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Physical Activity in Adolescents With an Orthopaedic Limitation

A Review of the Literature

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Nine out of 10 adolescents fail to achieve the *Healthy People 2020* recommended levels of aerobic and muscle-strengthening physical activity (J. E. Fulton et al., 2011). Whereas all adolescents constitute a vulnerable population because of their minimal physical activity, those with an orthopaedic limitation, such as slipped capitol femoral epiphyses, are at greater risk despite sharing characteristics with the general adolescent population such as normal cognition and independent ambulation. Twenty articles are reviewed describing components of effective physical activity interventions for adolescents aged 10–19 and their applicability to the target population of those with an orthopaedic limitation. Although physical activity interventions for adolescents with an orthopaedic limitation receive limited discussion in the literature, physical capability, belief in ability, and nontraditional activities, including dog-walking, are identified as behavioral facilitators.

Physical activity, including school-based physical education (PE) class, plays a pivotal role in maintaining adolescent health (Centers for Disease Control and Prevention [CDC], 2012). Nevertheless, implementing effective physical activity interventions is problematic; results from the 2010 *National Youth Physical Activity and Nutrition Study* (NYPANS) suggested that 85% of adolescents did not meet the criteria for regular physical activity (60 minutes of aerobic activity, 7 days per week). Seven percent of adolescents are considered totally inactive (Fulton et al., 2011; U.S. Department of Health and Human Services, 2011). The lack of physical activity is reinforced by the fact that only 3% of high schools provide daily PE class (45 minutes a day, 5 days per week) during a 36-week school year (CDC, 2012). Even in schools offering daily PE class, decreases in physical activity persist with only 38% of 12th graders participating compared with 68% of ninth-grade students (CDC, 2012). Because adolescence is the period of life associated with the greatest increase in inactivity, starting off at low levels is especially troubling (USDHHS, 2011). Amplifying this concern is evidence demonstrating that physical activity behaviors established in adolescence continue into adulthood (CDC, 2012; USDHHS, 2011).

Adolescent inactivity has an immediate impact exemplified by the now commonplace occurrence of diagnoses that were historically reserved for adults, including asthma, cardiovascular disease, diabetes, obesity, osteopenia, and premature death (CDC, 2012). Physical inactivity is estimated to contribute to 1.9 million deaths per year (World Health Organization, 2004). Obesity, identified by body mass index for age at or above the 95th percentile, is found in 17% of the adolescent population (Ogden, Carroll, Curtin, Lamb, & Flegal, 2010) with this rate increasing threefold since 1990 (Zarrett & Wilson, 2012). Diminished weight-bearing physical activity in the growing years contributes to fractures, decreased bone density, and bone health in adulthood (Biddle, Gorely, & Stensel, 2004; Kohrt, Bloomfield, Little, Nelson, & Yingling, 2004). In addition to the physical risk factors, psychosocial outcomes, such as decreased self-esteem (Biddle et al., 2004; Hallal, Victora, Azevedo, & Wells, 2006), depression (Kwan, Davis, & Dunn, 2012), decreased academic achievement (USDHHS, 2011), and negative attitudes toward health (McMahan, 2009) are associated with decreased physical activity.

Whereas most adolescents know about and recognize the importance of physical activity for illness prevention and improved body image (McMahan, 2009), participation rates demonstrate a disconnect between physical activity knowledge and action (Iannotti & Wang, 2013). Knowledge of physical activity is a poor predictor of participation (Hallal et al., 2006), but attitudes are important. Adolescents who do not perceive physical activity as being enjoyable or purposeful are less likely to commit and adhere to physical activity (Morgan, 2001; Pender, Murdaugh, & Parsons, 2011). Rationale offered to explain the disconnect includes the absence of a social environment (Davison & Lawson, 2006) as well as a lack of purpose or meaningfulness for the behavior (Morgan, 2001).

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Increasing adolescent physical activity is a benchmark objective of *Healthy People 2020* (CDC, 2012) and the *National Initiative to Improve Adolescent Health* (USDHHS, 2011). The value of addressing this problem for stakeholders and policymakers includes the more than $2.4 million annual cost of treating adolescent obesity-related inactivity (Gettys, Jackson, & Frick, 2011). Even simple physical activity interventions, such as walking, have a potential economic savings of $5 billion annually (Epping, 2011).

