

From screening to action: Overcoming challenges in musculoskeletal care

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ABSTRACT

Around the world, millions lose mobility and independence each year due to musculoskeletal disorders. This decline rarely begins suddenly; it often develops silently over years until everyday activities become difficult. By the time symptoms appear, prevention opportunities are often lost. Two urgent challenges must be addressed to change this trajectory. The first is detecting risk early. Advances in movement science, clinical screening and digital health now make early identification possible at scale. Wearable sensors, computer vision and simple functional tests such as gait speed and grip strength provide objective and real-world assessment of mobility and balance. Large population cohorts, biomarker research and artificial intelligence refine risk stratification by identifying early decline and predicting future disability. The second task is in motivating behavioural change once risk is recognised, and this remains the battle yet to be won. Many people hesitate to modify their routines when the benefits may take years to become apparent, as in most musculoskeletal conditions. This makes effective risk communication essential. Messages should be personalised, empathetic and culturally appropriate, helping individuals understand why action matters and how it protects independence and quality of life. Sustained engagement then depends on social support and digital tools that provide feedback and maintain motivation over time. Moving forward, the critical task is to ensure that those identified at risk act on this knowledge, stay engaged long enough for prevention to succeed, and enable musculoskeletal care to move from a reactive care model to true prevention.

Keywords: early diagnosis, health behavior, health communication, musculoskeletal disorders, risk assessment

INTRODUCTION

Musculoskeletal disorders are a leading cause of disability worldwide.¹ Conditions such as physical frailty, osteosarcopenia, mobility decline and falls affect millions of people and are increasingly recognised as major public health concerns.² This recognition is crucial because for most of these conditions, opportunities for prevention are often lost by the time symptoms appear. Functional deterioration is rarely sudden; it is usually preceded by a long period of

subtle decline in strength, balance and mobility that goes unnoticed until it begins to affect daily life. Detecting these problems early, while they are still reversible, offers a critical window to prevent permanent disability and preserve independence.³ In this context, there are 2 major challenges to overcome. The first is to identify risk at the earliest stage, and the second is to bring about behavioural change, ensuring that those identified as high risk take meaningful action to prevent future disability.

The growing burden of musculoskeletal decline

Globally, musculoskeletal disorders contribute substantially to the total years lived with disability, surpassing cardiovascular and respiratory diseases in many regions.¹ Osteoarthritis alone is estimated to affect more than 500 million people,⁴ while sarcopenia and physical frailty together affect up to one-third of adults over the age of 60, depending on the population studied.^{5,6} Falls remain the second leading cause of accidental injury-related deaths across the world, with older adults suffering the greatest number of fatal and disabling falls.⁷ Beyond the immediate suffering of pain, immobility and loss of independence, these disorders lead to a cascade of social and economic consequences. They increase the need for informal caregiving, reduce productivity and create heavy demands on health systems through long-term rehabilitation, surgery and institutional care. As life expectancy continues to rise and populations age, the burden of mobility-limiting conditions is expected to grow further unless preventive strategies are adopted early and systematically.

Traditional healthcare pathways remain primarily symptom-driven. Patients often seek help only after the onset of significant pain, difficulty walking, or a sentinel event such as a fall or fragility fracture. At this stage, much of the functional decline is difficult to reverse, and interventions, even when well designed, are less effective.⁸ This delayed response highlights the need to move away from reactive care that waits for injury or disability to appear and towards a proactive, preventive model that identifies risk before it manifests as disease.

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The first challenge: Detecting risk at an early stage

The first challenge—early risk detection—is becoming more achievable with rapid progress in movement science, clinical screening and digital health.⁹ For many years, clinicians relied on patients' self-reported symptoms, periodic examinations and basic clinical tests, such as handgrip strength or walking speed. While useful, these approaches lack granularity and may overlook the earliest phases of decline, when subtle losses in balance or coordination have begun but remain imperceptible to both patients and clinicians.

Objective measurement of movement

Recent advances in technology have transformed how human movement can be observed and quantified. Wearable sensors—such as accelerometers and gyroscopes, smartphone-based activity monitors and computer vision algorithms—now allow continuous and objective tracking of daily movement.¹⁰ Pressure-sensors can reveal alterations in gait symmetry and foot loading patterns, while inertial measurement units capture stride-to-stride variability and postural sway with high accuracy.¹¹ Computer vision systems using ordinary video cameras can reconstruct joint angles, monitor functional transitions and assess dynamic balance tasks without the need for laboratory-based equipment.¹² These tools have made it possible to observe musculoskeletal function in real-world environments rather than relying only on clinic visits. Clinicians can now monitor how individuals move during routine activities at home or in community settings, detecting small changes that would previously go unnoticed.

Clinical and population-level screening

Alongside sophisticated technologies, well-validated clinical assessments remain valuable. Widely used tests include the Short Physical Performance Battery (SPPB), which combines gait speed, balance and lower-extremity strength assessments, as well as individual measures such as the Timed Up and Go (TUG) test, chair rise time, static and dynamic balance, and handgrip strength. Although simple to perform, these assessments are robust markers of overall musculoskeletal health and show strong associations with morbidity.

In addition, routine radiological investigations, such as computed tomography and magnetic resonance imaging performed for unrelated clinical indications, often contain rich but underused imaging data that can reveal low muscle mass, reduced bone density, vertebral fractures and other markers of osteoporosis or sarcopenia. Opportunistic screening that extracts these measurements using automated or semi-

automated methods has shown promise in identifying high-risk individuals long before symptoms appear.¹³ Translating these incidental findings into musculoskeletal care pathways by flagging at-risk patients for follow-up assessment can significantly extend early detection efforts. As health systems mature towards value-based reimbursement models, using opportunistic imaging markers for risk stratification offers a cost-efficient way to prevent downstream disability and reduce reliance on high-cost interventions.

