

## Effect of 4-Weeks Traditional Archery Intervention on Hand-Eye Coordination and Upper Limb Reaction Time Among Sedentary Youth

**Mohd Azrul Anuar Zolkafi\***

Faculty of Sports Science and Coaching, Universiti Pendidikan Sultan Idris, 35900 Tanjung Malim, Perak, Malaysia  
Faculty of Medicine and Health Sciences, Universiti Sains Islam Malaysia, 55100 Pandan Indah, Kuala Lumpur, Malaysia

**Norsham Juliana Nordin**

Faculty of Medicine and Health Sciences, Universiti Sains Islam Malaysia, 55100 Pandan Indah, Kuala Lumpur, Malaysia

**Hayati Abdul Rahman**

Faculty of Medicine and Health Sciences, Universiti Sains Islam Malaysia, 55100 Pandan Indah, Kuala Lumpur, Malaysia

**Noor Aien Mon Sarip**

School of Health Sciences, KPJ Healthcare University College, 71800 Nilai, Negeri Sembilan, Malaysia

**Nur Islami Teng Abdullah**

Faculty of Health Sciences, Universiti Teknologi MARA, Puncak Alam, Selangor, Malaysia

**Mohd Azmani Sahar**

Faculty of Medicine and Health Sciences, Universiti Sains Islam Malaysia, 55100 Pandan Indah, Kuala Lumpur, Malaysia

### Abstract

This study aims to determine the effect of a 4-weeks traditional archery intervention on hand-eye coordination and upper limb reaction time in sedentary youth. Methods: Thirty sedentary youth with leisure time activities of less than 150 minutes/week (mean age =  $21.03 \pm 1.61$  years old) were randomly assigned into an intervention and a control group. A specific regimen of traditional archery training was given to the intervention group for 4 weeks, the control group on the other hand was requested to maintain their lifestyle. Result: There was significant intervention effect on hand-eye coordination of the intervention group ( $p < 0.05$ ). The reaction time of intervention group showed higher improvement compared to the control group, however, the intervention effect was not statistically significant ( $p > 0.05$ ). Conclusion: Archery training significantly improved the hand-eye coordination within 4 weeks.

**Keywords:** Traditional archery; Reaction time; Ruler drop test; Hand-eye coordination, Wall toss test.



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### 1. Introduction

In recent decade, mounting of evidence regarding benefits of sport training had been explored. Training in sports not only provides positive impact on general lifestyle but also enhance individual physiological and psychological function (Emeljanovas *et al.*, 2012; Merkel, 2013; Weintraub *et al.*, 2008). Specific skills such as agility and coordination were found to be improved with training in various types of sports (Bańkosz *et al.*, 2013; Kamandulis *et al.*, 2013). In order to evaluate agility and coordination, outcome measures involving reaction time and coordination components were frequently utilized.

There were various sports require high-speed total body movements. Responding to motion of ball, opposition players or teammates during training or games such as soccer, rugby and badminton were reported to have significant impact on agility and coordination (Bańkosz *et al.*, 2013; Gabbett *et al.*, 2008; Sant'Ana *et al.*, 2017).

Good hand-eye coordination reflex a healthy neurological function. The task involves complex process that begins with visual information to the brain being translated into 3-dimensional image. The brain must be able to identify the object and the accurate position of the object in space. Subsequently all the information is processed and the cerebellum will execute the motor coordination responsible for the task (Mauk *et al.*, 2000).

Up to date, data specifically on the health benefits with archery training were still limited. Recent findings reported that archery training provides health benefits on muscles and heart function as well as exert significant psychological effect (Aysan, 2016; Lo *et al.*, 2008).

Furthermore Aysan (2016) reported that archery training can be included as party of stress coping strategies. In other study, Lo *et al.* (2008) found that archery improves balance between sympathetic and parasympathetic nervous system. Thus, the positive effects of archery training reported in these recent studies showed that the game warrant further studies to enable holistic understanding of its benefit physically, physiologically and psychologically.

