as loneliness.
3. Whether loneliness, involving an affective experience implicating a lack supportive human relations can be alleviated by artificially intelligent companion-oriented oriented robots and therby alleviate affective distress.
4. Implications for future practices and research.

Assumptions

- In cases of emergent loneliness that is found to inhibit osteoarthritis treatment and adaptations,

robots being created and made available in different formats and that are often extremely humanlike may be helpful to an older suffering adult.

- Although current robots are not yet the same as those occurring in terms of reality, robots are currently being used in healthcare, education, and business to increasing degrees and their potential is worth investigating.
- Robots are discussed here because it is felt there is evidence of their possible benefits such as relieving loneliness and enabling communication in the socially isolated or severely debilitated case.
- Engineers are trying to build robots that look and behave like humans and thus need comprehensive knowledge not only of technology but also of human cognition, emotion, and behavior.
- Older adults are often sensitive to loneliness, which may contribute to mental and physical health, serious illness, and increased mortality [12].
- Social relationships are essential resources for psychological well-being and physical health.
- In older adults, there may be a trend towards increased vulnerability and loss of functions that are accompanied by diminishing social networks reinforcing a vicious circle. This decrease of social cohesion [4] presents risks for health and well-being that might be cushioned by introducing social robots [13].

It may be too that older adults who suffer from osteoarthritis and who receive treatment for depression can improve their status and that some may especially benefit from exposure to a social robot. These artificially intelligent robots can be shown to foster a positive emotional attachment and reduced feelings of suffering and loneliness, especially among cases who desire to live 'in place' and have experienced the loss of one or more human relationships [14] while meeting some of the socio-emotional needs of at least some older adults with debilitating osteoarthritis. Indeed it appears that the older population who may suffer from bouts of depression, and loneliness can experience a better quality of life post or ongoing social robot exposures [15].

Significance

It was felt this information would be consistent with the need for continuing efforts to broaden our knowledge base concerning what prevention/intervention strategies other than those currently considered standard osteoarthritis and depression practices might prove efficacious for socially isolated older adults [16], while minimizing the extent of the osteoarthritis and its anticipated disease progression.

Moreover, populations who are aging rapidly need to increase their engagement in social activities to tackle loneliness, depression, and isolation [16, 17] as well as limiting ongoing threats to their health [18]. In this regard, even before the pandemic emerged, a 2020 National Academy of Sciences, Engineering and Medicine report warned of the underappreciated adverse effects of social isolation and loneliness on health, especially among older populations. Social isolation and loneliness not only predict all-cause mortality at rates that rival clinical risk factors, such as obesity and smoking; but they are associated with a greater incidence of psychological, cognitive, and physical morbidity.

Accordingly, in the first section of this work, some background information on the topic of osteoarthritis is followed by the topic of depression. Then some recent data from the loneliness

literature is provided. The work concludes by summarizing the key findings from robot companion research.

Methods

The desired information was compiled from an extensive review of the English language literature embedded in the **PubMed** over the last 10 years. The link between depression and osteoarthritis disability and loneliness and robot surrogates was explored using the keywords: *Osteoarthritis, Depression*, *Loneliness*, *Older Adults*, and *Robots* and building on prior works, Narrated in descriptive form is a contemporary summary of a possible novel direction for enhancing older adult wellbeing. More specifically it explores the potential value of social robots in community based as well as hospital care of the lonely older adult suffering depression and painful arthritis [19]. Papers discussing COVID 19 were excluded as were applications in long term care, and dementia, along with proposals.

Results

As in the past, most current reports continue to state that osteoarthritis often produces lengthy periods of chronically intractable bouts of pain, joint stiffness and inflammation, as well as multiple functional, social, occupational, cognitive and emotional challenges and restrictions, plus a low life quality, fatigue, sleep disturbances, and feelings of emotional distress, depression or actual clinical depression despite years of study [4, 20-22]. Although not a 'death sentence, its significant overlapping negative aforementioned impacts that are often unrelenting and that may well impact and hasten progression rates towards joint surgery [23], are also increasingly observed to have a negative genetic influence on the risk of acquiring osteoarthritis [22, 24] and a bi-directional association with myalgic pain [24] and that may preside incrementally in those affected who are socially isolated or perceive this as a 'hurtful' state. While some articles discuss or attempt to recount efforts to reduce the magnitude of this problem or help to offset it biochemically or via physical therapy, most fail to pinpoint or offer any definitive set of strategies for reducing osteoarthritis pain that may arise from persistent loneliness and isolation feelings. Nonetheless, many authors agree that more needs to be done in this sphere [25], especially to treat both pain and depression in tandem [26]. Alternately, many current authors support the need to more successfully identify if the older adult is at risk for depression, and if so, to try to avert this accordingly.

