

**Examining the Effects of Practicing Archery on the Hand-eye Co-ordination, General  
Anxiety and Self-efficacy of Adult Non-clinical Participants.**

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## **Examining the effects of practicing archery on the hand-eye co-ordination, general anxiety levels, and self-efficacy levels of adult participants.**

The purpose of this study is to examine the effects of practicing archery on the hand-eye co-ordination, general anxiety levels and self-efficacy levels of adult participants, the main reason behind this is that archery is a slow paced and non-competitive sport, which means that it could be much more enjoyable for individuals with difficulties in any of the three areas this study is examining. This study is a quasi-experimental design and the methodology of this study involved recruiting 48 participants, 20 of whom regularly practice archery, and having them complete Zung's self-rating anxiety scale, Schwarzer and Jerusalem's general self-efficacy scale and an altered version of the hand-eye co-ordination test used by Faber et al in 2014, the analysis involved in this study includes descriptive statistics, a chi-square test and an independent samples t-test. The results of this study show a statistically significant difference ( $p < 0.05$ ) between the control group ( $n=28$ ) and archery group ( $n=20$ ) within all three variables. While this study does have some limitations which include the sample size and the necessary convenience sampling, it should be noted that the important point of this study is that practicing archery is beneficial to individuals who do not suffer from any kind of disorder and furthermore the main implication of the results is that archery could potentially be turned into an effective intervention for disorders such as dyspraxia or anxiety disorders.

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## **Introduction**

### **Literature Review**

The primary reasoning for the area of focus being archery, is that archery is a sport that is slow paced and non-competitive in nature, which makes it the perfect sport for participants that suffer from conditions affecting hand-eye co-ordination or endurance as well as participants who simply do not like more conventional forms of exercise. However as this literature review will show, practicing sport has been shown to improve anxiety levels, self-efficacy and hand-eye co-ordination, which leads to the question of whether these same areas will be improved in participants who practice archery over participants who do not?

There is a vast amount of research that has been done on the effect of practicing sports. Although the literature covers a wide variety of such research, this literature review will focus on the effects of practicing archery, as well as the effects of exercise on the generalized anxiety, self-efficacy and hand-eye co-ordination of participants. Although the literature presents these effects in a variety of contexts, this paper will primarily focus on their application to practicing archery.

Archery is one of the oldest practices in human history, as pointed out by McEwen, Miller and Bergman, the earliest example of a bow that has thus far been found was discovered to be from the Upper Palaeolithic area, otherwise known as the stone age, around two and a half million years ago. Since the creation of the bow, archery has been used for a wide variety of purposes, originally archery was vital for self-defence and for acquiring food, however since the invention of guns in the 19<sup>th</sup> century archery has since transitioned into a leisure activity (McEwen, Miller, & Bergman, 1991).

While a large amount of research has been done about archery, there is very little research looking at the positive effects of practicing archery on general members of the population rather than elite archers. An example of this research was completed by Hoagland in 2016. Hoagland's study involved having a purpose sample of 12 non-institutionalised "baby boomers", aged between aged between 53 and 71, with a gender split of 8 females and 3 males, participate in a six week archery exercise program. The participants then completed semi-structured interviews in which most reported many physical benefits including: upper body strength, balance, and improvement to individual physical limitations. Mental benefits were also reported and these included concentration, movement control, confidence, and relief from individual mental challenges (Hoagland, 2016).

While this study does show some of the benefits of archery, it should be considered with a degree of caution primarily due to the very low sample size of the population used in this study. Another issue is that the findings from this study are all based on interviews rather than empirical tests so there is no way to know if there are genuine improvements or if participants are perceiving an improvement through a placebo effect.

Another example of a study looking at the benefits of practicing archery for a longer period of time was run by Carrillo, Christodoulou, Koutedakis and Flouris in 2011. This study involved comparing the autonomic nervous system modulation, via heart rate monitoring, of both novice and experienced archers during a competition. There were seven novice archers, with less than a year experience and an age range of 14 to 21, and there were ten experienced archers, with more than four years' experience and an age range of 16 to 26. The results show that experienced archers had a lower heart rate, took more time per shot and had a greater increase in parasympathetic nervous system activation when compared with pre-competition values (Carrillo, Christodoulou, Koutedakis, & Flouris, 2011).

While this study does show that participants who regularly practice archery are generally more relaxed during competitions than novice archers there are still two other factors to consider. The first factor is that the experienced participants being able to take more time for each shot may indicate increased hand-eye co-ordination and a lower heart rate may indicate lower general anxiety, however as the researcher does not look into this, it leaves a rather important gap in the literature. The second factor to consider is that this study only had 17 participants in total, which means that this study may not be reliable and is definitely in no way generalizable to the archery population as a whole.

To summarise it seems most studies looking at the effects of practising archery suffer from a lack of participants, primarily due to the amount of time and effort archery interventions would take, this leads to most studies lacking validity due to the lack of generalisability. Furthermore it seems that there are little to no studies that look at the psychological or mood effects that practicing archery may have on participants, which in turn leaves a gap in the literature that needs to be filled in.

### **General Anxiety**

One of the factors that will be investigated in this study is the effect of practicing archery on the general anxiety levels of participants, anxiety is defined by Barlow in 2002 as a “future-oriented emotion, characterised by perceptions of uncontrollability and unpredictability over potentially aversive events and a rapid shift in attention to the focus of potentially dangerous events or one’s own affective response to these events.” While there has been some research into the effects of exercise on anxiety in the past, these studies tend to focus on more rigorous forms of exercise rather than something more slow paced like archery. However the research into the more rigorous forms of exercise has shown some promising results, with a lot of



studies showing a distinct decrease in anxiety levels after participation in exercise (Barlow, 2002).

For example in 2006, de Moor, Beem, Stubbe, Boomsma and de Geus looked at the effects of rigorous exercise on the anxiety, depression and personality traits of 19,288 participants. The results of this study found that 51.4% of the sample regularly participated in rigorous exercise and that participants who did engage in rigorous exercise displayed less anxiety ( $-0.18SD$ ), depression ( $-0.29SD$ ) and neuroticism ( $-0.14SD$ ) as well as more extraversion ( $+0.32SD$ ) (de Moor, Beem, Stubbe, Boomsma, & de Geus, 2006).

While this study does provide some promising results about the relationship between anxiety and exercise, there are still several factors that should be considered with this study. The first is that participants may have felt obliged to report that they participate in exercise due to societal expectations of engaging in exercise. The second factor with this study is that it only examines the effects of rigorous exercise which leaves a gap in the literature where less rigorous forms of exercise are concerned. A third factor to consider with this study is that it has a very high number of participants, which totalled at 19,288 people which does give much more credence to this study, primarily due to the power of statistic analysis used in said study. The final factor which should be noted is that this study was completed with a non-clinical population, which shows that exercise may be able to help with state-anxiety rather than just clinical anxiety.