Therefore, this study specifically aim to determine the effect of 4-weeks traditional archery intervention on eye-hand coordination and upper limb reaction time in sedentary youth.

## 2. Literature Review

Coordination and reaction time are key elements in embrace physical activities especially sport performance (Cristina-Elena and Liliana-Elisabeta, 2014; Radwan, 2014). The coordination is defined as a coordination of nervous and muscular system involving multiple effectors in order to produce precise and harmonious body movement (Deidrichsen *et al.*, 2010). It is normally involving at least two body parts which move simultaneously at the same time whether similar or against direction. Meanwhile, the reaction time is a required time duration to initiate an effector response to a affector stimulation (Saxena *et al.*, 2008). For instance, the reaction of players on ball especially in fast games such as table tennis or tennis game.

The exploration of eye-hand coordination and reaction time among archers were still limited despite an importance of this element in enhancing athletes' performance. Similar to other sports that employed eyes-hand coordination and reaction time such as air-rifle or darts, the investigation on both elements were still considered poor especially involving an experimental study. In fact, there were least reported data on the effect of archery that involves static and isometric movement on these components (Peñailillo *et al.*, 2016).

The effect of sport intervention especially on high frequency of repetition on similar routines could improve the familiarization to specific skills. Few studies had been conducted which compared the effects of intervention to improve an eye-hand coordination and reaction time among adolescents and youth. Udermann *et al.* (2004), explored the cup stacking intervention on 40 adolescents. Following 5 weeks of cup stacking intervention, the participants showed an improvement on the eye-hand coordination and reaction time through soda pop and yardstick test. Similarly, the significant improvement of eye-hand coordination following respective routine was further proved by Akarsu *et al.* (2009). The authors found that the athletes population who are familiar with variety of body movement in sport activities had significantly shorter eye-hand reaction time and greater visuospatial intelligence compared to non-athletes population.

Atan and Akyol (2014), compared the reaction time of upper limb by touch the button as the stimulus given. In overall, the football players were reported had superior reaction time compared to other sports. However, in few variables, jodukas and track and field athletes showed better results than football players. Furthermore, non-athletes population as expected was recorded the slowest reaction time almost in all variables tested.

A recent study by Çetin *et al.* (2018) reported that trained athletes had improved their eye-hand coordination in certain period of intervention despite non-significant improvement on other variables such as body balance and attention. Another study on baseball players Laby *et al.* (2018) reported that a significant relationship between eye-hand coordination and batting performance. Furthermore, the score of eye-hand coordination also suggesting the selection of players for productive team also could indicate the role of players in team.

Those findings could suggested how importance of eye-hand coordination and reaction time for athletes and team performance. However, in some games, the eye-hand coordination and reaction time could not provide significant impact on the overall performance. For instance, Razeghi *et al.* (2012) found that the eye-hand coordination was not affect the skills in darts game. In fact, both study groups (unilateral and cross lateral eye and hand dominant) were showed improvements in dart scores compared to baseline.

To date, lack of available studies which determine the relationship between the reaction time and eye-hand coordination among athletes. In other hand, there were few studies which reported the effects specific training of eye-hand coordination which improved individuals' motor performance (Bekkering *et al.*, 1994; Gribble *et al.*, 2002; Paul *et al.*, 2011). Therefore, those findings indirectly could provide some information regarding the interaction of visual training and reaction time especially among athletes.

Despite an improvement offered from the sport intervention, there is an issue that potentially interrupt the efficacy of eye-hand coordination and reaction time although familiarized with activities or well-trained persons. Domkin *et al.* (2013), reported that distraction like non-target objects momentarily interrupt and attenuates eye-hand coordination ability. This situation disturb focus of athletes although they had good capability in the respective elements. The disturbance factor on eye-hand coordination and reaction time definitely lessen the current performance but not the affect performance of athletes in longer time. This means that once the distracted stimulus avoided or removed, the performance of the athletes are expected showed an improvement.

