Can Exergaming Prevent Low Back Pain Among Adolescents?

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Low back pain among adolescents has had high prevalence in recent years and contributes to self-reported disability, a high economic burden worldwide, a reduction in quality of life and long-term impairment. It is critical to seek effective prevention and therapeutic procedures. This study explores promoting trunk stability exercises among adolescents who are physically inactive as the first step towards preventing low back pain and improving physical activity. By using a controlled trial design, convenience sampling with 8 participants for the control group and 8 participants for the experimental group who received 2 weeks of video workout programme, we assessed trunk endurance with the Biering-Sørensen test, prone plank test and side plank test. After the intervention we did not observe significant changes, except in the side plank test (0.05) in the experimental group. However, to increase trunk muscular endurance, specifically in adolescents, effective core conditioning programmes must be implemented in accessible settings.

Keywords: low back pain, physical activity, sedentary lifestyle

Introduction

Low back pain (LBP) is a primary public health concern that contributes to self-reported disability and a high economic burden worldwide (Bontrup et al. 2019). It is associated with a reduction in quality of life (Jonsdottir et al. 2019) and long-term impairment (Lötters and Burdorf 2006). Epidemiological studies found that LBP affects both adults and children, with schoolchildren reporting it most commonly (Balague, Troussier, and Salminen 1999; Harreby et al. 1999; Gunzburg et al. 1999; Jones and Macfarlane 2005; Hurwitz, Morgenstern, and Chiao 2005; Hartvigsen and Christensen 2007; Yao et al. 2011; Kędra et al. 2019; Joergensen et al. 2019). Harreby et al. (1997) found that 88 percent of children who have LBP from childhood will continue to have it as adults.

The World Health Organization defines physical activity as any bodily movement produced by skeletal muscles that requires energy expenditure. This may encompass moderate-to-vigorous physical activities which have

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the potential to promote health (WHO 2024). Several environmental constraints related to urbanization are believed to be attributed to the global inactivity epidemic, including fear of violence and outdoor crime, high-density traffic, decreased air quality, and lack of suitable exercise places, sidewalks, sports facilities, and parks (WHO 2024).

Sedentary Behaviour and Low Back Pain

Physical activity is defined as any activity produced by skeletal muscles that requires the expenditure of energy, while sedentary behaviour is any waking behaviour characterized by a 1.5 MET energy expenditure or less when sitting, reclining, or lying. Sedentary behaviours include most desk-based office work, driving a car, and watching television; they can also apply to persons who are unable to stand, such as wheelchair users (Bull et al. 2020). According to Mahdavi et al.'s (2021) meta-analysis, recent studies provide significant evidence that different types of sedentary behaviour are linked to the development or recurrence of LBP in both adults and children. Given the increasing trend of sedentary behaviour worldwide, particularly in the era of the COVID-19 pandemic, it is suggested that meticulous and robust preventive strategies be implemented to avoid the establishment of sedentariness early in childhood and to prevent its musculoskeletal consequences such as LBP.

In a systemic review, Kędra et al. (2020) explored the most recent literature on the association between physical activity and LBP occurrence in schoolchildren. The epidemiological data have shown that LBP is not only a health problem for adults but is also frequently reported by schoolchildren and that the prevalence of LBP in children and adolescents increases with the subjects' age. Mapping the aetiology, or at least a few risk indicators, will be a prerequisite for developing effective primary prevention. Moreover, the aetiology of LBP in childhood is still a matter of debate. Additionally, studies investigating risk factors for LBP report mostly unclear associations. The review provides moderate evidence for the association between physical activity and LBP in children and adolescents.

Studies have shown a direct relationship between trunk extensor muscular endurance and LBP frequency (Allen et al. 2014). The trunk extensor muscles (spinal extensors) are located posteriorly and are responsible for extending the spine and eccentrically controlling forward flexion (Kibler, Press, and Sciascia 2006). The literature has established several advantages for resistance exercises in young people, including enhancing bone health and decreasing the risk from sports-related injuries, including lower back-related injuries

(Faigenbaum et al. 2009). It has been recognized that exergames provide an enjoyable experience, and enjoyment may be the key factor in motivating individuals to participate in and continue the exercises as gameplay. Exergames are therefore successful at encouraging children to engage in physical activity (Haichun 2013).

The aim of the study is to assess the effect of 2 weeks of video movement intervention on trunk endurance.

Methods

Subjects

The study used a controlled trial design to assess the impact of trunk stability exercises through a video workout programme on trunk endurance among adolescents (age 15.8 ± 1,4) with a sedentary lifestyle. The inclusion criteria were: the participant must be aged between 10–18 years and not engage in any physical activities or sports outside school activities. The following were considered as exclusion criteria: specific low back pain, disability, other illness that would prevent them from exercising.

