A pilot randomised clinical trial comparing the effect of video game dance training with ladder drills on agility of elite volleyball players

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ABSTRACT

This randomised pilot study compared the effects of a six-week, dance video game training programme with traditional agility ladder drills. Twenty-seven elite volleyball players participated and the Illinois Agility Test was used as the primary outcome measure. Significant improvement was seen in agility scores of the video game dance group with both an intention-to-treat analysis (ITTA), (median [Mdn]=-0.95, p=0.028), and per-protocol analysis (Mdn=-1.58, p=0.012). The ladder drills group showed no significant change in agility with the ITTA (Mdn=-0.71, p=0.062), but improvement was seen with the per-protocol analysis (Mdn=-0.85, p=0.028). Between group comparisons showed no significant difference in agility scores for the ITTA (p=0.650). However, with the per-protocol analysis, the video game dance training group demonstrated a significantly greater improvement in agility scores (Mdn=-1.58 sec; p=0.029.) compared with the ladder drills group (Mdn=-0.85 sec.). Changes observed for both analyses exceeded the minimal detectable change for the Illinois Agility Test, indicating that dance video game training may be a useful tool for clinicians wanting to enhance agility. Further research is warranted in this area.

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INTRODUCTION

Agility is a complex psychomotor concept which includes both neuromuscular and cognitive components such as stimulus recognition and reaction, or execution of a response (Horička, Hianik, & Šimonek, 2014; Sheppard & Young, 2014). Agility typically involves considerable spatial or temporal uncertainty while initiating whole body movement with multi-directional changes, and rapid acceleration and deceleration (Sheppard & Young, 2014).

Much of the work done in relation to agility training involves programmes designed for speed, agility and quickness, and commonly utilises ladder drills (Parsons & Jones, 1998; Robinson & Owens, 2004; Sheppard & Young, 2014; Yap & Brown, 2000). The primary focus of this type of training is footwork mechanics, speed, and directional change. The movement patterns are relatively closed and stereotyped, which implies that ladder drills in isolation will not necessarily address all components of agility. Other approaches to agility training include functional training in open environments, which can challenge both the perceptual and decision-making aspects of agility (Bloomfield, Polman, O'Donoghue, & Mcnaughton, 2007; Brughelli, Cronin, Levin, & Chaouachi, 2008; Horička et al 2014; Robinson & Owens, 2004; Serpell, Young, & Ford, 2011). For example, a training programme whereby athletes react to video recordings of rugby players executing specific movements, showed that the perceptual and decision-making aspects of agility were trainable (Serpell, Young, & Ford, 2011).

Dance training, using traditional dance instructors, and incorporating ballet, jazz, modern and character forms has been shown to improve agility in skiers (Alricsson, Harms-Ringdahl, Eriksson, & Werner, 2003; Alricsson & Werner, 2004). Other researchers have shown that dance training may improve balance, a component of agility, and suggested that this improvement may reduce the risk of falling in older adults (Federici, Bellagamba, & Rocchi, 2005).

Another approach to dance training is video gaming. Whilst research has shown the usefulness of active video gaming for improving physical activity and fitness in children and adults (Biddiss & Irwin, 2010; Peng, Crouse, & Lin, 2012), less is known about its effect on motor control and movement. Studies exploring the impact of six weekly sessions of active video gaming on movement skill, concluded that this type of activity may not contribute significantly to the development of perceived or actual movement skills (Barnett, Ridgers, Reynolds, Hanna, & Salmon, 2015; Johnson, Ridgers, Hulteen, Mellecker, & Barnett, 2016). Barnett et al. (2015) utilised the Nintendo Wii gaming system for conducting their study, whilst Johnson et al. (2016) used the XBOX Kinect. These findings were contrary to that of Vernadakis, Papastergiou, Zetou, and Antgoniou (2015) who found that biweekly training, for eight weeks, using games on the XBOX Kinect resulted in significant improvements in object control skill. Improvements were maintained at one-month post intervention. The variability in findings were probably related to the level of immersion in the game, duration of training, the type of games used, the type of game controllers and the outcome measures.

Pasch, Bianchi-Berthouze, van Dijk, and Nijholt (2009) found that four movement specific parameters influenced level of game immersion: natural control, mimicry of movement, proprioceptive feedback and physical challenge. These authors concluded that gaming systems utilising hand-held controllers may not be the best choice for active video gaming targeting motor skills.