## 3. Methodology

### 3.1. Study Design

This is a randomised controlled trial involving 30 healthy male sedentary youth. Prior to selection, health screening was conducted among 208 youth between the ages of 18 to 30 years old. The sampling frame include youth with leisure time activities of less than 150 minutes/ week using Short Questionnaire to Assess Health (SQUASH) and without any prior diagnosis of any chronic diseases, whilst the exclusion criteria are those with congenital or genetic disorders, history of fall and musculoskeletal problem. They were randomly allocated to intervention (n=15) and control (n=15) group.

The subjects were also further assessed by a physician during the screening process to assure their current health status. Their blood pressure was measured and blood pressure range of 100-130/60-85 mmHg were included in this study. Prior taking their blood pressure, all subjects were requested to sit and relax for 5 minutes and their blood pressure were measured twice (Mendham *et al.*, 2015). All suitable subjects were informed thoroughly on the protocol and purpose of this study, hence their written consents were obtained. Ethical approval was obtained from institutional ethical board (USIM/REC/0416-3).

### 3.2. Intervention Programme

Intervention package for this study include 4-weeks traditional archery training (figure 1). All subjects in this group received proper lessons from a certified archery trainer. Each subject was given bear bow with no assistive device attached. The string weight was measured at 40 pounds. The distance between subjects and target buds was 10 meters. They completed 3 sessions per week particularly 6 shots per session for 7 sessions per day. No specific training were assigned to the control group.

### 3.3. Data Collection Procedures

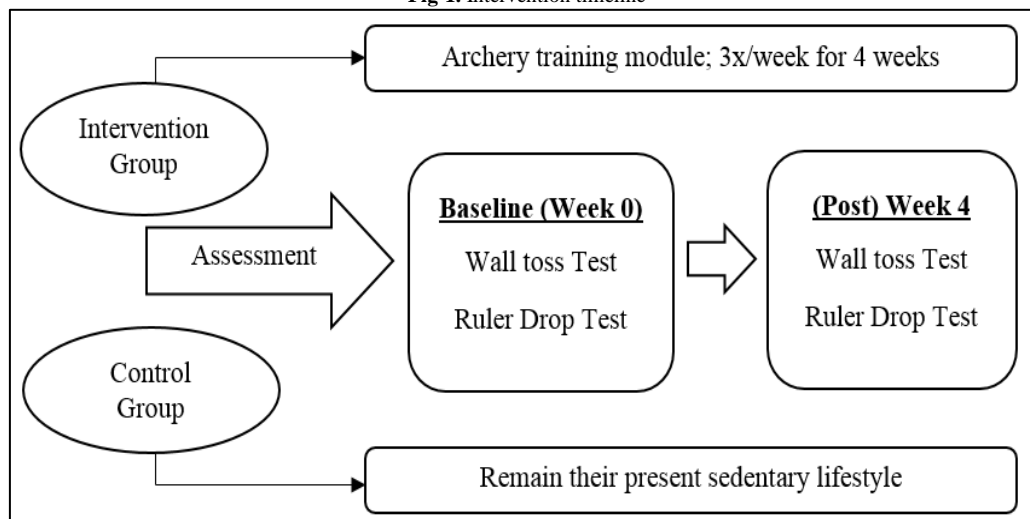
Data were collected at two time points; pre-training and 4-weeks post-training. Their body mass index (BMI) and physical activities (Short Questionnaire to Assess Health-Enhancement Activities [SQUASH]) were taken only at baseline to assure there were no significant difference of these parameters between subjects in intervention and control group. Wall toss test and ruler drop test were utilised to determine the effect of the training on coordination and agility.

The protocol of wall toss test (WTT) was adapted from Du Toit *et al.* (2011). Subjects were instructed to stand behind a horizontal line drew on the floor with a distance of two metres from the wall. Once they are ready, subjects were requested to throw a tennis ball to the wall and subsequently catch the ball using alternate hand. The sequence of throwing and catching continues for 30 seconds and the successful catch was counted.