Trunk Endurance Tests

To assess trunk endurance we used the Bering-Sørensen test (Coorevits et al. 2008) and plank tests. The Bering-Sørensen test is a trunk-holding test in an antigravity prone position and is commonly used to measure the endurance capacity of the back muscles with predictive validity. In the starting position the participant is half prone, lying on a plinth with the superior edge of the iliac crest at the edge of the plinth and the arms crossed over the chest. The lower limbs are strategically stabilized with straps. The participant is asked to maintain the upper body in a horizontal position and the timer is started. The test ends if the participant can maintain the position for 4 minutes (240 seconds) or can no longer maintain the set position before 4 minutes elapses. The stop time is recorded.

The prone plank test and the side plank test (left and right) were used to examine trunk endurance (Bohannon et al. 2018). It is a valid and reliable assessment for both younger and older individuals. The aim of the prone plank test is to hold an elevated position for as long as possible. The subject starts with the upper body supported off the ground by the elbows and forearms, and the legs straight, with the weight taken by the toes. The hips are lifted off the floor, creating a straight line from head to toe. As soon as the subject is in the correct position, the stopwatch is started. The head should be facing toward the ground and not looking forwards. The test is over when the subject is unable to hold the back straight and the hips are lowered. The aim of the side plank test is to hold an elevated position for as long as possible. The subject lays on the right side and the upper body is supported off the ground by the right elbow and forearm. The legs are straight, with the left foot (top) in front of the right foot. The hips is lifted off the floor so that the elbow and feet support the body, creating a straight line from head to toe. As soon as the subject is in the correct position, the stopwatch is started. The test is over when the subject is unable to hold their back straight and the hip is lowered. After five minutes of rest, the other side is tested.

Procedure

The procedure began with assigning participants to the intervention and control groups equally and voluntarily by asking them which group they were interested in joining. The first visit included an explanation of the research topic and its significance to the participants and society, as well as the collection of demographic information. For study purposes we developed a stand-alone video device for increasing spine stability (figure 1). We performed a literature review in the field of hardware selection and exercise interventions. The literature in the field of movement therapy to increase spine stability highlights the importance of a multi-stage approach. In the third part of the video content we add pre-planned training sessions. There are 8 levels in this part, which follow each other in order of difficulty. For our experimental group we chose the first level, which is the easiest and intended for beginners with little or no experience with exercising. To increase participants' motivation for training we chose a cartoon video design (figure 2).

The intervention plan includes three training sessions per week, each beginning with the warm-up, followed by trunk exercises, and ending with a cool-down. The warm-up consisted of 9 whole-body exercises (e.g. imitation of walking, stair climbing or squatting). Each exercise was performed with own body weight and lasted 30 seconds. The main part of the workout programme consisted of 9 exercises (figure 2). To stimulate the target muscles we used curl-ups, hip extension in four point kneeling position, squats, side and back bridge and single leg dead lifts. Participants performed 9 repetitions of each exercise with a 30-second break between them. Participants performed 4 cycles per training session. At the end of the workout was the cool-down which consisted of relaxation and some stretching exercises. All exercises were shown on the screen with written instructions. Both groups were assessed at the beginning and at the end of the 2-week intervention period.

Figure 1 A Stand-Alone Video Device

Figure 2 Trunk Stability Exercise: Squat

Statistical Analysis

The data was analysed using the Microsoft Excel program. The differences between the intervention and control group was tested using one sample t-test. The significance was set at $p < 0.05$. The study hypothesized that adolescents receiving two-weeks of intervention would demonstrate greater physical fitness compared to the control group.

Results and Discussion

Regarding trunk endurance measurements, the observed results were not significant, except in the experimental group in the side plank test (left side) ($p = 0.05$). The complete results for both groups are presented in table 1.

The purpose of the current study was to analyse the effect of a video work-

Table 1 Results for Trunk Endurance Tests (Mean and Standard Deviation)

	BS_PRE	BS_POST	PP_PRE	PP_POST	SPL_PRE	SPL_POST	SPR_PRE	SPR_POST
(a)	47.1±20.1	51.1±17.3	20.7±13.1	26.8±15.5	18.2±11.5	24.7±11.2*	18.9±9.5	23.7±9.5
(b)	94±49.7	74.6±48.5	32.5±23.6	27.9±26.1	23.4±17.5	19.5±13.4	26.3±24.5	25.8±13.8

Notes Row headings are as follows: (a) experimental, (b) control. BS – Biering Sørensen test, PP – Prone plank test, SPL – Side plank test left side, SPR – Side plank test right side, PRE – Baseline measurements, POST – Follow up measurements. * $p = 0.05$.

out programme on trunk endurance. The main findings of this study were that trunk endurance measures did not significantly differ between baseline and follow up tests among the control and experimental group. The only exception was the side plank (left side) test in the experimental group ($p = 0.05$).

Trunk muscular strength has been suggested to predict back pain and musculoskeletal disorders in children and adolescents. However, strengthening exercises that target both the superficial and deep trunk muscles are recommended (González-Gálvez et al. 2019). González-Gálvez et al. (2019) used Pilates as a recommended intervention attributed to reduce back pain, which enhances flexibility, posture, strength, balance and coordination among children. The study sample consisted of 101 students aged 14–15 years, randomly distributed into two groups: experimental group and control group. The intervention consisted of two 55-minute sessions per week for 6 weeks. After 6 weeks of intervention, the Pilates method seems to provide significant improvements in the strength of the flexor and extensor muscles of the trunk among school-age children. Based on these findings, González-Gálvez, Marcos-Pardo, and Carrasco-Poyatos (2019) suggested that the Pilates method could be utilized to improve functional stability and as a preventive tool for back disorders among children and adolescents.