Background

In general, adolescent physical activity interventions have focused on the adolescent population as a whole, with selected studies focusing on those with severe disabilities or athletes (Dobbins, DeCorby, Robeson, Husson, & Tirilis, 2009; Feltz & Magyar, 2006; Michielsen, Van Wijk, & Ketelaar, 2010). There is a gap in the literature focusing on the physical activity needs of adolescents with an orthopaedic limitation, a group of otherwise healthy individuals with normal cognitive ability who have an injury or deformity, transient or chronic, which necessitates physical activity modifications. Traditional forms of individual physical activity, particularly running and contact sports, are often prohibited for this group due to the physical mechanics of the limitation and a requisite need for limb preservation. Conversely, activities such as walking are considered appropriate and within this group's capabilities (Gettys et al., 2011). Compounding the problem, certain orthopaedic diagnoses can be both potential predisposing factors to and consequences of inactivity (Gettys et al., 2011; Taylor et al., 2006).

To give context and provide a means of extrapolation to other types of orthopaedic limitations in this subgroup of adolescents, slipped capital femoral epiphyses is briefly described. Slipped capitol femoral epiphyses is a condition of the hip in which the proximal femoral epiphyses are depicted as "slipping" from the femoral head (Lehmann, Arons, Loder, & Vitale, 2006). This condition typically occurs between the ages of 11 and 15 years (Gettys et al., 2011) with males being affected almost three times as often as females (Lehmann et al., 2006). The incidence of slipped capital femoral epiphyses in the United States is approximately 10.8 cases per 100,000 adolescents (Murray & Wilson, 2008). Treatment includes surgical stabilization and short-term activity/mobility restrictions (Lehmann et al., 2006).

Adolescents with a slipped capitol femoral epiphyses generally have a body mass index greater than the 95th percentile at the time of diagnosis; subsequent increases in obesity-related risk factors are frequent (Gettys et al., 2011; Taylor et al., 2006). Orthopaedic complications, such as avascular necrosis of the femoral head, loss of the hip joint due to chondrolysis, and chronic pain are associated with this condition (Gettys et al., 2011; Taylor et al., 2006). Despite the ability to perform activities like walking, decreased levels of physical activity reinforce the relationship between obesity and slipped capitol femoral epiphyses (Gettys et al., 2011).

All adolescents with orthopaedic limitations are at increased risk for the negative consequences of inactivity, intensifying the need for innovative approaches acceptable to this population. As effective interventions in the general adolescent population are predicated on breaking the vicious cycle of inactivity, poor diet habits, and negative attitudes (Frenn, Malin, & Bansal, 2003; Mohamadian et al., 2011), the influence of these factors must also be considered in interventions in this population. The orthopaedic condition and prognosis are not solely responsible for the adolescent's perceived quality of life; satisfaction with physical and emotional health can significantly contribute to the success of physical activity interventions and overall health (Mohamadian et al., 2011).

Human–animal interaction, in the form of dog-walking, is proposed an approach with high potential for increasing physical activity commitment and adherence in this population. Several studies investigating the use of human–animal interactions for physical activity document a decrease in cardiovascular risk factors (Baun & Johnson, 2010; Friedmann, Son, & Tsai, 2010), along with positive psychological impacts (Marino, 2012). The use of dog-walking for physical activity has emerged as a health promotion intervention in its own right with the positive interaction between the participant and dog serving as the reason for physical activity engagement and subsequent decreases in obese individuals (Johnson & Meadows, 2010; Kushner, Blatner, Jewell, & Rudloff, 2006). Many in this population may not have their own pet; however, the inclusion of a nonpet, therapy or shelter dog, also offers a potential source of purpose and emotional support that has been demonstrated in previous human–animal interaction studies (Johnson & Meadows, 2010; Johnson & McKenney, 2011).

The goal of this article is to provide a descriptive literature review of physical activity interventions in adolescents with an orthopaedic limitation. The objectives of the review are to (1) describe characteristics of effective physical activity interventions in the selected studies for relevance and applicability to the population of focus and (2) determine whether alternative forms of physical activity, such as dog-walking, are potential areas for interventions in adolescents with an orthopaedic limitation. The aim is not a comprehensive review of adolescent physical activity; rather, it is to gain an understanding of the availability, need, and types of physical activity for adolescents with orthopaedic limitations by synthesizing the characteristics of adolescent physical activity participation and perceptions.