One important observation is that despite decades where osteoarthritis was deemed an evitable genetic or age associated physical problem, its emotional correlates are now shown of additional value and high salience in explaining findings of disease variations such as declines in vitality, poor life quality, reduced cognitive and physical functioning among diverse older adults with one or more diseased joints and that may enhance the need for surgery [25, 27]. Moreover, in addition to associated ongoing mechanical disturbances, osteoarthritis which may be accompanied by diverse degrees of vascular changes, soft tissue contractures, muscle spasm, crystal deposition, and disease related alterations in sensory inputs to the central nervous system may reduce functional ability as perceived by the sufferer that may impact their ability to interact or participate in social actions and others [28]. In addition a pervasive pain experience that reaches catastrophic proportions is often accompanied by bouts of reactive depressive, even if the actual extent of joint pathology itself is not striking and surgery is forthcoming [29] because depression that stems from a progressively emergent state of increased pain sensitivity is considered a disability medically speaking in its own right [30], as is its central nervous system influences including individual behaviors, and increases in pain sensitivity. This emergent state

may foster or result in feelings of helplessness, anxiety, poor coping ability, poor self-efficacy, and sleep disturbances that can all prove disabling. In turn, data show this negative series of feedback responses are significantly correlated with future pain and disability, and decreases in physical function [31], while generating a low sense of morale.

Compounding osteoarthritis presence and its highly resistant and unpredictable nature, are misconceptions in this regard about the importance of optimal mental health, mindset, and psychosocial factors in averting osteoarthritis [32-36], ideas long engendered about its irremediable trajectory by medical organizations and personnel, as well as suboptimal intervention outcomes that have more to do with study design than efficacy failure even where indicated. The experience of constant pain and increasingly difficulties in accomplishing everyday tasks, that engender fatigue, may likewise elicit persistent feelings of sadness, loss of interest and pleasure in daily activities, feelings of hopelessness, and low self-worth and isolation, low life quality, but this is rarely explicitly assessed [37]. Moreover, those older individuals already suffering from primary depressive symptoms may experience a declining ability to garner social support, they may be angry and fearful as well as anxious with poor sleep patterns, excessive pain catastrophizing that all foster interference with their daily activities, alongside a greater likelihood of premature death, higher rates of inflammation, increased blood pressure, memory challenges, a decreased desire for physical activities, illness uncertainty, weakness, social withdrawal, and higher rates of bone attrition, and inactivity, factors that could all interact to magnify the extent of osteoarthritis disability, and possible overuse of existing health services [38-40]. Expected too in the absence of dedicated intervention are high-levels of kinesiophobia, and its negative influence on physical as well as social activities, progressive decreases in mental health, plus a higher prevalence of comorbid conditions relative to age and gender, plus pain [38]. They may incur an increasing sense of perceived failure to cope with their difficulties that may compound their recovery trajectory post surgery [5].

Robotics

In recent times there have been reports of cases in which quality of life and loneliness of elderly people have been affected by interactions with a pet-type robot 'AIBO' and robots in general [41] with statistically significant improvements in speech, emotional words and satisfaction index. The loneliness scale values also improved [42]. This was very revealing because as loneliness is a common problem in long-term care facilities and other situations but one improved following animal-assisted therapy as well as animal like social robots designed to decrease or reverse loneliness [43]. An interactive robotic dog that can reduce loneliness appears to provide a target of sorts for attachment that is mostly beneficial and equak to a living dog.

In sum, as of 2012, several studies have indeed reported positive effects of companion-type robots on (socio) psychological (eg, mood, loneliness, and social connections and communication) and physiological (eg, stress reduction) parameters [44, 45].

Another study described that the telepresence robot system designed to improve the well-being of elderly by supporting them to do daily activities independently, was also designed to facilitate social interaction in order to help users overcome a sense of social isolation and loneliness as well as to support the professional caregivers in everyday care [46].