The XBOX Kinect is a camera-based gaming system which tracks the movements of each player's upper and lower limb segments and trunk as they engage in activity. For dance games, the players follow the moves of virtual onscreen dance instructors. The gaming programme matches the camera-detected movement of the player against that of the programme and provides individualised player feedback in the form of stars and points displayed on the screen. This type of individual feedback is provided during both individual and group play. The more precise a player is at replicating the dance moves the higher their scores. Unlike conventional dance training, the XBOX Kinect provides both intrinsic (visual, auditory, vestibular, somatosensory) and extrinsic (scores that rank performance, and indicators of accuracy of movement) feedback, which is ideal for motor learning (Roopchand-Martin, Nelson, Gordon, & Yee Sing, 2015). Research has shown that this type of training is acceptable to young persons and athletes (Adachai & Willoughby, 2014; Roopchand-Martin, Mason, & Gibson, 2016).

Rehabilitation of some athletes may involve agility training. For many facilities, space constraints may be a hindrance to therapists delivering open-chain, sport-specific training activities. Video gaming systems, like the XBOX Kinect, do not require much space and if dance video gaming is shown to be beneficial some therapists may find it feasible to integrate this into their rehabilitation programmes for athletes.

Volleyball is the fifth most popular sport in the world with an estimated 900 million spectators worldwide (Dawson, 2016) and 220 federations registered with the International Federation for Volleyball (International Federation for Volleyball, 2018). Training programmes for volleyball players include agility activities, yet we could not find any published research outlining specific agility programmes for this group. This study sought to compare the effects of six weeks of dance training, using the XBOX Kinect, with traditional agility ladder drills on the agility of elite volleyball players at the University of the West Indies.

METHODS

Participants

The target group for this study was elite volleyball players from the University of West Indies volleyball club. Elite players were defined as persons who regularly competed in local and regional tournaments. Participants were excluded if they had a current musculoskeletal injury, which prevented them from performing physical activity, or if they were already involved in dance training. Groups of players were presented with the research during their training sessions, and recruited over a two-week period.

Procedure

Following approval from the University's ethics committee (reference number: ECP 213,13-14) a six-week, pilot randomised clinical trial was conducted (Clinical Trials.gov Identifier: NCT02370368). Thirteen players were targeted for each group based on an effect size of 1, alpha level of 0.05 and power of 0.8. Participants were assigned subject numbers and, baseline evaluations consisting of agility testing and recording of age and gender, was conducted by two unblinded, final year physiotherapy students, who were trained by the researchers. Reassessments were done within two days of completion of the training programme by the same assessors. Computerised randomisation was undertaken prior to baseline evaluation, randomly assigning participants to either video game dance training or agility ladder drills. Participants were asked to refrain from engaging in any other physical activity training apart from the research activity and their normal volleyball training.

Agility was assessed with the Illinois Agility Test, which has been shown to be a valid and reliable test for use with athletes (Hachana et al., 2013; Roozen, 2004; Topend Sports, 2015). The minimal detectable change for this test was reported to be 0.52 seconds (Hachana et al., 2013). The TC Timing System (Brower Timing Systems http://browertiming.com/products/tc-timing-system, Utah, United States) was used to track time to complete the agility course. Participants were asked to warm up with 5 minutes of jogging. Following this, they began in prone lying, with their hands aligned with the TC motion start sensor. On the "go" signal, they rose and manoeuvred the course as fast as possible (Topend Sports, 2015). Three trials were performed and the shortest time to complete the course was recorded. A 5 minute rest period was allowed between trials. All participants did one trial run prior to actual data collection. During the trial run they were asked to go at a slow pace to avoid fatigue.

Exercise Intervention

Both groups engaged in three training sessions per week for six weeks (the duration was determined based on the player's ability). Previous research involving video game training and motor skills have ranged from six to twelve weeks duration (Barnett et al., 2015, Peng et al., 2012).

The agility ladder drills were conducted in small groups, not exceeding four persons. Two ladders were laid out on the ground approximately 122 cm apart. Each ladder was 457 cm long, 43.8 cm wide and the flat, plastic rungs were 38.1 cm apart. Training began with activities requiring relatively simple footwork and increased in complexity at two-week intervals. Throughout training, participants were encouraged to go as fast as they could. Each session lasted approximately 45 minutes and was led by a physiotherapy student who was trained by the researchers to conduct the routine.