Moreiraa et al. (2012) believes that exercise training programmes that focus on low back stability and mobility through strength and stretching exercises would be beneficial for preventing LBP in schoolchildren. The study included 58 healthy pupils from 4th to 8th grade from a Brazilian state school, divided into a control and experimental group. All the students were evaluated before and after the intervention period, which lasted six weeks. Resistance tests of the abdominal and trunk extensor muscles were performed in a random sequence. The Kraus-Webber test was used to assess abdominal resistance, while the Biering-Sørensen test (Moreau et al. 2001) was used to assess back extensor muscle resistance. The exercises performed during the programme sessions followed the guidelines for children's resistance training (Behm et al. 2008; Faigenbaum et al. 2009). The training was done twice a week for 60 minutes per session. However, abdominal muscular exercises were insufficient to achieve muscle resistance improvement.

Behm et al. (2008) discuss that individuals with high levels of trunk muscular endurance were more likely to have good overall trunk stability and be less prone to LBP. These findings show that increases in trunk muscular endurance may increase spinal stabilization and have a protective effect on the incidence of LBP. However, to increase trunk muscular endurance, especially in children, effective conditioning programmes must be implemented in accessible settings. The study demonstrated that individuals who had poor performance on the Biering-Sørensen muscular endurance test were more likely to have LBP than those who demonstrated greater performance.

Exergaming refers to video games that require partial or full-body movements to play, with the participant's body functioning as the de facto controller (Zeng and Gao 2016). According to Sunyue et al. (2019), over the past decade, exergaming's technological advances have affected the quality of population-based exergaming programmes and led to the creation of novel interactive exercise tactics. Specifically, exergaming combines interactive exercise equipment and activities to get children moving, capitalizing on children's fascination with computers and video engagement. Despite non-exergame video games' potential negative physiological health impact (e.g. obesity), exergaming has the potential to assist in the promotion of healthier lifestyles among schoolchildren (Biddiss and Irwin 2010).

According to Comeras-Chueca et al.'s (2021) systematic review, physical inactivity and poor motor skills are problems facing today's schoolchildren. Exergaming could be an attractive method to help address them. The aim of the study was to investigate the impact of exergaming on health-related physical fitness and motor competence in children and adolescents. The most-used devices in the interventions were gaming consoles such as Xbox 360 with Kinect, Nintendo Wii, Sony PlayStation 2, and dance mats. The interventions ranged from 6 weeks to 12 months with frequency of sessions ranging from 2–7 days per week and each session lasting 10–60 min. The control groups either received another intervention that did not include exergaming, such as physical education or exercise sessions, learning sessions, or were simply instructed to continue with their usual daily routines. The results of the studies showed that exergaming is a useful technique for increasing various aspects of health-related physical fitness as well as a promising method for enhancing motor competence in children and adolescents.

Conclusion

Concerning LBP, epidemiological studies found that LBP affects not only the adult population, but also children and adolescents. Several studies found that there is a relationship between decreasing trunk stability and the development of LBP. As a result, Mahdavi found that trunk stability exercises are highly recommended for individuals who suffer from LBP and also for the healthy individual as a preventive approach. However, physical inactivity, such as not being physically active during school breaks, watching TV and video gaming increases LBP prevalence.

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Ali gibalne videoigre zmanjšajo tveganje pojava bolečine v spodnjem delu hrbta pri mladostnikih?

Bolečina v spodnjem delu hrbta je med mladostniki v zadnjih letih zelo razširjena in povečuje mišično-skeletne težave, vpliva na ekonomske posledice ter zmanjšuje kakovost življenja. Pomembni so učinkoviti preventivni prijemi, med katere spadajo gibalne videoigre. V raziskavi smo preverili, ali dvotedenska gibalna intervencija vpliva na vzdržljivost trupnih mišic pri gibalno neaktivnih mladostnikih. V raziskavi je sodelovalo 16 udeležencev, osem v kontrolni in osem v eksperimentalni skupini. Vzdržljivost trupnih mišic smo vrednotili s testom Biering-Sørensen ter s sprednjim in z bočnim mostom. Po koncu intervencije nismo opazili značilnih sprememb. Izjema je bil bočni most (leva stran) pri eksperimentalni skupini, kjer je bila sprememba mejno značilna (0,05). Kljub neznačilnim spremembam je za povečanje vzdržljivosti trupnih mišic, zlasti pri mladostnikih, treba iskati motivacijsko ustrezne pristope in skrbeti za njihovo redno gibalno aktivnost.

Ključne besede: bolečina v ledvenem delu hrbta, gibalna aktivnost, sedentarnost