Methods

Definition of Orthopaedic Limitation

In this review, an orthopaedic limitation is defined as an injury or deformity that is a recognizable diagnosis by the WHO *International Classification of Diseases* code (World Health Organization, 2013). Although the diagnoses are not limited by typology (acute, chronic,

congenital, transient), eligible studies will describe activity levels of the participants characterized by a minimum requirement of independent functional ambulation. Examples include clubfoot, developmental dysplasia of the hip, healed fracture of the lower extremity, and slipped capitol femoral epiphyses.

Search Strategy

A search was performed of MEDLINE, PubMed, CINAHL, and Psych INFO identifying studies with any relevance adolescent physical activity, modified or alternative, and characteristics of the population of interest. Key words and search terms, including adolescents, physical activity, orthopaedic diagnoses/injury, disability (transient or acquired), and barriers to adolescent physical activity, were used. A manual search of textbooks and authored, peer-reviewed books with topics specific to adolescents and/or physical activity was conducted as well. Previous reviews addressing adolescent physical activity were examined for pertinent studies and as a primer for review approach. The search resulted in 56 articles and five books.

Selection Criteria

Criteria for study inclusion were determined by the following parameters: (1) publication within the timeframe of 2001–2013, (2) male and/or female participants between the ages of 10 and 19 years, (3) studies in which the objective measure or focus was adolescent physical activity, and (4) studies reporting correlates (benefits and barriers) associated with adolescent physical activity. Studies that included participants with cognitive impairment or severe physical disability impeding independent ambulation were excluded from this review.

Physical activity type comprised a broad classification in which any form of organized or leisure-time activity necessitating aerobic and voluntary effort (Cervantes & Porretta, 2010) was allowed. Articulation of the amount of physical activity was necessary for inclusion. Empirical, cross-sectional, and descriptive study designs were included because of the exploratory nature of the review. Based on the paucity of studies involving adolescents with an orthopaedic limitation and physical activity produced by the search, it was decided to also include populations and interventions with similar and/or transferrable attributes. Examples include physical activity interventions targeting obese adolescents, settings outside of school-based PE class, and activities, including dog-walking, that are not traditionally considered for physical activity. Twenty studies were identified that met eligibility for review (see Table 1).

Results

Population

Twelve of the 20 research populations in this review were billed as "normal" adolescents, that is, adolescents without cognitive, psychological, or severe physical impairment. Three studies focused on a population that met the definition of an orthopaedic limitation proposed for this review (Anand & Chorney, 2007; Ceroni et al., 2012; Harris-Hayes, Steger-May, Pashos, Clohisy, & Prather, 2012). Four additional studies worked with populations that had related characteristics, including obesity, musculoskeletal pain, and athletic status (Daley, Copeland, Wright, & Wales, 2008; Jannini, Doria-Filho, Damiani, & Silva, 2011; Snyder et al., 2010; Stommen, Verbunt, Gorter, & Gossens, 2012). One additional study (Newton et al., 2007) focused on an underserved population based on socioeconomic status.

Obesity was a physical trait commonly attributed to the review population, but inconsistently applied as a research construct. Obesity was frequently assumed to be a consequence of decreased physical activity, including those with implications for the target population (Anand & Chorney, 2007; Jannini et al., 2011). Psychosocial characteristics describing physical activity behaviors were described (Araujo-Soares, McIntyre, & Sniehotta, 2009; Molloy, Dixon, Hamer, & Sniehotta, 2010), but no study included developmental stage despite it being an implicit factor in decision making and a predictor for physical activity intent (McMahan, 2009).

Environment

Examination of the physical environment included issues of accessibility (Cook et al., 2014) and setting (Gyurcsik, Spink, Bray, Chad, & Kwan, 2006) with both studies illustrating a relationship between increased physical activity and decreased environmental barriers. These findings are supported by earlier reviews demonstrating the association of barriers to physical activity and participation levels in adolescence (Davison & Lawson, 2006; Dobbins et al., 2009). Description of the setting for studies specific to adolescents with an orthopaedic limitation is limited to research-based healthcare setting (Harris-Hayes et al., 2012) or absent (Anand & Chorney, 2007; Ceroni et al., 2012). Excluding the use of cross-sectional, school-based surveys, no study used PE class as the intervention site. Lubans, Morgan, Callister, and Collins (2009) identified extracurricular activities in a school-based setting.