The dance intervention utilised the Just Dance 2014 disc and the XBOX Kinect 360, which was connected to a multimedia projector. Images were projected onto a screen (350 cm wide and 250 cm high). The camera for the Kinect system was placed directly in front of participants. Training was undertaken in small groups of no more than four persons. At the start of each session a physiotherapy student set up a playlist to run for approximately 45 minutes. The programme began with simple dance routines and progressed to selections involving more complex choreography at two-week intervals. No feedback or guidance was provided apart from instructing participants to follow the virtual dance instructors as best as they could.

Participants were asked to report any aches, pains, discomfort or injuries to the principal investigator. Injuries were managed by the qualified physiotherapist and orthopaedic specialist associated with the study.

Statistical Analysis

Data were analysed using non-parametric tests; the Wilcoxon Rank Sign test was used for all within group comparisons and between group comparisons were assessed with the Mann Whitney U test. Both an intention to treat analysis (ITTA) and a per-protocol (including only those participants who completed the training protocol as prescribed) were undertaken. Six participants who withdrew were reassessed at the time of withdrawal and their data were used for their post-test value in conducting the ITTA. For the other six who withdrew, the initial agility scores were used for the missing data points. All analyses were done with an alpha level of 0.05.

RESULTS

A total of 27 participants took part in this study (12 males, 15 females). Fourteen were randomised to the dance group and 13 to ladder drills. Fifteen (55.5% of participants) completed the study (Figure 1). Reasons for withdrawal included an increase in school workload, injury and other personal issues. A female participant in the ladder drills group developed severe knee

