



Physical performance and disability in schizophrenia



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ABSTRACT

Despite 50 years of pharmacological and psychosocial interventions, schizophrenia remains one of the leading causes of disability. Schizophrenia is also a life-shortening illness, caused mainly by poor physical health and its complications. The end result is a considerably reduced lifespan that is marred by reduced levels of independence, with few novel treatment options available.

Disability is a multidimensional construct that results from different, and often interacting, factors associated with specific types and levels of impairment. In schizophrenia, the most poignant and well characterized determinants of disability are symptoms, cognitive and related skills deficits, but there is limited understanding of other relevant factors that contribute to disability. Here we conceptualize how reduced physical performance interacts with aging, neurobiological, treatment-emergent, and cognitive and skills deficits to exacerbate ADL disability and worsen physical health. We argue that clearly defined physical performance components represent underappreciated variables that, as in mentally healthy people, offer accessible targets for exercise interventions to improve ADLs in schizophrenia, alone or in combination with improvements in cognition and health. And, finally, due to the accelerated aging pattern inherent in this disease – lifespans are reduced by 25 years on average – we present a training model based on proven training interventions successfully used in older persons. This model is designed to target the physical and psychological declines associated with decreased independence, coupled with the cardiovascular risk factors and components of the metabolic syndrome seen in schizophrenia due to their excess prevalence of obesity and low fitness levels.

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1. Background

Schizophrenia-spectrum disorders are among the world's most disabling illnesses Murray and Lopez, 1997. Despite the striking nature of psychotic symptoms in schizophrenia, and partially related to cognitive deficits, the most debilitating problem in these conditions is impairments in everyday functioning, which spans major functional domains of independence in residence, productive activities, and social interactions Harvey, 2010. An increasingly complex society has increased the level of everyday functional demands, including life and health maintenance, perception–cognition, physical self-maintenance, purposeful activity resulting from the motivation to explore, and social behaviors, requiring evolving skill sets and effective deployment thereof. In schizophrenia, the breadth of resultant impairments across activities of daily living (ADLs) from the most basic (i.e., bathing, brushing teeth) to the more involved (instrumental ADLs; for example, financial and medication management, community mobility, shopping, housework; job skills) requires targeted assessments that can quantify the level of dysfunction and reveal, when relevant, the physical parameters associated with specific physical and psychological skills, and how they interact

with each other to produce disability. Our conceptual framework defines a successful endpoint in the treatment of schizophrenia as adequate functioning in the community, including residential, vocational and social settings. Effective participation in each of these settings requires the *ability to function successfully in the physical environment*, which includes *physical capacity and motor abilities*, as well as translation of those skills into *goal-directed physical activity behavior* in each of these settings. This has been a highly neglected topic in the past.

Embedded in the discussion of physical performance as it relates to independence is a larger ecological factor, the unprecedented obesity epidemic throughout developed nations, with the US showing the highest prevalence. Poor physical health, associated with excess body fat and related cardiometabolic derangements, is pervasive in schizophrenia, even more so than in the society at large, and is underpinned by the patients' excessively low levels of physical fitness. A vicious cycle of physical impairment and low activity levels, exacerbated by symptomatic and cognitive deficits, may represent a major impediment to effective everyday functioning in schizophrenia. We argue that improving physical performance in schizophrenia is a neglected topic that, if effectively addressed, can lead to meaningful reductions in disability, including reduced symptoms and improved cognition, beyond those which can be achieved using current approaches.

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This is because everyday activities require complex environment-bound interactions among health-related, cognitive- and physical performance variables. Without adequate physical performance levels, everyday functioning suffers on every level, as do cognition and skills deployment. The aggregate of the components of physical performance, including endurance, strength, power, flexibility, balance, mobility, flexibility, motor coordination, muscle mechanics, and gait efficiency, strongly correlates with everyday outcome in the Western population as a whole. Underlying neurobiological and treatment-emergent motor deficits of schizophrenia aside, physical performance components represent variables that, just as in mentally healthy people, offer accessible targets for interventions to improve ADLs, while also improving cognition and health. We believe that improving functioning of people with schizophrenia is possible using training programs which specifically target the patterns, skills and levels of physical decline inherent to this disease. We present in this paper, training options which provide the greatest potential for enhancing independence and improving metabolic health in these patients, and the rationales supporting their use.

2. Physical performance factors in mentally healthy people

Physical performance, defined as the ability to perform muscular work satisfactorily Brouhard et al., 1990, is imperative for all activities of daily living (ADLs) including basic and instrumental ADLs, and mobility tasks important for independent living Guralnik and Simonsick, 1993; Lawton, 1988. Understanding the differential contribution of various physical performance factors facilitates the development effective interventions aimed at preserving and improving independence.

In the general population, psychiatric symptoms, cognitive performance, number of physical health limitations and age all explain variance in disability. These factors, however, do not confound the robust relationship between physical performance and disability, making physical performance the strongest predictor of ADL limitations Van Heuvelen et al., 2000. These limitations reduce independence and the quality of life on an individual, and subsequently increase disability levels and commensurate healthcare costs to society.