Social environment was discussed in 15 of the 20 studies. The most commonly reported social correlates were social support, particularly encouragement and positive feedback (Cook et al., 2014; Lubans et al., 2009; Newton et al., 2007), and self-efficacy (Harris-Hayes et al., 2012; Robbins, Pis, Pender, & Kazanis, 2004; Snyder et al., 2010; Stommen et al., 2012). Four of the five dog-walking studies offered the animal as a form of social support (Timperio, Salmon, Chu, & Andrianopoulos, 2008) or motivation (Mathers, Canterford, Olds, Waters, & Wake, 2010; Salmon, Timperio, Chu, & Veitch, 2010; Sirard, Patnode, Hearst, & Laska, 2011) in the physical activity setting.

Study Design

The majority of studies used nonexperimental designs with one qualitative study and 10 cross-sectional

Table 1. Studies of Adolescent Physical Activity Interventions

Author(s) (Year)	Topic	Design/Subjects	Findings and Outcomes
Anand & Choney (2007)	PA after SCFE	Cross-Sectional 43 subjects	67% resumed PA Type and level not identified
Araujo-Soares et al. (2009)	PA environment	Quasi-experimental 157 subjects	Planning for PA associated with increase in PA level
Ceroni et al. (2012)	PA after lower extremity fracture	Quasi-experimental 100 subjects	Moderate PA levels in fracture subjects decreased at 6 and 18 months
Cook et al. (2014)	PA environment	RCT 536 subjects	Perceived physical barriers significant mediators to PA participation
Corder et al. (2011)	PA environment	Cross-sectional 799 subjects	Lowest level of accuracy of perceived vs. actual PA in inactive subjects
Daley et al. (2008)	PA environment	Qualitative 28 subjects	PA availability associated with positive experience
Gyurcsik et al. (2006)	PA environment	Cross-sectional 281 subjects	Barriers related to health and transportation increase with age
Harris-Hayes et al (2012)	PA after DDH	Quasi-experimental 222 subjects	DDH group with PA level comparable to control group
Jannini et al. (2011)	PA environment	Cross-sectional 200 subjects	Subjects with orthopaedic diagnosis reported increased pain and decreased PA but no decrease in perceived ability
Lubans et al. (2009)	PA environment	RCT 424 subjects	Increased PA with self-monitoring (pedometer) and social support
Mathers et al. (2010)	PA environment-DW	Cross-sectional 928 subjects	75% of subjects with pet reported no increase in PA
Molloy et al. (2010)	PA environment	Cross-sectional 903 subjects	PA increases in females associated with social support
Newton et al. (2007)	PA environment	Quasi-experimental 353 subjects	Caring group reported increases in intent for future PA
Robbins et al. (2004)	PA environment	Quasi-experimental 168 subjects	PA duration increases associated with enjoyment and belief in ability
Salmon et al. (2010)	PA environment-DW	Cross-sectional 1220 subjects	Average PA increases of 120 min/week in older adolescents with dog
Sirard et al. (2010)	PA environment-DW	Cross-sectional 618 subjects	PA significantly associated with dog ownership
Snyder et al. (2010)	PA environment	Cross-sectional 325 subjects	Increases in QOL associated with PA in athletes but no difference in perceived health
Stommen et al. (2012)	PA with chronic MSK pain	Quasi-experimental 42 subjects	Chronic pain subjects PA levels comparable to control
Timperio et al (2008)	PA environment-DW	Cross-sectional 281 subjects	Dog ownership associated with PA, decrease odds of obesity
Yam et al. (2012)	PA environment-DW	RCT (protocol) 40 subjects	NA

Note. DDH = developmental dysplasia of the hip; DW = dog walking; MSK = musculoskeletal; QOL = quality of life; PA = physical activity; RCT = randomized control trial; SCFE = slipped capitol femoral epiphyses.

studies. The reviewed cross-sectional studies document associations between physical activity participation and environmental correlates that are capable of replication. Six studies used experimental designs with two quasi-experimental studies comparing adolescents with an orthopaedic limitation and a control group with no limitations that allowed for inferences about physical activity participation after fracture (Ceroni et al., 2012) or in the presence of a hip condition (Harris-Hayes et al., 2012). Moreover, comparing groups of adolescents with musculoskeletal pain (Jannini et al., 2011) or those with limited opportunity for physical activity (Newton et al., 2007) illustrated what predictors in the intervention can be varied to optimize the outcome (Polit & Beck, 2012).