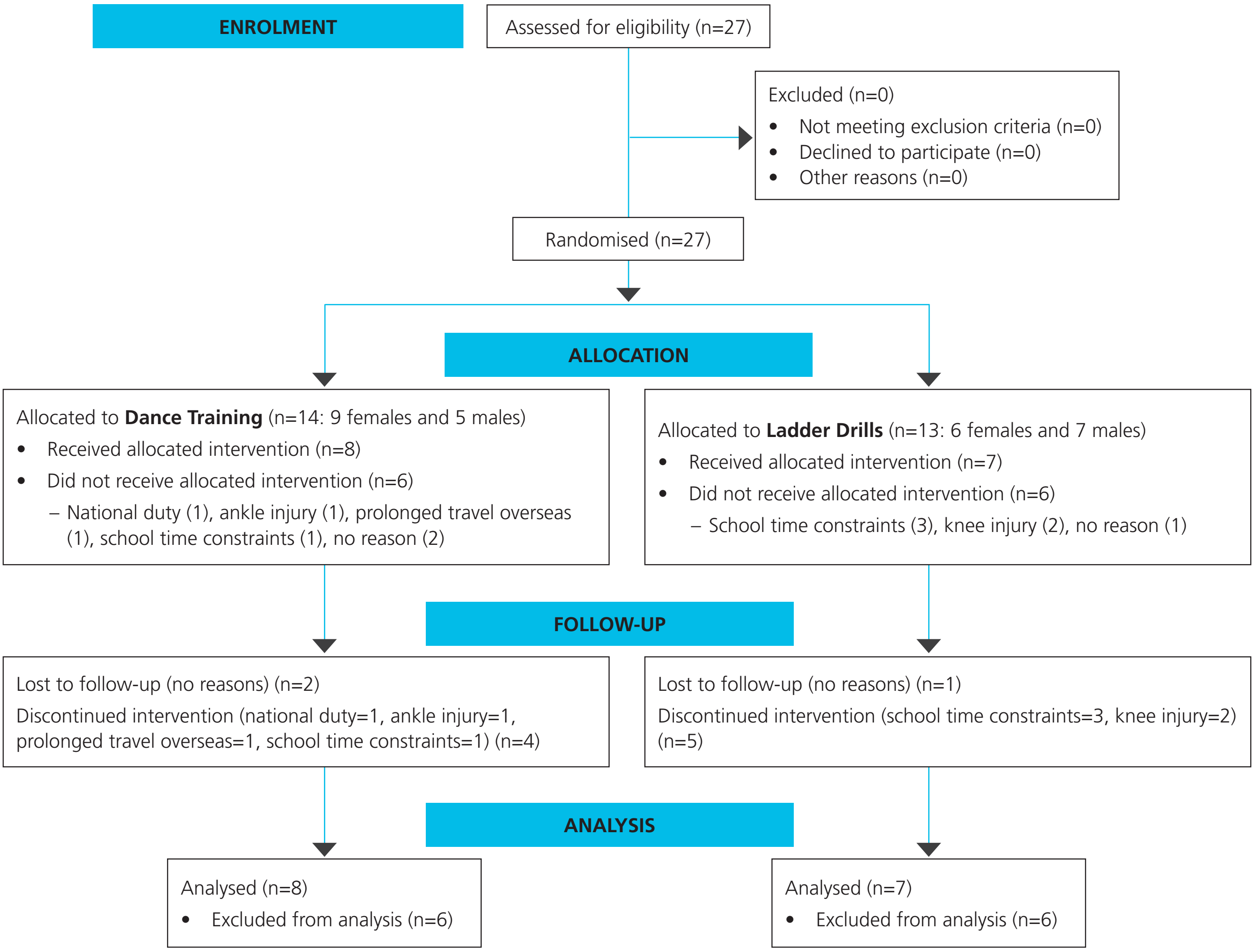

Figure 1: Study participants

pain and swelling after her first training session. Ultrasound investigation revealed features of tendinopathy, which was not detected at baseline, and the participant was withdrawn from the programme. Two adverse events were reported for the dance group: a minor hamstring strain and muscle soreness. Both participants received treatment and had no interruptions in their training schedule.

The baseline mean age was slightly higher for the dance (24.36 SD 5.66 years) compared to the ladder drills (23.54 SD 5.27 years) group. The mean age for both groups was higher at the end of the study (dance = 26.63 SD 6.18 years; ladder drills = 24.29 SD 6.62 years), indicating that withdrawal occurred among younger participants. A larger percentage of persons who withdrew (75%) were females. A Kolomgorov Smirnov test revealed normal distribution for pre- and post-test age and agility scores.

The ITTA showed an improvement in agility scores for both groups; with the median difference in agility scores exceeding the minimal detectable change (0.52 seconds) for the Illinois Agility Test (Table 1). The results from the Wilcoxon Signed Rank test, however, showed this change to be significant for the group that did dance training (Mdn=-0.95*, Z=-2.19,* p=0.028*,* r=0.58), but not for the ladder drills group (Mdn=-0.71, Z=-1.87, p=0.062, r=0.52). The between group comparison showed no significant difference (U=81, p=0.650, r=0.09) in median agility changes.

The findings from the per-protocol analysis demonstrated significant improvements in agility scores from baseline for both the dance training (Mdn=-1.58, Z=-2.52, p=0.012, r=0.70) and ladder drills (Mdn=- 0.85, Z=-2.19, p=0.028, r=0.56) groups (Table 2). The Mann-Whitney test showed that improvements in the Illinois Agility Test scores were greater for video game dance training (Mdn=-1.58 sec.) than ladder drills (Mdn=-0.85 sec.), U=9, p=0.029, r=0.57 (Table 1). The within- and between-group changes exceeded the minimal detectable change for the Illinois Agility Test.

Table 1: Intention to Treat Analysis (ITTA) of agility scores for video game dance training and ladder drills.

ITTA	Video game Dance Training n=14 (9 females, 5 males)		Agility Ladder Drills n=13 (6 females, 7 males)	
Initial Illinois Agility Test Scores (sec)	Pre-test	Post-test	Pre-test	Post-test
Mean SD	19.32 SD 1.89	18.52 SD 1.92	18.87 SD 1.35	18.34 SD 1.62
Minimum	16.32	16.32	17.18	16.48
Maximum	23.78	22.18	21.50	21.08
Range	7.46	5.86	4.32	4.6
Median	18.98	18.67	18.55	17.68
Wilcoxon Sign Rank Test	*Mdn=- 0.95, Z=-2.19, p=0.028, r=0.58		*Mdn=- 0.71, Z=-1.87, p=0.06, r=0.52	
Mann Whitney Test	U=81, p=0.650, r=0.09			

Notes: SD, standard deviation; *Mdn = Median difference, lower scores indicate faster completion of the test at the end of the study.

Table 2: Per Protocol Analysis of agility scores for video game dance training and ladder drills.

Per Protocol Analysis	Video game Dance Training n=8 (5 females, 3 males)		Agility Ladder Drills n=7 (1 female, 6 males)	
Initial Illinois Agility Test Scores (sec)	Pre-test	Post-test	Pre-test	Post-test
Mean SD	19.82 SD 1.89	18.27 SD 2.00	18.23 SD 1.13	17.37 SD 1.12
Minimum	18.06	16.35	17.18	16.48
Maximum	23.78	22.19	20.55	19.83
Range	5.72	5.84	3.37	3.35
Median	19.25	17.81	17.18	16.48
Wilcoxon Sign Rank Test	*Mdn=-1.58, Z=-2.52, p=0.012, r=0.70		*Mdn=- 0.85, Z=-2.19, p=0.028, r=0.56	
Mann Whitney Test	U=9, p=0.029, r=0.57			

Notes: SD, standard deviation; *Mdn = Median difference, lower scores indicate faster completion of the test at the end of the study.