2.1. Sarcopenic obesity

The US is facing an obesity epidemic of unprecedented magnitude. Two thirds of the population (68.8%) is overweight Flegal et al., 2010. Obesity rates (BMI > 30) exceed one-third in most sex-age groups Flegal et al., 2012. Recent projections by the CDC estimate an additional 33% increase in obesity and a 130% increase in severe obesity (BMI > 40) over the next 2 decades Finkelstein et al., 2012. Excess body weight and attendant poor metabolic health limit everyday functioning Kyrou et al., 2011; Houston et al., 2007, especially when combined with other behaviors such as smoking or a sedentary lifestyle Seidell, 1995. A shift in body composition towards increased adiposity and reduced muscle mass due to inactivity reduces all factors associated with physical performance. Termed *sarcopenic obesity* (literally 'fat with little flesh'), increased adiposity and reduced muscle mass when combined with *gradual age-related losses in muscle quality, mass, and strength*, often reduce ADL performance. Sarcopenic obesity is associated with a three- to fourfold increase in the likelihood of disability, moderated by lifestyle factors, health behaviors, and socioeconomic status Baumgartner et al., 1998, 2004; Castaneda and Janssen, 2005. Sarcopenia increases mobility limitations Dufour et al., 2013; Morley et al., 2011; Waters et al., 2010 and worsens CVD (cardiovascular disease) risk Chung et al., 2013; Clark and Manini, 2012; Cruz-Jentoft et al., 2010; Dominguez and Barbagallo, 2007; Kaess et al., 2010; Mitchell et al., 2012; Prado et al., 2012; Senechal et al., 2012.

2.2. Obesity-related health status and comorbidities

Adverse cardiometabolic changes, such as elevated fasting blood triglycerides, low levels of high-density lipoprotein, high fasting blood glucose, and elevated blood pressure, are all markedly accentuated by weight gain. The resultant micro- and macrovascular end-organ damage worsens existing patterns of decline in musculoskeletal, respiratory and cardiovascular system functions. Once manifest, these comorbidities and their sequelae, (i.e., coronary artery disease, angina pectoris, diabetes mellitus and peripheral neuropathy, hypertension, stroke) carry overt functional implications by themselves Peeters et al., 2004, which are amplified by dynapenia Chung et al., 2013; Dominguez and Barbagallo, 2007; Kaess et al., 2010; Prado et al., 2012; Stephen and Janssen, 2009.

2.3. Muscle strength and power

In healthy individuals, bone and muscle grow in harmony with changes in weight. This adaptive physiological mechanism is impaired in obesity. A progressive mismatch between body mass and strength occurs because of a progressive decline in muscle quality including: decreased fiber size and number, reduced intrinsic contractility; fat infiltration; motor unit restructuring, and impaired neurological modulation of contraction Stenholm et al., 2008; Visser et al., 2005. Obese persons with their higher body mass have reduced relative strength levels creating limitations in body-weight dependent daily activities such as walking, climbing stairs, rising from a chair or transferring from a lying to a standing position.

Muscle power (or work rate) is the product of the force produced by a muscle and its movement velocity Newton and Kraemer, 1994. Reduced muscular power and movement velocity are associated with a reduction in the ability to perform activities of daily living (ADLs), including stair climbing, rising from a chair and walking without assistance Bassey et al., 1992; Foldvari et al., 2000; Grabiner et al., 1993; Whipple et al., 1987. The relationship between gait speed and independence is well established Friedman et al., 1988; Gibbs et al., 1996; Guralnik et al., 1994; Judge et al., 1996; and many ADLs, such as stopping abruptly to avoid a car at a crosswalk, recovering from a stumble, or grabbing a handrail and entering a bus depend on speed Cummings and Nevitt, 1989; Dutta et al., 1997; Smeesters et al., 2001.

2.4. Flexibility

Flexibility, defined as "an intrinsic property of the body tissues that determines the range of motion achievable without injury at a joint or group of joints", improves the compliancy of connective tissues and muscle length (sarcomerogenesis), increasing stored elastic energy, antagonist compliance and the velocity at which peak power is produced, respectively Edgerton et al., 1986; Greg et al., 1994; Holt et al., 1996; Hunter and Marshall, 2002; Wilson et al., 1992; Worrell et al., 1994. These mechanical changes increase in importance as age Allander et al., 1974; Jette et al., 1990, inactivity Caspersen et al., 1985 and obesity Park et al., 2010 further interfere with flexibility.

2.5. Balance

Balance can be defined using a number of criteria Spirduso, 1995. The role of balance in performing ADLs is complex. Balance, if only mildly impaired, such as with normal aging, may be an independent predictor of vigorous ADLs only Van Heuvelen et al., 2000; whereas more pronounced balance impairments affect both basic and instrumental ADLs Ensrud et al., 1994; Laukkanen et al., 1994; Lord et al., 2001. With the exceptions of visual and vestibular problems, balance can be improved through exercise training.

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