Another study which looks at the effects of exercise on anxiety was run by Johansson, Hassmen and Jouper in 2011, who looked at the effects of practicing Qigong yoga, in a 4 day training camp, on the state anxiety, tension, depression, anger, vigour, fatigue and confusion of 8 men and 51 women with a mean age of 50.8 and a standard deviation of 12.9. The scales used were obtained from the profile of mood states for both the qigong group and control

group. Results were obtained using both independent sample t-tests and mixed anovas. The results for the Qigong group were: state anxiety dropped from 39.5-34.8, tension dropped from 6.7-2.4, depression dropped from 6.8-2.7, anger dropped from 2.8-0.6, vigor increased from 14.8-18.8, fatigue dropped from 6.0-2.5 and finally confusion dropped from 5.5-2.9. The control group results were: state anxiety dropped from 39.7-38.2, tension dropped from 7-5.5, depression dropped from 6.5-6, anger dropped from 2.9-3.2, vigor increased from 14.1-14.5, fatigue increased from 4.9-5.3 and finally confusion dropped from 6.1-4.6 (Johansson, Hassmen, & Jouper, 2011).

While this study does have a lot of in-depth analysis, there are still several factors to consider. The first is that this study looks at the effects of a slower paced form of exercise on the emotional states of participants which is similar to what this study will attempt to do, as archery is a necessarily slow sport to ensure the accuracy of the shooter. The second factor to consider is that the changes in the control group's moods could simply be attributed to the fact that they had to listen to a lecture on traditional Chinese medicine which may have relaxed the participants simply due to boredom, which would also account for the increase of fatigue in the control group. The final factor to consider is that the power of this study may be called into question due to the number of participants that were involved.

Another study which compares the effects of both high and low intensity exercise was run by Abby, King, Taylor and Haskell in 1993. This study involved having 357 adults, between the ages of 50 and 65, randomly assigned to four different groups including high intensity exercise groups, high intensity home exercise, low intensity home exercise or a control group, the participants were involved in these groups for a year. The psychological measures used in this study were the Beck Depression Inventory as well as the Taylor Manifest Anxiety Scale. The results of this study show that anxiety levels dropped by -2.3 for males and -1.2 for females in high intensity groups, -1.2 for males and -1.3 for females in high intensity home

and -1 for males and -1.1 for females in the low intensity home group. There were also some changes reported in depression levels, in the high intensity group exercise there was a -0.4 change for males and a 0.2 change for females, -0.9 for males and 0.7 for females in high intensity home and -0.5 for males and 0.4 for females in the low intensity home group (Abby, King, Taylor, & Haskell, 1993).

While this study does show some promising results, there are still some issues that need to be considered. To begin with this study was published in 1993 which means that it is a lot older than any other study that has been mentioned in this review thus far, while this does not necessarily mean the results do not provide insight, it should be considered that if this experiment were repeated the results may differ due to modern methods of assessment. There may also be unrecognised factors that resulted in the high decrease in anxiety levels for the males in the high intensity group, as the decrease was close to double the decrease for any other group meaning there is most likely an unexpected factor. Finally it should be noted that the low intensity exercise group has very similar decreases in anxiety to the high intensity group which is a very promising result for this study

To summarise it appears that even though there has been a large amount of research completed in the area of anxiety and exercise, there is a lack of research into the effects of anxiety and low intensity exercise. Furthermore there have not been any studies looking at the effects of practicing archery on anxiety, and considering the relatively slow and methodical nature of archery, this is a rather important gap in the literature concerning exercise and anxiety.

### **Self-Efficacy**

Another area that will be investigated in this study is the effects of practicing archery on the self-efficacy of participants, self-efficacy is described by Scholz et al (2002) as an “optimistic

sense of personal competence that seems to be a pervasive phenomenon accounting for motivation and accomplishments in human beings.” While there has been some research into the relationship between exercise and self-efficacy in the past, the majority of said research seems to be limited to populations that contain only clinical participants or exclusively female participants. This research has displayed some promising results with the majority of studies showing an increase in self-efficacy once participants begin practising exercise. Furthermore some research about the relationship between self-efficacy and exercise does look at slower paced forms of exercise and the results from these studies also appear to be positive (Scholz, Dona, Sud, & Schwarzer, 2002).

An example of a study looking at the effects of self-efficacy on exercise was run by Hu, Motl, McAuley and Konopack in 2007. This study involved having 28 college aged female participants go through a process of efficacy manipulation via false feedback, before participating in a 30 minute moderate intensity exercise trial between two and three days after the manipulation took place, enjoyment was then measured via the physical activity enjoyment scale, self-efficacy was measured via a self-efficacy scale. The results show that participants who had higher levels of self-efficacy displayed considerably more enjoyment ( $M= 101.36$ ) than participants who had lower levels of self-efficacy ( $M= 89.50$ ) (Hu, Motl, McAuley, & Konopack, 2007).

While this study does provide some very interesting results, and does demonstrate the relationship between self-efficacy and exercise, there are still some factors to consider. The first thing to consider is the very limited population size as all of the participants are women and there are only 28 of them which severely limits the generalizability of the study. The second is that exercise enjoyment was not examined before the efficacy manipulation which could have given an indication of how much the manipulation influenced exercise enjoyment.

An example of a study looking at the relationship between exercise and self-efficacy in a clinical setting was run by Kangas, Baldwin, Rosenfield, Smits and Rethrost in 2015. This study involved 116 participants with a mean age of 34.5 years old, with a range of 18 to 61, 75.9% of which were females, 35% of the participants were diagnosed with clinical depression. Participants were assessed for self-efficacy and depression before drawing up exercise plans for 150 minutes of exercise per week, daily assessments were sent via email to the participants for each of the 28 days of the study. Results show that on days with no exercise, participants with low depressive symptoms had a mean self-efficacy score of 5.7 and participants with high depressive symptoms had a mean self-efficacy score of 4.95, on days with exercise participants with low depressive symptoms had a mean self-efficacy score of 5.92 and participants with high depressive symptoms had a mean self-efficacy score of 5.6 (Kangas, Baldwin, Rosenfield, Smits, & Rethrost, 2015).

This study does provide some interesting insight into the important effects exercise can have on self-efficacy, even on participants with clinical depression, however there are still some factors to consider. The first is that although the study does have an adequate amount of participants, the gender split of the participants leaves this study lacking in generalisability. The second factor to consider is that this intervention is very short in duration as it only lasted 28 days so it is possible that the effect may or may not fade in the future.