Ruler drop test (RDT) is a reaction time test to assess subjects focus and agility. All subjects were requested to sit on a chair and maintain the upright posture in front of an assessor before starting the test. A ruler was held by the assessor with 0 cm located above the subjects' fingers. The subjects were allowed to practice holding the ruler with their two fingers and the test will only start once they were ready. Subjects were then informed that the assessor will release the ruler at any time without alerting them, hence they have to catch it with their thumb and forefinger. Once the ruler was dropped, the number on the ruler displayed just over the subject's thumb will be recorded. The lower the number that was recorded, the faster the subject's reaction time.

Data were reported as mean  $\pm$  SD. Split plot ANOVA (SPANOVA) was used to determine the intervention effects in this study at  $p < 0.05$ . All statistical analyses were performed using MS-Windows version 20.0 (SPSS 20.0).

Fig-1. Intervention timeline



## 4. Results

Subjects' age, leisure time activities and anthropometric are included in Table 1. Subjects of both groups were matched with regards to age and body mass index.

Table-1. Physical characteristics of participants

Variables	Intervention Group Mean $\pm$ SD	Control Group Mean $\pm$ SD
Age (years)	21.07 $\pm$ 1.62	21.00 $\pm$ 1.60
Body Weight (kg)	78.58 $\pm$ 12.28	83.34 $\pm$ 8.11
Height (m)	1.66 $\pm$ 0.04	1.68 $\pm$ 0.05
BMI (kg.m <sup>-2</sup> )	28.61 $\pm$ 4.25	29.59 $\pm$ 6.36
Percentage of body fat (%)	33.4 $\pm$ 9.2	33.8 $\pm$ 9.8
Skeletal muscle mass (kg)	29.7 $\pm$ 4.5	31.1 $\pm$ 4.2
Total body water (kg)	38.7 $\pm$ 5.6	40.4 $\pm$ 5.2
Body fat mass (kg)	27.9 $\pm$ 12.4	31.1 $\pm$ 15.8
Sitting (min/week)	1118.8 $\pm$ 249.2	1111.8 $\pm$ 383.1
Physical Activity (min/week)	93.8 $\pm$ 103.5	97.06 $\pm$ 91.6
Leisure Time (minutes/week)	132 $\pm$ 86.43	210 $\pm$ 173.64

There was significant intervention effect for hand-eye coordination (Table 2) with subjects from intervention had higher increased in WTT ( $+6.07 \pm 5.42$ ) compared to the control group ( $+1.86 \pm 3.48$ ). The between groups test ( $p > 0.05$ ) indicates no changes between groups over time. The within subject test indicate that there is a significant time effect;  $p < 0.001$ , the groups do change in hand-eye coordination over time. Interaction effect between group and time;  $p < 0.05$  indicate that there is a significant difference following 4-weeks of archery training.

**Table-2.** Repeated measures for baseline and post hand-eye coordination between control and intervention group

WTT	Pre Mean ( $\pm$ SD)	Post Mean ( $\pm$ SD)	Difference Mean ( $\pm$ SD)	Group Effect Mean (partial ETA square)	Time Effect Mean (partial ETA square)	Interaction Effect Mean (partial ETA square)
Control	16.67 ( $\pm$ 4.89)	18.53 ( $\pm$ 6.73)	1.86 ( $\pm$ 3.48)	0.644 (0.008)	0.001 (0.448)*	0.017 (0.186)*
Archery	15.53 ( $\pm$ 5.96)	21.60 ( $\pm$ 6.72)	6.07 ( $\pm$ 5.42)**			

\*SPANOVA, significant value was set at  $p < 0.05$ . \*\*Paired T-test, significant value  $p < 0.05$ . The result presented was based on toss/30 seconds.