When occupational therapists were surveyed as regards a similar mode of intervention several perceived robots as serving as "a useful device" and one that acts as "an assistant" rather than "a companion". This

set of respondents stated the most important functions of such a robot would be its health aspects such as emergency alarms, health parameters monitoring, physical activity and memory training, and ability to encourage reminders about medication. Functions such as mood detection, encouraging contact with friends, and monitoring of food consumption were highly accepted by almost all respondents. However, the socially robotic induced functions designed to increase everyday activities and decrease the sense of loneliness were rated poorly in terms of outcome efficacy by most respondents [47].

In other research a key question has been whether when implementing robotics it is important to help care personnel accept care robots, and to diminish any fears that their introduction would make the treatment of elderly people inhumane or in some way add to their loneliness. As such, education is crucial in changing attitudes and making care personnel understand that care robots can perform routine tasks, allowing care personnel to focus on providing improved care and nursing [48]. Lim [49] note benefits relative to the use of social robot interventions to reduce cognitive decline, depression, and loneliness among older adults, even though the types, functions, and programs of effective social robots have not yet been confirmed.

More recent study does show technological rather than sole reliance on human involvement and solutions can support the elderly, improve their quality of life and reduce their feelings of isolation and loneliness [50]. The Euro-Japan ACCRA (Agile Co-Creation for Robots and Aging) project that specifically aims to build a reference co-creation methodology for the development of robotic solutions for ageing does stress the importance of research however, to validate this approach, especially from the end-user's perspective. As such, they reported a positive perception by older adults as regards the application of a robotic solution for a problem when based on the users real needs and capabilities [16, 17, 50]. Researchers [51, 52] conclude significant improvements in mental well-being in using social robots such as Paro. Most also concur further research may help us to understand the advantages of using a Paro like intervention as a form of depression therapy and where social robots may be helpful conversational promoters [53].

Other reports allude to robopets as having the potential to benefit older adults living in care homes, potentially through their ability to increase engagement and interaction opportunities that could be applied in the community [43]. With the robot acting as a catalyst, this form of engagement and interaction may also afford comfort and help, while reducing agitation and loneliness [54]. In addition, social robots could tackle both emotional and social loneliness by empowering impaired or aging adults to engage in different forms of social interaction inside and outside a facility [19, 55]. This may empower older isolated dejected adults to engage in different forms of social interaction that can support aging-in-place and fill the gaps of the intensified shortage of health and social manpower [56, 57], especially in light of the impact of arthritis on social isolation [58].

Tan et al. [59] who focused on (1) examining the social well-being of single older adults through the companionship of social robots and (2) understanding the perceptions of single older adults when interacting with social robots found four main themes emerged from the participants' interactions with LOVOT, such as caring for a social robot, the comforting presence of the social robot, the meaningful connections forged with the social robot, and a preference for LOVOT over pets. The results indicated that single older adults can obtain psychosocial support by interacting with LOVOT as a companion and that this process makes single older adults feel like they have a greater sense of purpose and someone to connect with. Moreover, the study implied social robots can provide companionship to older adults who live alone and can alleviate loneliness by allowing single older adults to form health

affirming social connections [60].

By mitigating emotional distress and loneliness, robotic interventions may enhance existing pain therapies and offer innovative solutions for resource-limited healthcare systems. Those suffering loneliness are also likely to benefit [61].

Discussion

As outlined above, it is clear that many older adults with osteoarthritis may feel isolated and depressed for several reasons. Firstly, because they may already be clinically depressed and hence prone to excess disability, as well as more severe disease activity. Second, and in the context of osteoarthritis, a disease frequently associated with obesity and cardiovascular problems including diabetes, related work shows depression can potentially increase the burden of the disease quite significantly in those with one or more of these comorbid conditions. In particular, high body mass indices, often associated independently with depression, can significantly increase the risk for perceiving one's body negatively, and for reducing the ability of the individual with osteoarthritis to carry out activities of daily living that affect wellbeing.

Indeed, among a fairly representative sample of studies that have specifically examined the relationship between depression and osteoarthritis, most provide clear support for improved efforts to identify, study and treat this psychosocial factor, which has a strong bearing on pain, self-efficacy for managing their disease, and higher levels of anxiety and fear-avoidance feelings. Treated suboptimally one can predict immense impacts on wellbeing, mobility and function, plus fewer social contacts, given a strong desire to be more sedentary than not.