Another example of a study looking at the relationship between exercise and self-efficacy as well as anxiety was run by Katula, Blissmer and McAuley in 1999. This study involved having 80 older adults, with a mean age of 67.06, and an age range of 60-75, there were 17 male participants and 63 female participants, all participants also had to obtain a physician's clearance before participating. Participants were then divided into low, medium and high intensity exercise groups for the six month trial, both self-efficacy and state anxiety were measured at the end of the trial, self-efficacy was measured via an improvised self-efficacy

scale and state anxiety was measured via Spielberger's state anxiety inventory. The results of this study show that participants who were in the light exercise group had a self-efficacy increase of 2.54, the medium exercise group had an increase of 6.7 and the high intensity group had a decrease of 4.98. The only level where greater self-esteem was seen to decrease anxiety levels in a significant way was at the moderate level ( $p < 0.05$ ), there was a non-significant relationship at light levels ( $p < 0.11$ ) and a non-significant inverse relationship at high levels ( $p < 0.9$ ) (Katula, Blissmer, & McAuley, 1999).

While this study does provide some interesting insights into the relationships between exercise, self-efficacy and anxiety, there are still some factors to consider. The first is that this is a relatively older study, thus there are most likely better measures that could provide clearer results. The second is that while there is an adequate number of participants in this study, they were mostly females thus removing most generalisability.

In summary while there is some research on the relationship between exercise and self-efficacy, there are several gaps in the literature primarily involving male participants but there is also very little research involving low intensity exercise such as archery, and thus there is a gap for this study.

### **Hand-eye Co-ordination**

The final area that shall be investigated in this study is the effect of practicing archery on the hand-eye co-ordination of participants. Hand-eye co-ordination is described by Hiraoka et al (2013) as eye and hand movements that are co-ordinated via the neural interactions between the execution processes for eye movements and hand movements. There has been very little research into the area of hand-eye co-ordination at all, and the research that has been completed has mostly been focused on the area of developmental co-ordination disorder or dyspraxia as it is also known. While there is very little to draw from in terms of hand-eye co-

ordination research, the research that has been completed does seem to show an increase in hand-eye co-ordination when it comes to participating in exercise (Hiraoka, Kurata, Sakaguchi, Nonaka, & Matsumoto, 2013).

An example of a study looking at the effects of exercise on co-ordination is a study by Hession, Eastwood, Watterson, Lehane, Oxley and Murphy in 2014. This study involved having 40 children (28 males and 12 females), with a primary diagnosis of dyspraxia, between the ages of 6 to 15, participate in 8 weeks of horse riding (thirty minutes a week), and an audio visual presentation of horse movements before and after the 8 weeks of horse riding. The Raven's test was used to measure cognitive ability, The childhood depression inventory was used to measure mood and finally co-ordination was measured via walking gait using the Gaitrite testing system. The results of this study show that 51.3% of participants demonstrated reliable improvement on the Raven's test, the overall childhood depression inventory scores dropped by 19% and finally the gaitrite test looks at a variety of different factors including the left and right versions of single support, double support, toe in/out, stride length, cycle time and finally cadence, of those factors the only one that did not produce a statistically significant improvement was stride length left ( $p=0.0517$ ). Qualitative reports from parents also reported improvement in hand-eye co-ordination (Hession, et al., 2014).

This study provides some very interesting results, however some factors do still require discussion. To begin with it shows that even sports that potentially require less co-ordination than archery can provide massive benefits in a very short period of time, which shows some promise for this proposed study. It should also be noted that while the number of participants in this study is sub-optimal it is due to the nature of the study and thus could not be increased.

An example of a study looking at the effects of exercise on the hand-eye co-ordination of participants without a disability affecting hand-eye co-ordination was completed by Chen, Wu, Song, Chou, Wang, Chang and Goodbourn in 2017. In this study 38 Taekwondo athletes (22 males, mean age = 19.9 years) 24 Karate athletes (15 males, mean age = 18.9) and 35 non-athletes (20 female, mean age = 20.6 years), had their hand-eye co-ordination tested via the finger-nose-finger task, their attentional processing speed and attentional control was tested via the covert orienting of visual attention task. The results of this study show that participants who practice Karate had better hand-eye co-ordination than the other two groups, but Taekwondo athletes had better COVAT scores than the other groups (Chen, et al., 2017).

This study provides some interesting information, however there are still several factors to consider. The first is that this study demonstrates that different kinds of sports can improve co-ordination, specifically hand-eye co-ordination, in different ways, which does lend some promise to the proposed study. The second factor is that the population for this study is somewhat low which does affect its generalisability.

In summary while there has been some research done into the effects of exercise on hand-eye co-ordination, the vast majority of this research is focused on participants with disabilities that affect hand-eye co-ordination, despite the fact that hand-eye co-ordination is something that every can improve. In conclusion, while there has been research looking at every aspect that has been mentioned in this review, there are still many gaps in the literature, as well as factors that may affect the results of already completed pieces of research. This leaves a gap in the research that allows this proposed study to fit in well with the research that has been completed.



## **Rationale**

The rationale for this study was developed from a previously suggest study which had to be abandoned due to time constraints. The previously suggested study involved using archery as an intervention for children with dyspraxia, as supported by previous research by Hession et al, Fong et al and Miyhara et al, which show that children with dyspraxia improve in the areas of anxiety, self-efficacy and hand-eye co-ordination when participating in sports. As a result this study is effectively laying the groundwork for the original study to be completed in the future. (Fong, Chung, Chow, Ma, & Tsang, 2013) (Hession, et al., 2014) (Miyahara & Baxter, 2011)

Another part of the rationale is the gap in the existing research in relation to studies around the effects of practicing archery, this is an important gap that needs to be filled in as archery is a sport that can easily be practised by a wide variety of people including people in wheelchairs and people suffering from dyspraxia.

The main potential implication for this study is that the results could potentially provide reason for further research into using archery as an intervention for people who suffer from deficits in hand-eye co-ordination, anxiety or self-efficacy.

## **Hypotheses**

The hypotheses for this study are: participants who practice archery have higher levels of hand-eye co-ordination than control participants, participants who practice archery have lower levels of anxiety than control participants and participants who practice archery have higher levels of self-efficacy than the participants who do not practice archery.

## **Methods**

### **Participants**

There were 48 participants in this study in total. The archery group contained 20 participants 11 of which were males, with an age range of 19 to 69, the mean age was 32 and the standard deviation was 14. The levels of archery practice for the archery group ranged from six months to 50 years, with a mean of 5 years and 2 months and a standard deviation of 10 years and 9 months. All of the archery participants were obtained from Wicklow Archers and UCD Archers. The control group contained 28 participants, 18 of which were females, with an age range of 20 to 29, the mean age was 21 with a standard deviation of two years. All of the control participants were recruited from a third year psychology course in National College of Ireland. Two participants were removed from the study due to them meeting the exclusion criteria of a diagnosis of generalized anxiety disorder.