Moreover, large longitudinal studies, including national ageing cohorts and resources such as the UK Biobank, have generated extensive normative data that enable risk models to account for age, sex, comorbidities and lifestyle factors. Biomarker research is expanding this further by identifying blood-based indicators of inflammation, bone turnover and muscle degradation that may signal early decline long before clinical symptoms appear.

Predictive analytics

When these diverse data streams are collected at scale, powerful statistical and computational methods can identify patterns that are invisible to the human observer. Machine-learning algorithms can map the trajectories of functional decline, cluster individuals into distinct risk profiles and predict the likelihood of falls, fractures or mobility loss over defined time horizons. These predictive models are increasingly capable of recommending tailored interventions, such as targeted exercise, nutritional support or referral for rehabilitation. Several emerging digital platforms integrate gait data, sensor-based metrics and self-reported health information to produce personalised risk scores. This enables clinicians to identify high-risk individuals years before disability develops and to plan early preventive measures. Collectively, these innovations mean that early detection of musculoskeletal decline is now technologically feasible. The challenge is no longer whether we can measure risk, but whether we can convince people to act on it.

The second challenge: Behavioural change

Identifying risk is only half the battle. Helping people to act on that information is far more complex. Awareness of risk does not automatically lead to behaviour change, particularly when the individual feels healthy and perceives no immediate threat. Human behaviour is shaped by a combination of psychological factors, cultural influences, health literacy and social support. Many people struggle to see the value of altering their routines when the benefits may only be apparent years later, a difficulty especially relevant to musculoskeletal health.

Understanding the psychology of prevention

Behavioural science offers useful frameworks to understand why individuals may fail to act despite being informed of risk. The Health Belief Model suggests that people are more likely to engage in preventive action if they perceive themselves as personally susceptible and if they believe the consequences of the condition will be serious.¹⁴ The COM-B model highlights the importance of capability, opportunity and motivation: even when people understand their risk, they may not feel physically able to change, may lack environmental support or may not be sufficiently motivated.¹⁵ In addition, the natural tendency to prioritise immediate comfort over long-term benefit, undermines adherence to prevention strategies.

Communicating risk effectively

Risk communication must therefore be more than the delivery of numerical probabilities or generic warnings.¹⁶ It needs to be personalised, empathetic and framed in terms that resonate with the individual's life priorities.¹⁷ People respond when they understand what is at stake for their independence, social participation and quality of life. For example, explaining that continued muscle weakness could make climbing stairs difficult, reduce the ability to play with grandchildren or threaten the capacity to live alone often makes risk feel real and urgent. Besides, the way of communication should avoid technical jargon, clearly explain why the risk exists, and be adapted to the person's literacy and cultural background.¹⁸ The identity of the person communicating the risk matters as well. Advice given by a trusted clinician, a physiotherapist, a community leader or even a peer who has faced similar risk is often far more persuasive than impersonal campaigns or automated messages.

Maintaining long-term engagement

Even when individuals accept that they are at risk and agree to act, sustaining that behaviour over time remains challenging. Improvements in musculoskeletal health often take time to become noticeable, and people can lose motivation if progress seems slow or invisible. Several strategies can help maintain long-term engagement. Digital platforms can provide regular feedback on progress, such as improvements in walking speed or balance, which reassures individuals that their efforts are working. Group-based exercise programmes and peer-support groups foster accountability and a sense of shared purpose. Breaking long-term prevention into small, achievable milestones allows individuals to celebrate progress early. Gamified applications that reward consistency or encourage friendly competition can make participation more

enjoyable. Tapping on these elements, community-based multicomponent programmes have demonstrated success by combining risk education, motivational coaching and practical adherence supports such as reminders, home safety checks and supervised exercise.¹⁹ These initiatives bridge the gap between early detection and sustained prevention, showing that effective risk communication combined with behavioural nudges can translate knowledge into action.

Integrating prevention into health systems

For meaningful impact, early detection and prevention must become part of routine healthcare rather than isolated research projects. Primary care and community health settings provide a natural entry point. Short functional assessments, simple sensor-based screenings and basic risk questionnaires could be incorporated into regular check-ups. Individuals found to be at elevated risk could then be referred to preventive exercise programmes, physiotherapy-led clinics or tele-rehabilitation platforms. Health systems must also address equity. Digital tools can unintentionally exclude those with limited resources, low digital literacy or reduced access to technology.²⁰ Community-based delivery models, culturally adapted messaging and affordable devices are necessary to ensure that preventive strategies reach those most in need. Policymakers and payers (i.e., insurers, government agencies and employers) should consider incentivising preventive care by covering the cost of early screening and long-term functional health interventions, recognising that the savings from reduced falls, fractures and institutional care are substantial.

Looking ahead: From screening to action

The future of musculoskeletal health will depend not only on our ability to measure decline but also on our success in preventing it. Technological advances have given us sensitive tools to identify risk early. The next frontier is to convert risk awareness into sustained behavioural change at a population level. Achieving this requires integrated ecosystems where clinics, community programmes and digital platforms work together. Behavioural scientists and health communication experts must collaborate with clinicians, engineers and policymakers. Reimbursement models and health system priorities should shift towards maintaining independence and preventing disability, rather than primarily funding treatment after decline has occurred. Most importantly, individuals need to be empowered with clear, personalised and actionable information about their functional health, supported over time to stay engaged and motivated.

If these elements are aligned, the silent decline that now leads so many people into frailty and loss of independence can be intercepted early. Instead of waiting for fractures, falls and severe mobility loss to trigger care, health systems can build proactive pathways that keep people strong, mobile and socially connected throughout life.

Ethics statement

No patient data was used in this article.

Declaration

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