However in addition to standard forms of therapy, it appears socially oriented robots may well reduce to some degree excess suffering and health care usage, pain-related fears of movement and poor functional status that stem from feelings of depression and isolation. In this regard, preliminary data show both 'pets' and social robots can provide or offer dynamic communication opportunities and positive interaction patterns for mitigating the distress of an older impaired and isolated adult [62].

This approach, while not yet well developed, may support the disabled or impaired older adult's desire to remain independent, while having a positive effect on features of the osteoarthritis disease process, such as pain. That is, given that an increased prevalence of at least moderately severe depression is observed among a reasonable percentage of older adults and that a fair number have declining mental health, repeated robotic interactions may heighten their ability to be more active physically, as well as socially, rather than perpetuating the avoidance thereof.

To this end, such efforts do not negate a role for efforts to impact depression directly, including some form of cognitive behavioral therapy, emotional and social support, plus a combination of adequate nutrition, exercise, stress control strategies, weight management, and sleep assistance, plus efforts to minimize inflammation and negative beliefs. However, loneliness and social isolation are increasingly prevalent public health concerns among community-dwelling older adults that may be exacerbated by osteoarthritis and may be greatly benefited by exposure to robotic methods of reducing levels of loneliness and social isolation. Minimizing the extent of any comorbid condition, plus reducing the risk for cardiovascular disease, insofar as these problems can heighten the risk of depression, plus educating osteoarthritis sufferers' about treatment options can potentially help affected individual's to control their pain, and thereby to heighten or optimize their mental function. Finally, reducing the stigma of depression due to negative media, ageism, or social network influences, a social carefully construed

robot application may be especially helpful as well. In addition, as opposed to using antidepressants to treat depression, and narcotics to treat pain, the importance of minimizing depression safely without side effects cannot be underestimated in the context of both weight control, as well as pain control and the probability socially constructed tailored automated robots can help is quite high.

However, caution is advised because some research offers only weak support for social robots to universally mitigate loneliness. Clearly, as with other forms of therapy, some participants may feel uncomfortable with this form of intervention, or have limited dexterity and strength as well as vision and hearing attributes. However, as with other osteoarthritis interventions, greater attentiveness to the desirability of the therapy and comfort with this as well as adaptations can certainly be addressed. To date, one study showed most participants (68.7%) did not think an automated companion robot would make them feel less lonely and felt somewhat-to-very uncomfortable (69.3%) with the idea of being allowed to believe that an artificial companion is human. In adjusted models, even though one additional year of age was also associated with lower likelihood of perceived benefit of reducing loneliness, those with high confidence using computers experienced greater comfort and heightened social robot acceptance [63, 64].

However, Lei et al. [65] cautions to not be too optimistic given that participants' acceptance of technology in the face of loneliness may not increase the intention to use the robots in cases where there were signs of related emotional anxiety, hesitant attitudes, the perceptions of an unreal social presence, and usability difficulties. The study has however provided health workers with valuable insights into why they should avoid introducing robots to their clients without due thought and in light of the prevailing needs and health regimens of older isolated/depressed adults.

In sum, because both comorbid as well as reactive depression can influence pain perception as well as the severity of comorbid conditions, and functional disability quite markedly, even if social robots can reduce loneliness, strategies to treat or minimize depression remain highly indicated in efforts to foster optimal health status and overall health outcomes and osteoarthritis associated life ‘quality’. While social oriented companion robotics may impact the extent of any excess health care utilization by the affected adult or serve as a proxy in poor service areas, osteoarthritis treatments may require input from the target person in conjunction with the provider to benefit from this. In addition Lee et al. [66] conclude well-designed robotic interventions, as complements to existing aging and clinical interventions, have the potential to improve health behaviors among socially isolated older adults and this should be explored further.

However, it is fair to say, more favorable outcomes of socially automated social support has considerable potential. Indeed, Tobis et al. [67] found older adults not only assessed the robot in question more positively with respect to its roles as a companion and assistant than their providers, they also had higher scores on their need to increase their knowledge about the robot. Regarding the robot's functions, the greatest differences between groups were observed for the social aspects on a survey, including experiencing a decreasing sense of loneliness when accompanying the user in everyday activities. Mean scores of the Animacy, Likeability, and Perceived Intelligence scales were significantly higher for older participants than for caregivers, suggesting providers have their own preferences and should step back when helping their clients.