### **Materials**

The materials used in this study were A4 copies of the information sheet, consent form, anxiety scale and self-efficacy scale as well as a tennis ball for the hand-eye co-ordination task. The measures used in this study include Zung's self-rating anxiety scale, Schwarzer and Jerusalem's general self-efficacy scale and an altered version of Faber's hand-eye co-ordination test.

Zung's self-rating anxiety scale involves 20 different questions on a four point Likert scale, with scores capable of ranging from 20 to 80, five of these questions needed to be recoded (5,9,13,17 and 19). The validity of this test was affirmed by Dunstan, Scott and Todd in 2017, they looked at the efficacy of Zung's scale when compared with the depression anxiety stress scale. Their study involved 376 participants, 340 of which were non-clinical participants. The results of Dunstan, Scott and Todd's study show that Zung's scale has a Cronbach's alpha of

0.84 and the predictive ability of Zung's scale was found to be statistically significant ( $p < 0.001$ ) (Dunstan, Scott, & Todd, 2017).

Schwarzer and Jerusalem's general self-efficacy scale involves 10 different questions on a four point Likert scale, with scores capable of ranging from 10 to 40 none of these questions need to be recoded. The validity of this test was confirmed by Scholz, Dona, Sud and Schwarzer in 2002 who completed a study looking at whether self-efficacy is a universal construct by using the Schwarzer and Jerusalem scale with 19,120 participants across 25 different countries. The results of their study show that the Schwarzer and Jerusalem scale has a Cronbach's Alpha of 0.75 and all of the English speaking countries scoring 0.85 or above (Scholz, Dona, Sud, & Schwarzer, 2002).

The hand-eye co-ordination test used in this study was an altered version of Faber, Oostereveld and Njihuis-Van der Sanden's hand-eye co-ordination test. In 2014 Faber et al completed a study which looked at the difference in hand-eye co-ordination between 23 local and 20 national league table tennis players. Their hand-eye co-ordination test involved having participants throw a table tennis ball at a vertical table tennis table with one hand and catch the ball with the other as many times as possible in thirty seconds from a distance of one meter. The results of this study show a statistically significant difference between the two types of players ( $p < 0.05$ ). As carrying around a table tennis table would not have been practical for my study, the test has been altered to use a tennis ball and a wall, instead of a table tennis ball and table, from a distance of four meters instead of one meter to account for the increase in target size and projectile size (Faber, Oostereveld, & Njihuis-Van der Sanden, 2014).

Materials shall be in the appendix in the order of Ai (information sheet) Aii (consent form) Aiii (anxiety scale) Aiv (self-efficacy scale).

## **Design**

This study featured a cross-sectional design. The independent variable is whether participants regularly practice archery or not, and the dependent variables are general anxiety levels, general self-efficacy and hand-eye co-ordination.

## **Procedure**

The procedure involved addressing the group of potential participants to briefly explain what the study is about, the people who decided to participate were then handed the information sheet, consent form, the self-rated anxiety scale and the self-efficacy scale. After participants had filled in the consent form and the surveys, they were given their code number for the data set before being asked to complete the hand-eye co-ordination task, one at a time, until everyone had finished the task. After completing the hand-eye co-ordination task participants were thanked for their involvement.

## **Data Analysis**

The data analysis used in this study includes, descriptive statistics, a chi-square test, an independent samples t-test and a mann-whitney test. Descriptive statistics were used to analyse gender, age, years of practice, hand-eye co-ordination, anxiety levels and self-efficacy levels. A chi-square test was used to ensure the gender differences between groups would not significantly effect the results. And finally the independent samples t-test and the mann-whitney test were used to examine the differences in hand-eye co-ordination, anxiety and self-efficacy between groups. All analysis was conducted using SPSS.

## Results

The archery group contained 20 participants, 11 of which were male and all of which were between the ages of 19 and 69. The mean hand-eye co-ordination score for the archery group was 15.30, the mean anxiety score was 30.70 and the mean self-efficacy score was 32.35. For more information see table 1 below.

*Table 1. Descriptive Statistics for Archers*

	Mean (95% Confidence Intervals)	Std. Error Mean	Median	SD	Range
Hand-eye	15.30 (13.29-17.30)	.95	15.50	4.29	8-22
Anxiety	30.70 (28.06-33.33)	1.25	30.5	5.62	20-44
Self-efficacy	32.35 (30.23-34.36)	1	33.50	4.51	25-40

The control group contained 28 participants, 18 of which were female with an age range of 20-29. The mean hand-eye co-ordination score for the control group was 10, the mean anxiety score was 39.38 and the mean self-efficacy score was 28.3. For more information see table 2.

*Table 2. Descriptive Statistics for Control*

	Mean (95% Confidence Intervals)	Std. Error Mean	Median	SD	Range
Hand-eye	10 (8.9-11.03)	.5	10	2.6	5-15
Anxiety	39.38 (35.44-43.33)	1.92	38.50	10.17	24-58
Self-efficacy	28.3 (26.45-30.26)	.92	28.50	4.91	18-38

To begin with a Chi-Square test was performed to examine the relationship between gender and archery participation. The relationship was non-significant,  $\chi^2(2, N = 48) = 1.76$   $p = 0.184$ .

To examine the first hypothesis which was that the archery group has higher levels of hand-eye co-ordination than the control group, we performed an independent samples t-test. The results show that participants in the archery group scored significantly higher in hand-eye co-ordination ( $M = 15.3$ ,  $SD = 4.29$ ) than those in the control group ( $M = 10$ ,  $SD = 2.66$ ),  $t(29.34) = 4.88$ ,  $p = .000$ . *Cohen's D = 1.42*

To examine the second hypothesis, which was that the archery group has lower levels of anxiety than the control group, we performed an independent samples t-test. The results show that participants in the archery group scored significantly lower in anxiety levels ( $M = 30.7$ ,  $SD = 5.62$ ) than those in the control group ( $M = 39.39$ ,  $SD = 10.17$ ),  $t(43.70) = -3.78$ ,  $p = .000$ . *Cohen's D = 1.1*

To examine the third hypothesis, which was the archery group has higher levels of self-efficacy than the control group, we performed a third independent samples t-test. The results show that participants in the archery group scored significantly higher in self-efficacy levels ( $M = 32.35$ ,  $SD = 4.51$ ) than those in the control group ( $M = 28.35$ ,  $SD = 4.91$ ),  $t(46) = 2.87$ ,  $p = .006$ . *Cohen's D = 0.84*

Graphs of linearity shall be included in the appendix in the order of Av hand-eye co-ordination (both control and archery) Avi anxiety levels (both control and archery) and Avii self-efficacy (both control and archery).