Although not an outcome of the study, it was noted that the athletes were very engaged in the gaming activity. They would often sing along while dancing and a competitive environment emerged as they attempted to beat their own scores as well as that of other participants. This competitive behaviour was not observed for the participants involved in the ladder drills programme.

DISCUSSION

This pilot study sought to compare the effect of video game-based dance training with ladder drills on agility of volleyball players. The ITTA showed no difference between the two forms of training but did demonstrate a significant improvement in agility scores with dance training. The per-protocol analysis showed that dance training resulted in greater improvements in agility scores compared to ladder drills. The changes noted were well above the minimal detectable change for the Illinois Agility Test (Hachana et al., 2013), indicating that this type of training may lead to improvements in sport performance.

The training disc utilised in this study contained modern dance moves, with the music type being primarily popular and hip hop. The athletes knew all the songs and would often sing along while dancing. The feedback provided by the gaming system immediately created a competitive environment, with participants trying to beat their own scores as well as their group members. This training programme met the four parameters identified by Pasch et al. (2009) for greater game immersion (natural control, mimicry of movement, proprioceptive feedback, and physical challenge) and this could have contributed to the improvements noted. To create a similar competitive environment the ladder drills were also done in small groups. The degree of competition however, appeared to be much less than that of the dance group and this may have led to less effort during training compared to the dance group and therefore smaller changes.

As indicated previously, agility training should be an open activity involving considerable spatial or temporal uncertainty, in addition to physical and cognitive demands (Sheppard & Young, 2006). It was felt that the dance training used in this study met more of these characteristics as opposed to the ladder drills. The dance training required processing of constantly changing visual, auditory and proprioceptive information whilst performing complex, constantly changing, whole body movements through a wide range of motion. The ladder drills involved directional changes, acceleration and deceleration through a smaller range that than of the dance training and with less complex movement patterns. Movement combinations were more stereotyped and involved primarily footwork mechanics.

The trend for improvements in agility from dance training was like that reported by Alricsson and Werner (2004), who showed enhanced agility in young elite cross-country skiers following 3 and 8 months of dance training. The improvements in this study were larger than those of Alricsson and Werner (2004) and this may be due to differences in the agility outcome measure (hurdles compared to the Illinois Agility Test) and/or the type of dance training. The sessions in our study were accompanied by pop music with choreography requiring a wide range of complex movements, whereas Alricsson and Werner (2004) utilised a traditional dance instructor with music combinations involving jazz, ballet, modern and character.

No other studies examining video gaming and motor skills have incorporated dance games. Despite the differences in game choice, our findings were like that of Vernadakis et al. (2015), who reported significant improvement in object control skills following video gaming training with the XBOX Kinect.

Differences in training duration could have also accounted for the conflicting findings between our study and others exploring the effects of video game training on motor skills. The total training exposure in our study was greater than that of Johnson et al. (2016) and Barnett et al. (2015) who concluded that video game training did not improve motor skills.

This study has some limitations that require consideration. Firstly, it was a small pilot study and therefore it is important to note that the findings cannot be generalised to other volleyball players. Both groups were involved in their regular volleyball training, in addition to the study intervention. Since the researchers did not track attendance to regular training, variability in degree of training may have had an impact on the results and we could not account for this in our analysis. Neither the evaluators nor trainers were blinded to group allocation (due to the nature of the study it was not possible to blind the trainers), and this could have led to some degree of bias.

CONCLUSION

This pilot study showed improvements in agility scores of elite volleyball players with video game dance training and indicates that there is a need for further research exploring the role of dance video gaming as an agility training tool. Further research is also warranted to compare the effectiveness of this method of training with other established agility training programmes such as agility ladder drills and field drills with cones. Sports physiotherapists may wish to consider exploring dance video gaming as an optional modality for agility training with volleyball players.

KEY POINTS

1. Video game dance training with the XBOX Kinect may be useful as an agility training tool for volleyball players.
2. Further research should be done comparing video game dance training with established forms of agility training for athletes.

DISCLOSURES

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There are no competing interests by any of the authors. We, the authors declare that we have no financial affiliation (including research funding) or involvement with any commercial organisation that has a direct financial interest in any matter included in this manuscript.

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