Study length ranged from 10 days to 23 months. Only two studies used a longitudinal design that included a third data collection time point at a minimum of 12 months after the intervention that is associated with physical activity sustainability (Araujo-Soares et al., 2009; Ceroni et al., 2012). Small sample sizes noted in the slipped capitol femoral epiphyses study (n = 43) (Anand & Chorney, 2007), chronic musculoskeletal pain (n = 84) or study protocol (n = 40) by Yam et al. (2012) are often inadequate to determine effect size of an intervention (Marino, 2012; Polit & Beck, 2012). Arguably, it is difficult to determine effect size for a study when no comparable intervention exists as evidenced by the first-time studies in this review (Cook et al., 2014; Newton et al., 2007; Yam et al., 2012).

No two studies used the same tool to assess physical activity. Self-report as the outcome measurement was used in 12/20 of the selected studies, generally by survey or questionnaire and using both primary and secondary analyses (Dobbins et al., 2009). Subjective perceptions about physical activity were collected with validated psychometric instruments such as the Pediatric Outcomes Data Collection Instrument (PODCI) assessing quality of life related to musculoskeletal function in the Snyder et al. (2010) study. Objective measurement was most commonly performed with step count by accelerometer. Multiple measures of physical activity, considered to be the most comprehensive assessment of physical activity due to the combination of perception and actual participation, were employed in seven studies (Corder et al., 2011; Harris-Hayes et al., 2012; Lubans et al., 2009; Mathers et al., 2010; Robbins et al., 2004; Sirard et al., 2011; Timperio et al., 2008; Yam et al., 2012).

Theoretical frameworks, including social–cognitive theory and theory of planned behavior, were clearly identified in three of the 20 studies. The indirect use of theory was evident in 11 studies by the inclusion of concepts related to ecological theory, health promotion model, and social support theory (McMahan, 2009; Pender et al., 2011). The fundamental principles of musculoskeletal biomechanics, supporting the relationship between weight-bearing physical activity and bone health, were noted in three studies as the basis for the physical activity interventions (Anand & Chorney, 2007; Ceroni et al., 2012; Stommen et al., 2012).

Outcomes

Sixty percent of the reviewed studies reported physical activity-level changes. The studies by Cook et al. (2014) and Lubans et al. (2009) reported significant increases in the physical activity levels of adolescents assigned to the intervention group ($p = .002$ and $p < .05$, respectively). The cross-sectional study by Mathers et al. (2010) with healthy adolescents was the only study to find no improvement in physical activity level. Two studies demonstrated decreases in weight related to the physical activity intervention (Jannini et al., 2011; Timperio et al., 2008). Inactivity was associated with a 37% decrease in becoming obese (Timperio et al., 2008) and those with an orthopaedic disorder at a greater risk for obesity ($p = .001$) (Jannini et al., 2011).

Adolescents sustaining a femur or tibia fracture had no significant increase in moderate physical activity 6 months after the injury when compared with adolescents with no fracture history ($p = .174$) (Ceroni et al., 2012). In adolescents with an identified orthopaedic diagnosis or chronic musculoskeletal pain, there were no differences in physical activity levels when compared with their healthy counterparts (Harris-Hayes et al., 2012; Snyder et al., 2010; Stommen et al., 2012). According to Harris-Hayes et al. (2012), adolescents with developmental dysplasia of the hip, despite reporting poor function, achieved levels of activity similar to participants with no limitation ($r = .33, p < .0001$).

Self-efficacy was the overriding concept identified in influencing physical activity behaviors. The positive relationship between self-efficacy, physical activity enjoyment, and continuing participation was found significant ($r = .297$, $p < .001$) by Robbins et al. (2004) and was the most direct measure of this concept. In the three studies specifically examining adolescents with an orthopaedic limitation, results suggested that the psychological component of the confidence in ability (self-efficacy) was more important than actual physical capability.

Review Summary

Strengths of the review method include a proposed definition of an adolescent with an orthopaedic limitation offering the opportunity to describe a little-known group with respect to physical activity participation. Moreover, such a definition allows for the delineation of individuals with this type of limitation from those with neuromuscular disorders, such as cerebral palsy, and those with developmental/intellectual disabilities. The overriding limitation of this review is the nominal data available regarding the role of physical activity in this population. The weakness of such an approach leads to difficulties in generalizing the outcomes to adolescents with an orthopaedic limitation, weak conclusions about interventions for this population based on the lack of studies, and the limited knowledge to inform future study design.