## Discussion

There three hypotheses for this study were that participants who practice archery would have higher levels of hand-eye co-ordination than participants who don't, participants who practice archery would have lower levels of anxiety than participants who don't and finally participants who practice archery would have higher levels of self-efficacy than participants who don't. All three of these hypotheses were shown to be true in the results as archers were higher than non-archers in hand-eye co-ordination and self-efficacy to a statistically significant degree as well as archers being lower than non-arches in anxiety levels to a statistically significant degree.

The results of this study are similar to the results of some previous archery studies. For example the participants in Hoagland's study in 2016 reported a variety of improvements including movement control which is reflected in the hand-eye co-ordination results of this study. Furthermore Hoagland's study involved looking at the effects of practicing archery on elderly participants and their results are reflected in this study as one participants who was 69 years old with 50 years practice managed to reach the college average (a score of 10) in the hand-eye co-ordination test. Another study that has similar results to this study was run by Carrillo, Christodoulou, Koutedakis and Flouris in 2011 which found that more experienced archers had lower levels of autonomic nervous system activation which may indicate lower levels of anxiety. This is shown in this study as participants who practice archery had significantly lower scores on the anxiety scale than the participants who did not practice archery (Hoagland, 2016) (Carrillo, Christodoulou, Koutedakis, & Flouris, 2011).

There are also several similarities between this study and other studies that look at levels of anxiety. For example a study run by de Moor, Beem, Stubbe, Broomsma and de Geus in 2006 found a -0.18 standard deviation between participants who practice rigorous exercise and

participants who don't, where as in this study there was a statistically significant difference between the two groups ( $p < 0.05$ ) with the mean difference being 8.68 which is a lot more pronounced than the previously mentioned study. This very large difference may be due to the sample of participants selected for this study as everyone in the control group is currently enrolled in a high pressure college course which could easily account for the high anxiety level difference. However as indicated by Carrillo et al's 2011 study it is also possible that archery trains participants to be less anxiety than more rigorous forms of sport due to increased activation of the autonomic nervous system in high pressure situations (de Moor, Beem, Stubbe, Boomsma, & de Geus, 2006) (Carrillo, Christodoulou, Koutedakis, & Flouris, 2011).

Another study that examines the effects of a slower sport on anxiety was run by Johansson, Hassmen and Jouper in 2011 who examined the effects of a 4 day Qigong yoga intervention on a variety of areas including state anxiety. Their study found that the experimental groups anxiety scores had decreased by 4.7 where as their control groups anxiety scores had decreased by 1.5. While this difference is also a lot lower than the mean difference found in this study ( $M = 8.68$ ) it should be noted that this may be due to the fact that the lowest amount of practice that any of the archery group had was six months where as this studies intervention only lasted four days which could account for the very large difference. Other factors that may account for the large difference include the issue of all of the control participants in this study working on their own thesis at the time of testing which may have caused an increase in the anxiety scores in this study. The final factor that may account for this difference is the implication of Carrillo et al's study that archery may cause participants to have lower levels of anxiety (Johansson, Hassmen, & Jouper, 2011) (Carrillo, Christodoulou, Koutedakis, & Flouris, 2011).



Self-efficacy levels were another variable in this study, and the results found are comparable to several previous studies that examined sport and self-efficacy. For example a study examining the effects of 150 minute exercise plans on the self-efficacy of participants with and without clinical depression was run by Kangas, Baldwin, Rosenfield, Smits and Rethrost in 2015. Their results show that exercise caused non-clinical participants self-efficacy to rise from 5.7 to 5.92, whereas this study's results found a statistically significant ( $p < 0.006$ ) difference of 4 in the mean scores. These studies are reasonably comparable as the archers were recruited on their shooting nights so most had already been shooting for 10-20 minutes by the time they were participating in the study. The reason behind the rather large difference could be due to two separate reasons, the first is that the studies used different scales and that all of the archery participants have over six months practice whereas the other study only ran for 28 days. The second reason is that the archery group in our study was shooting for far less time than the participants in Kangas et al's study were exercising and thus were much less likely to be tired which may have affected their scores on the self-efficacy scales (Kangas, Baldwin, Rosenfield, Smits, & Rethrost, 2015).

Another study which examined both self-efficacy and state anxiety was run by Katula, Blissmer and McAuley in 1999. This study involved having 80 older adults participate in exercise programs of high, medium or low intensity for six months and their self-efficacy and state anxiety levels were measured at the end of the trial. They found a self-efficacy increase of 2.54 for the low groups mean scores and 6.7 for the medium groups mean scores, whereas our study found a difference of 4 for the mean self-efficacy scores.

This result does seem to match perfectly with our study in the fact that archery is definitely a low to medium intensity sport depending on the individual shooter's fitness levels and unlike previous studies this trial went on for a period of six months which matches the minimum amount of practice that the archery participants in this study had. In terms of anxiety levels

they found a non-significant increase with low levels ( $p < 0.11$ ) and a significant increase at medium levels ( $p < 0.05$ ) which does also match this study's results as we found a statistically significant difference in anxiety levels ( $p < 0.05$ ). This also matches the idea that archery is between a medium and low intensity sport depending on the individual shooter's fitness as the anxiety score is more towards the medium group's score in Katual et al's study. However this could also be down to the implication of archery causing decreased anxiety in Carrillo et al's 2011 study (Katula, Blissmer, & McAuley, 1999) (Carrillo, Christodoulou, Koutedakis, & Flouris, 2011).

Hand-eye co-ordination was the final area examined in this study, and while it is one of the least researched areas in psychology there are still some studies that the results of this study can be compared to. An example of a study that looks at co-ordination was run by Hession, Eastwood, Watterson, Lehane, Oxley and Murphy in 2014 who had 40 children with dyspraxia complete an 8 week horse riding intervention, they found statistically significant results in all but one area of the gaitrite test ( $p < 0.0517$ ). The results of Hession et al's study do compare with the results of this study in the fact that the co-ordination aspect of Hession et al's study increased after the 8 week trial and the archery group in this study showed higher levels of hand-eye co-ordination after at least 6 months of practice. It is interesting that the results of Hession et al's study were nearly entirely significant despite the study only being 8 weeks long, which leads to the question of whether participants with dyspraxia are more capable of having their co-ordination increased and whether participating in archery would be more beneficial for these participants than for non-clinical participants. This also leads to the question of whether the archery participants in our study would show any kind of improvement after only 8 weeks of practice instead of six months (Hession, et al., 2014).