It also appears therapies that foster feelings of efficacy and confidence and engage the mental and social capacities of the arthritis sufferer such as social robots are expected to be more positively impacted than not [68]. Educational programs to foster an individual's self-management capacity, and

that could be delivered remotely, may similarly heighten the individual older adult osteoarthritis options, especially for those who are isolated with limited social support and feel distressed [12].

To this end, regular screening and follow up assessments using the robotic unit and an appropriate set of measurement instruments are indicated. In addition, from what we know about the nature of culture and perceptions of homogeneity on health delivery and communication outcomes the development of socially interactive robots and their non-verbal communication attributes should be given more consideration [69]. Other benefits should be explored even if loneliness is not impacted significantly after using a socially constructed robotic device [70, 71], for example their inputs appeared to foster adherence. The main mechanism of effect within group settings however, does appear to be the stimulation of social interaction with other humans [72]

Among the many products now available, Broadbent et al. [14] describes an automated social robot device termed ElliQ, which is a consumer robot with a friendly appearance that uses voice, sounds, light, and buttons through a touch screen to facilitate conversation. It also provides opportunities for engagement in music, video calls, and assessments, plus stress relief approaches, games, and health reminders. According to 15 US government agencies ElliQ is not only highly engaging for older people but may be able to improve their life quality and reduce their sense of loneliness. In addition, the development of a weekly report that patients can share with their clinicians to allow better integration into routine care is described but more work is strongly indicated for current findings to be deemed generalizable [73]. Nakai et al. [74] specifically highlight the potential of robotics to complement traditional therapies in alleviating pain and enhancing emotional well-being.

Conclusions

This brief overview concerning the most common joint disease osteoarthritis and its depressive implications among older adults shows in addition to its physical correlates of disability it may be beneficial to examine the emotional factors implicated in mediating or moderating the extent of osteoarthritis-related disability.

At the same time, loneliness and social isolation, prevalent public health concerns among community-dwelling older adults and others may be reduced through selected technology-driven solutions especially among individuals who are poorly supported clinically or perceive this.

Two main symptoms of the disease, namely pain and disability, as well as feelings of depression, and loneliness may be mitigated by adjunctive socially mediated robotic ‘humanoids’ or pets. Cases previously sedentary may be more rather than less willing to pursue activities deemed beneficial to them over time. In addition resilience and self efficacy may improve.

In essence we conclude that although multiple functional limitations experienced by older adults with end-stage osteoarthritis are likely to arise due to an array of physical rather than mental disturbances, those with severe osteoarthritis subjected to carefully tailored robotic exposure, may be able to counter feelings of futility, loneliness and depression [75]. As per Lee et al. [70, 71] adherence, an important management attribute, may depend on the robot's conversational abilities, accurate initial framing, and user willingness to form a "relationship, but is yet quite promising. However, as with any intervention promising outcomes may not flow in the face of repetitive dialogue or mismatched expectations and ill designed introduction processes.

It also appears that even though social robots are quite well advanced as far as health assistant goes, a

lack of holistically oriented care, and a predominant focus on physical factors at the expense of psychological and social factors plus a failure to foster empathetic communications may greatly mar treatment impacts and potential, plus self-efficacy for managing the disease. This limited approach may also heighten anxiety and fears about undertaking recommended activities or rehabilitation directives, as may provider hesitance due to their beliefs in direct rather than indirect care options. However, it is clear, the lives of many older adults with osteoarthritis can be improved if not cured by directly targeting depression early on and efforts to recognise a subject's companionship needs.

In the meantime, osteoarthritis, a highly prevalent progressively disabling chronic health condition affecting one or more joints of a high number of older adults is likely to foster various states of depression and isolation and a low likelihood of any favorable intervention response in that event. Those with longstanding disease histories, plus those cases with severe or chronic pain, and multiple joint problems, as well as those with high stress levels, and few social contacts may be worse off as a whole all things considered and should be especially targeted and if appropriate introduced to the possible utility of employing a socially oriented robot to raise their life quality. We also agree with the need to simultaneously use other options to combat loneliness, such as group therapy, so as to foster social interaction opportunities, as well as the ability to live independently. Preventing loneliness in its own right may however reduce the risk of osteoarthritis and its disabling consequences at low cost at the outset and should be incorporated into successful aging preventive programs, asthma care and pain programs, and applied to those over 65 suffering or at risk for social isolation [76-78].

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Conflicts of Interest

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