Discussion and Recommendations

Adolescents with an orthopaedic limitation can be easily characterized in the research literature. The need for physical activity in this group exists and may even be heightened by issues related to bone density, delayed achievement of peak bone mass, and chronic pain (Hallal et al., 2006; Jannini et al., 2011; Stommen et al., 2012). Furthermore, adolescents in this population share many of the same characteristics as adolescents in general related to barriers to physical activity including access, availability, and purposeful activity in which actions are based on motivation (Cook et al., 2014; Lubans et al., 2009). Despite social environment being unidentified by the studies of adolescents with an orthopaedic limitation, studies with similar population or premises (Jannini et al., 2011; Stommen et al., 2012) offer potential predictors related to physical activity participation, including self-efficacy and the importance of perceived ability.

Ability, vocalized by adolescents with an orthopaedic limitation and similar populations, is the most crucial finding in the reviewed studies. Neither population perceived or reported a decrease in ability related to motion (Harris-Hayes et al., 2012), pain (Stommen et al., 2012), or previous injury/surgery (Anand & Chorney, 2007; Ceroni et al., 2012). Moreover, interest and level of participation (Daley et al., 2008; Harris-Hayes et al., 2012) were irrespective of the diagnosis. The unanswered subtext is the type of activity capable of providing an appropriate form of physical activity in addition to an environment capable of sustainability.

Physical activity connectivity was described by Gyurcsik et al. (2006) as the activity's fit matching the

skill of the participant, interest in the activity based on deductive reasoning, and participation based on motivation. Future studies and interventions of physical activity interventions in adolescents with an orthopaedic limitation can apply this connectivity by using the concepts identified in this review, ability (self-efficacy), social support, and purposeful activity in a physical activity intervention framework.

Dog-walking for physical activity is offered as one example for applying this framework and with the potential to address the needs of this population. Walking is recognized in this review and studies specific to human–animal interaction as a low impact activity requiring minimal skills, equipment, and cost (Epping, 2011). Hence, the activity matches the ability of the adolescent. As suggested by the dog-walking studies in this review, the animal serves a source of motivation, support, and purpose (Sirard et al., 2011; Timperio et al., 2008) and perhaps even a reason for commitment and adherence.

Other types of physical activity interventions and other approaches to increasing overall activity necessitate consideration as well as dog-walking is not a panacea, nor amenable, to all adolescents in this population. Activities such as bicycling and swimming are also within this group's capabilities and may even potentially improve the outcome of their orthopaedic condition (Kohrt et al., 2004). Interventions to increase physical activity in adolescents with an orthopaedic limitation can further be found in the settings of everyday life. School-based approaches allowing more time for unstructured physical activity between classes (Long et al., 2013) and community programs that support walking or bicycling routes both offer opportunities for increasing activity and fit the needs of this population.

Implications for Nursing Practice and Research

Simply by providing patient education on the relationship between physical activity and the medical diagnosis, healthcare providers can improve physical activity levels and the outcome of the condition (Vuori, Lavie, & Blair, 2013). Orthopaedic nurses are uniquely positioned to identify adolescents who are at risk for decreased physical activity due to an orthopaedic limitation based on the knowledge of the relationship between bone mass, joint preservation, and weight-bearing activities. Clinical assessment of physical ability, current activity level, and physical activity interest should be an implicit component in patient interactions. Counseling the adolescent's families and school personnel on the appropriate types of activity, instead of activity restrictions, further emphasizes the value of physical activity in a group with a predisposition to inactivity.

The goal of the current review of physical activity interventions in adolescents with an orthopaedic limitation is to summarize predictors of musculoskeletal health. The results underscore the need to study this population as a cohort and the importance of matching physical activity type to participants. The development of empirically based research, such as testing dog-walking for physical activity, offers the added benefit of transforming the presumption of "good" often seen in human–animal interactions as well as physical activity interventions to measurable outcomes in the physiological and psychosocial markers of health. Furthermore, demonstrating an innovative and effective physical activity intervention tailored to the physical and psychosocial needs of the target population will determine its sustainability and generalizability to other adolescent populations, within and outside the realm of orthopaedic nursing (Diana, 2012).

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