Another study which examines hand-eye co-ordination was run by Chen, Wu, Song, Chou, Wang, Chang and Goodbourn in 2017. In this study groups of participants practicing Karate, Taekwondo and no sport at all were compared for hand-eye co-ordination levels. It was found that the Karate group had higher levels of hand-eye co-ordination than either of the other groups. This could have implications for this study as while archers did have higher levels of hand-eye co-ordination all of the archery group were shooting indoors at approximately 20 meters, with varying target face sizes, which is the standard indoor set up, Chen et al's study does imply that different types of archery such as shooting outdoors at a greater distance, with smaller faces or with moving targets may improve hand-eye co-ordination to a higher level (Chen, et al., 2017).

In summary even though this study does have a fairly novel area of focus, the results of this study are very similar to other studies in the area and thus this study has managed to fill in some of the many gaps around the effects of practicing archery on participants, this study has also contributed some interesting findings to the existing knowledge surrounding the effects of the practice of a low intensity sport on participants.

### **Limitations:**

While the results of this study should be considered valid there are several limitations with this study. To begin with this study features a cross-sectional design which limits the amount of information this study can provide by a rather large degree as there is no way to ensure these effects are lasting rather than a simple coincidence.

Another limitation is that this study does suffer from a lack of generalisability due to the sample size and due to the fact that all of the control group were college students with 27 out of the 28 control participants being from the same final year psychology class at National College of Ireland. The convenience sampling of the control group does also present some

additional issues, particularly in relation to the anxiety scale results, as 27 out of the 28 control group were in the same final year psychology class, which means that all of these participants are also running their own thesis along with several other modules at the same time, which could quite easily increase the stress and anxiety levels of these participants.

Another issue with this study is the lack of a definite “no” answer in the anxiety scale, as this caused a lot of the archery group to become confused by the study as they had little to no experience with psychological surveys. This led to these participants taking a longer time as they had to be instructed to fill in the “a little of the time” option instead which may have affected their scores on either the self-efficacy scale or the hand-eye co-ordination scale due to boredom.

The final issue with this study occurred during the hand-eye co-ordination test. Several of the participants had to redo this portion of the test as they instinctively moved closer to the wall than the four meter marker when the ball landed short of bouncing all the way back to them. This led to them having to retake this portion of the study as they then had an unfair advantage over participants who had stayed at the four meter mark.

In summary while this study does have a number of limitations it should be considered that this is a study that was written for an undergraduate thesis and thus mistakes in methodology should be expected, however despite this, the limitations in this study were not as severe as they could have been and the results of this study do still show promise.

### **Implications:**

Despite the limitations of this study there are several future implications that can be gathered from the results. To begin with there are numerous future studies that could be completed on the basis of this research. The most pressing one would simply be to run the same study in a

longitudinal fashion rather than as a cross sectional study in order to eliminate some of methodological issues with this study.

Another study which could yield promising results would be a longitudinal study to examine the effectiveness of using archery as an intervention for dyspraxia. As this study shows practicing archery is effective at improving the hand-eye co-ordination of people who practice it and the main issue for people with dyspraxia is a deficit in the area of hand-eye co-ordination, thus it could be a potentially effective intervention. The obvious issue with this proposed study is the ethical issue of having vulnerable participants learn how to use a potentially lethal weapon, which is an issue that is particularly polarising in today's political climate, thus it may be necessary to alter the arrows so that they cannot do any damage to a person or animal. Another interesting study would be to attempt to incorporate archery into the therapy of a group of participants suffering from clinical anxiety, then compare their recovery progress with a control group who experience regular therapy in order to examine the effects of archery on anxiety to a greater degree than this study was capable of doing.

In terms of policy the results of this study show that introducing archery as part of the physical education curriculum for Irish schools may be beneficial. However due to the safety issues associated with practicing archery it would have to be restricted to the senior years of secondary school, and as this is not a longitudinal study there has yet to be any research that examines how much practice is necessary to gain any benefits from practicing archery. Thus until further research can be conducted to examine the benefits of practicing archery in a longitudinal fashion, archery should not be introduced as part of any policy.

In summary this study has a lot of implications for future research, as there is a possibility that archery could be used to attempt to improve the hand-eye co-ordination, anxiety and self-

efficacy of participants. However there is not much that can be done with regards to policy due to this study primarily due to the safety concerns that arise from practicing archery.

**Conclusion:**

The hypotheses for this study were that participants who practice archery would have higher hand-eye co-ordination than control participants, participants who practice archery would have lower anxiety than control participants and that participants who practice archery would have higher self-efficacy than control participants. The results of this study show that all three of these hypotheses were true, with archers have significantly higher hand-eye co-ordination ( $p < 0.00$ ), lower anxiety ( $p < 0.00$ ) and higher self-efficacy ( $p < 0.006$ ). These results have produced a number of different implications such as new studies that could be run in the future as well as potential implications for physical education policy depending on the results of said future research. Thus this study has managed to fill in some of the many gaps that exist in the research surrounding archery as well as the research surrounding hand-eye co-ordination and slower forms of exercise.

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## **Appendix**

Ai).

### **Information Sheet**

#### ***PROJECT TITLE***

The Effects of Practicing Archery on the Hand-Eye Coordination, Self-Efficacy and Anxiety of Non-Clinical, Participants.

#### **INVITATION**

You are being asked to take part in a research study on the benefits of practicing archery. This study aims to look at the effects of practicing archery on the participants hand-eye coordination, self-efficacy and non-clinical anxiety.

My name is Sean Butler, I am an undergraduate student with National College of Ireland, the supervisor for this study is (to be inserted once this has been decided). This study will be undergoing a full ethical review by the ethics board at National College of Ireland.

#### **WHAT WILL HAPPEN**

In this study, you will be asked to complete a 10 question scale that measure your self-efficacy, a 20 question scale that measures your non-clinical anxiety levels and finally you will also be asked to perform a hand-eye coordination test which involves simply throwing a tennis ball at a wall with one hand and catching it with the other as many times as possible in 30 seconds.

#### **TIME COMMITMENT**

The study typically takes 15 minutes to complete.

#### **PARTICIPANTS' RIGHTS**

You may decide to stop being a part of the research study at any time without explanation. You have the right to ask that any data you have supplied to that point be withdrawn/destroyed. There will not be a penalty to withdrawing your data however as the data will be completely anonymous I will not be able to withdraw your data once data collection is complete.

You have the right to omit or refuse to answer or respond to any question that is asked of you. This is also without any kind of penalty.

You have the right to have your questions about the procedures answered (unless answering these questions would interfere with the study's outcome). If you have any questions as a result of reading this information sheet, you should ask the researcher before the study begins.

#### **BENEFITS AND RISKS**

There are no known benefits or serious risks for you in this study. The only risk that has been identified is that some of the questions in the self-efficacy and anxiety scales may make you feel uncomfortable, if this is the case please inform the researcher so that your data can be withdrawn. None of the scales used in this study are being used as a clinical diagnosis.

## **COST, REIMBURSEMENT AND COMPENSATION**

Your participation in this study is voluntary.