Higher reduction in time taken for RDT (Table 3) was shown in the intervention group ( $-25.2 \pm 32.92$ ) as compared to the control group ( $-3.27 \pm 40.76$ ). Despite the higher reduction, the intervention effects on RDT was not statistically significant ( $p > 0.05$ ). The group effect is not significant ( $p > 0.05$ ) indicates no changes occur between group. Meanwhile, within subjects indicate a significant time effect ( $p = < 0.05$ ) which suggested that the upper limb reaction time changes over time even without any intervention. However, interaction effect between groups ( $p > 0.05$ ) indicate that no-significant difference following 4-weeks of archery training.

**Table-3.** Repeated measure for baseline and post upper limb reaction time between control and intervention group

RDT	Pre Mean ( $\pm$ SD)	Post Mean ( $\pm$ SD)	Difference Mean ( $\pm$ SD)	Group Effect Mean (ETA value)	Time Effect Mean (ETA value)	Interaction Effect Mean (ETA value)
Control	182.07 ( $\pm$ 38.88)	178.80 ( $\pm$ 38.07)	- 3.27 ( $\pm$ 40.76)	0.325 (0.035)	0.044 (0.137)*	0.116 (0.086)
Archery	182.53 ( $\pm$ 23.37)	157.33 ( $\pm$ 30.84)	- 25.2 ( $\pm$ 32.92)**			

\*SPANOVA, significant value was set at  $p < 0.05$ . \*\*Paired T-test, significant value  $p < 0.05$ . The result presented was based on milliseconds.

## 5. Discussions

Archery is a static sport that requires high control in movement in order to achieve precision in hitting given target (Taha *et al.*, 2017). Therefore reaction time and body coordination are important aspects that enhance performance in this kind of sport. There were few studies have reported that archery is one of the sports that improved reaction time and body coordination, however the studies were limited to comparing between archers and non-archers (Kian *et al.*, 2013; Strydom and Ferreira, 2010). This study on the other hand clearly proved that 4-weekstraditional archery training improved hand-eye coordination and upper limb reaction time of sedentary young adult. Those with low physical activities was found to have poor coordination and stability. These two factors were associated with increased risk of injury in later stage of life. Therefore, archery training can be one of the options to enhance good coordination and stability among community dwellers who are classified as sedentary.

Both WTT and RDT were previously described to improve with frequent trainings (Weedon *et al.*, 2018). In this study, subjects for both control and intervention group did not receive any training specifically for the test within the 4 weeks. The improvement indicate that the short term training provide adequate stimulation to produce benefit effects on the parameters described. Hand-eye coordination is a complex process with inputs and controls from a diverse array of sensory and motor systems. In this study, subjects in the intervention group had successfully improved their WTT score from poor to average (Beashel *et al.*, 2001). WTT are standard test for hand-eye coordination that have also been utilised in other studies such as table tennis (Faber *et al.*, 2014; Safari *et al.*, 2017) and taekwondo (Elsawy, 2010).

RDT has been frequently used as part of sport performance evaluation tests and has also been proven clinically useful to assess concussion related injury. This simple test was previously described to always have improvement in the later sessions as compared to the baseline session due to practice effect.

Minimising the practice effects can be done by allowing the subjects to repeat the test until their performance stabilised (Del Rossi *et al.*, 2014). Therefore, in this study, we allow the subjects to try and be comfortable with the test before data was taken in each session, hence the most pronounced data will be taken as their best performance in each sessions. Both groups in this study indicated that their baseline RDT results were above average level (Davis *et al.*, 2000), thus the interaction effect for this test was found to be not statistically significant. The limitations that may influence RDT result may include subjects' dietary intake and motivation during the day of the test, however these data have not being taken into account in this study (Eckner *et al.*, 2011).



## 6. Conclusion

In conclusion, the 4 weeks of traditional archery training is able to improve hand-eye coordination of sedentary male youth. However, significant effect on upper limb reaction time may require longer training or additional intervention.

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