## **CONFIDENTIALITY/ANONYMITY**

The data we collect do not contain any personal information about you at all. No one, including the researcher, will be capable of linking the data you provided to you in anyway once data collection is complete.

The data collected in this study will be reported to National College of Ireland as well as presented at the National College of Ireland researcher conference.

## **FOR FURTHER INFORMATION**

Sean Butler will be glad to answer your questions about this study at any time. You may contact him at x15530487@student.ncirl.ie

Alternatively if you wish to speak to the supervisor of this research project you should contact (supervisors name here) at (supervisors email here)

If you want to find out about the final results of this study, you should contact Sean Butler using the email address above.

Aii)

## Consent Form

**PROJECT TITLE:** The Effects of Practicing Archery on the Hand-Eye Coordination, Self-Efficacy and Anxiety of Non-Clinical, College-Aged Participants.

**PROJECT SUMMARY:** This project aims to look at the effect of practicing archery on the hand-eye coordination, self-efficacy and anxiety of non-clinical college aged participants. These aims will be achieved by examining the differences in scores on tests examining the hand-eye coordination, self-efficacy and anxiety between participants who practice archery and participants who don't.

By signing below, you are agreeing that: (1) you have read and understood the Participant Information Sheet, (2) questions about your participation in this study have been answered satisfactorily, (3) you are aware of the potential risks (if any), and (4) you are taking part in this research study voluntarily (without coercion).

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Participant's Name (Printed)\*

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Participant's signature\*

Date

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Name of person obtaining consent (Printed)

Signature of person obtaining consent

Participants may use their initials if they do not wish to give their full name.

**Aiii). Self-rating Anxiety Scale**

	A little of the time.	Some of the time.	Good part of the time.	Most of the time.
1. I feel more nervous and anxious than usual.				
2. I feel afraid for no reason at all.				
3. I get upset easily or feel panicky.				
4. I feel like I'm falling apart and going to pieces.				
5. I feel that everything is all right and nothing bad will happen.				
6. My arms and legs shake and tremble.				
7. I am bothered by headaches neck and back pain.				
8. I feel weak and get tired easily.				
9. I feel calm and can sit still easily.				
10. I can feel my heart beating fast.				
11. I am bothered by dizzy spells.				

12. I have fainting spells or feel like it.				
13. I can breathe in and out easily.				
14. I get numbness and tingling in my fingers and toes.				
15. I am bothered by stomach aches or indigestion.				
16. I have to empty my bladder often.				
17. My hands are usually dry and warm.				
18. My face gets hot and blushes.				
19. I fall asleep easily and get a good night's rest.				
20. I have nightmares.				

Aiv).

### Self-Rating General Self-Efficacy Scale

	Not at all true.	Hardly true.	Moderately true.	Exactly true.
1. I can always manage to solve difficult problems if I try hard enough.				
2. If someone opposes me, I can find the means and ways to get what I want.				
3. It is easy for me to stick to my aims and accomplish my goals.				
4. I am confident that I could deal efficiently with unexpected events.				
5. Thanks to my resourcefulness, I know how to handle unforeseen situations.				
6. I can solve most problems if I invest the necessary effort.				
7. I can remain calm when facing difficulties because I can				

rely on my coping abilities.				
8. When I am confronted with a problem, I can usually find several solutions.				
9. If I am in trouble, I can usually think of a solution.				
10. I can usually handle whatever comes my way.				

**General Information:**

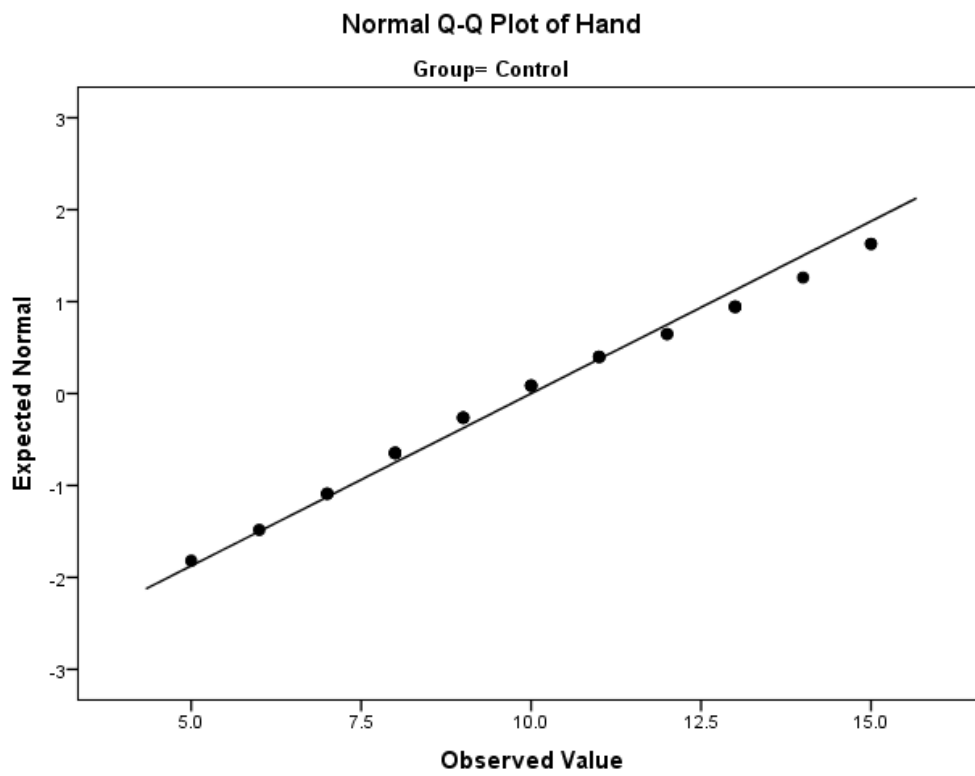
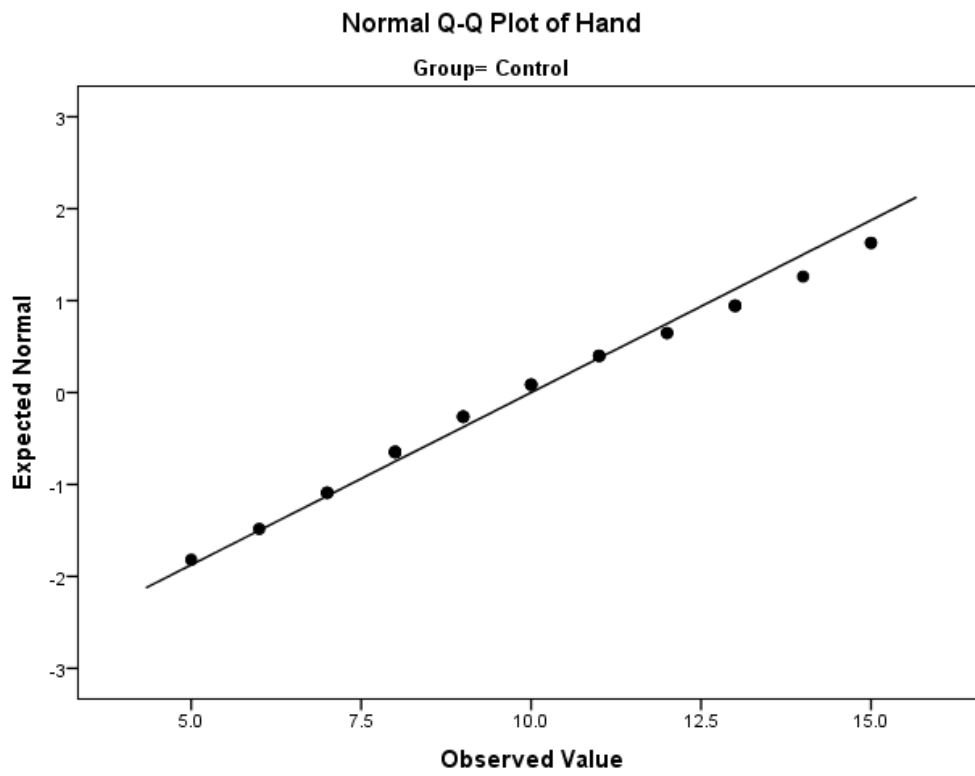
Age:

Gender:

Do you play any sports may impact this study (e.g. baseball or tennis)?

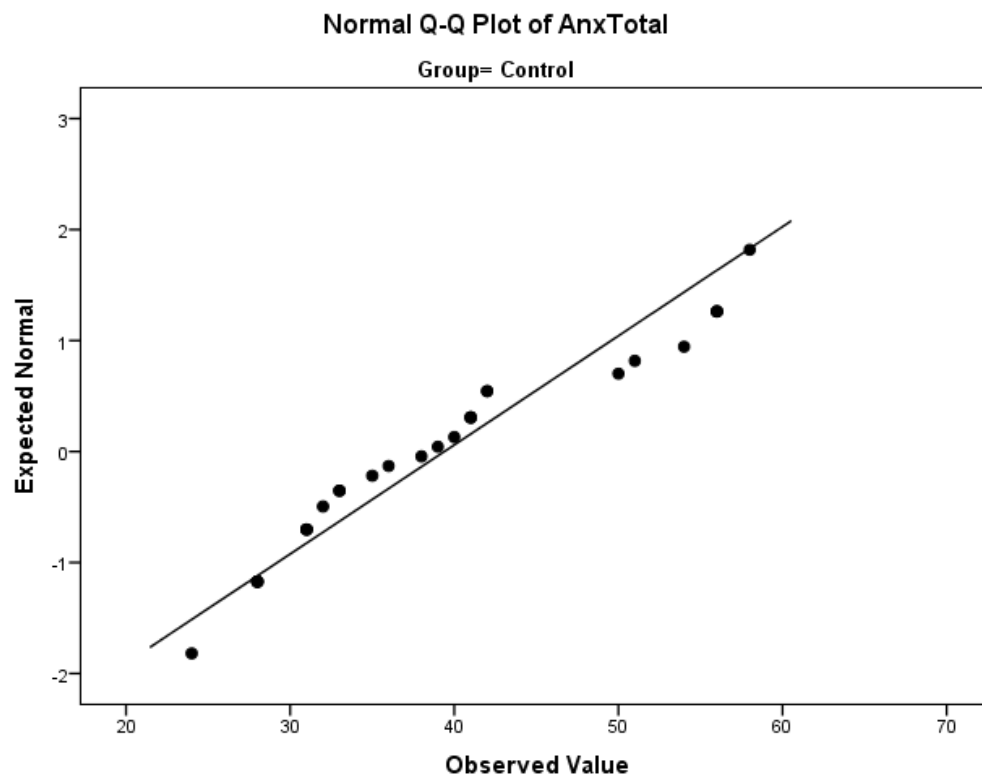
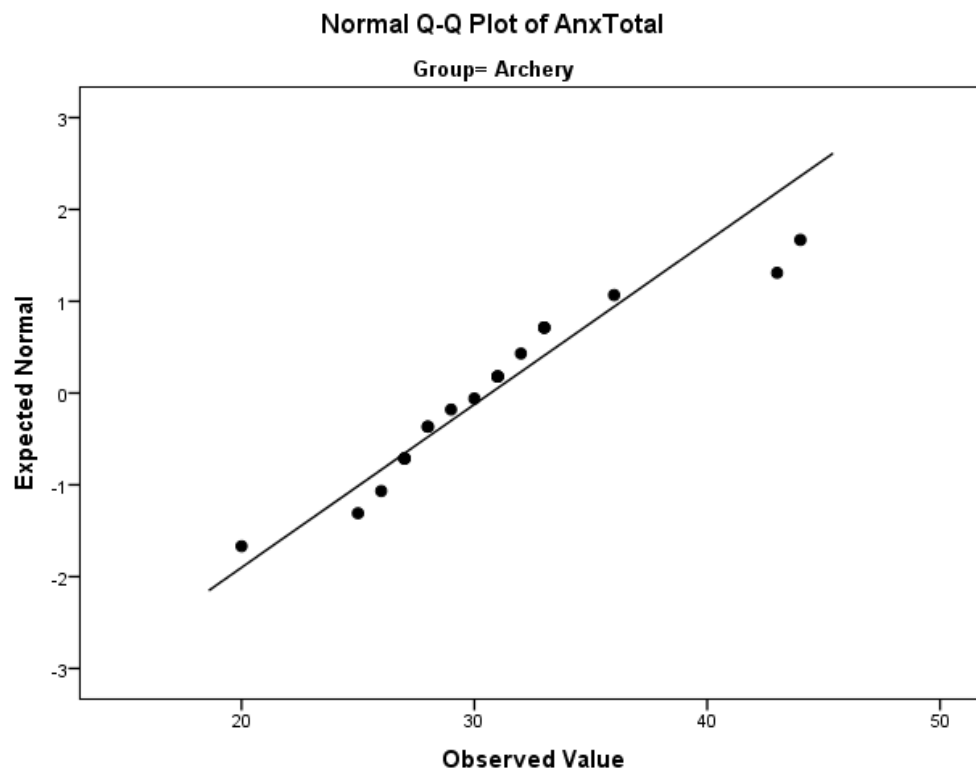
Do you have any clinically diagnosed disorders that may impact the results of this study (e.g. dyspraxia or generalised anxiety disorder)

Av).





Avi)



Avii)

