EXAMINING THE USE OF THE *SHORE HANDWRITING SCREENING* TO ASSESS THE HANDWRITING SKILLS OF PRE-KINDERGARTENERS

By

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## Abstract

The purpose of this study was to examine the use of the *Shore Handwriting Screening* (SHS; Shore, 2003) and the SHS Score Sheet, created by researchers at East Carolina University, and assess their relationship to a standardized fine motor assessment in the pre-kindergarten population. Standardized assessments to measure handwriting skills of pre-kindergarten students are lacking (Feder & Majnermer, 2003; Puranik & Lonigan, 2009; Rosenblum, Weiss, & Parush, 2009). A prominent reason students are referred to occupational therapy in school is because of handwriting difficulties and fine motor problems (Asher, 2006; Feder, Majnemer, & Synnes, 2000). In order to provide the most effective intervention for students, it is important that occupational therapy practitioners are appropriately evaluating students' skills. Pre-kindergarten students' scores on the SHS were compared to their scores on a portion of a standardized fine motor assessment, the *Bruininks-Oseretsky Test of Motor Proficiency*, Second Edition (BOT-2; Bruininks & Bruininks, 2005). Testing the SHS and BOT-2 across two socioeconomic groups provided an opportunity to compare the scores across a broad range of pre-kindergarten

students. Thirty-six students from a federally funded pre-kindergarten program and fourteen students from a private pre-kindergarten classroom completed the SHS and BOT-2 and scores were compared within and across the two classrooms. Results show that the SHS displayed moderate to strong correlations with three subtests of the BOT-2 (Fine Motor Precision, Fine Motor Integration, and Manual Dexterity). Students from the private pre-kindergarten classroom obtained higher scores on both the SHS and three of the four subtests of the BOT-2 in comparison to the federally funded pre-kindergarten students. The SHS, along with the SHS Score Sheet, is a functional and practical handwriting screening that shows evidence of being related to a standardized fine motor assessment.

# EXAMINING THE USE OF THE *SHORE HANDWRITING SCREENING* TO ASSESS THE HANDWRITING SKILLS OF PRE-KINDERGARTENERS

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By

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LIST OF ABBREVIATIONS

SHS: Shore Handwriting Screening

BOT-2: Bruininks-Oseretsky Test of Motor Proficiency-Second Edition

SES: Socioeconomic status

SD: Standard deviation

TPS: Total Point Score

SC: Scale Score

SS: Standard Score

FM: Fine Motor

UL: Upper-Limb

HI: Higher-income

LI: Lower-income

# CHAPTER 1: INTRODUCTION

Handwriting is a fundamental skill that all students must learn in order to be successful in school because students use handwriting skills daily, to complete work in all academic areas (Case-Smith, 2002). Handwriting is the way through which young students convey their knowledge to their teachers. It is a psychomotor skill through which children communicate (Hamstra-Bletz & Blote, 1993). Handwriting difficulties can affect approximately 10% to 27% of elementary students (Bouwien, Smits-Engelman, Van Galen, 1997; Hamstra-Bletz & Blote, 1993; Karlsdottir & Stefansson, 2002; McHale & Cermak, 1992). Those students who continue to suffer from handwriting problems may have a difficult time succeeding in school, leading to continued challenges as they grow older (Engel-Yeger, Nagauker-Yanuv, & Rosenblum, 2009).

Since functional handwriting is vital to students' success and many students struggle with this skill, an important area addressed by school-based occupational therapy practitioners is success with functional handwriting (Tseng & Chow, 2000). A prominent reason students are referred to occupational therapy in school is because of handwriting difficulties and fine motor problems (Asher, 2006; Feder, Majnemer, & Synnes, 2000). When students are identified as unsuccessful with producing written work, occupational therapy practitioners first need to complete a comprehensive evaluation of the quality of students' handwriting skills before providing recommendations and determining an intervention plan. It is important to know that the students are being appropriately evaluated and that the students' skills have been adequately reviewed. One way to assess handwriting skills is through the administration of standardized assessments. However, standardized assessments to measure handwriting skills of young students are lacking (Feder & Majnemer, 2003; Puranik & Lonigan, 2009; Rosenblum, Weiss, & Parush, 2003).

## Problem Statement

Occupational therapy practitioners in schools spend a large amount of time addressing handwriting skills of students (Asher, 2006); therefore, a standardized handwriting assessment has the potential to greatly benefit occupational therapists and the students that they are serving because it provides a consistent and unified way of assessing students' handwriting skills. However, there is currently no standardized handwriting assessment available for occupational therapists to assess the pre-kindergarten age student. Establishing a standardized handwriting assessment to assess young writers is important because occupational therapists should be using valid tools in practice to indicate accurate ability and progress (Feder & Majnemer, 2003; Feder, et al., 2000; Van Hartingsveldt, De Groot, Aarts, & Nijhuis-Van Der Sanden, 2011; Unsworth, 2000) and to identify students with deficits as early as possible (Engel-Yeger, et al., 2009; High, 2008).

The *Shore Handwriting Screening* (SHS) is a tool that was designed for screening purposes but has not been quantified for measurement and comparison (Shore, 2003). This tool has the potential to be used as a quantitative measure. Researchers have developed a scoring rubric for this screening tool that has been used to calculate a single overall percentage score. However, the validity of this score has yet to be established.

## Purpose of the Study

The purpose of this study was to compare student performance on the SHS to a standardized motor assessment in order to determine the relationship between the two assessments to help validate the quantified scoring of the SHS. This provided evidence that future research should be conducted to assess the SHS and SHS score sheet's ability to measure fine motor skills related to handwriting in pre-kindergarteners. In time, standardizing a

handwriting assessment for this population may give occupational therapists the opportunity to better evaluate young student performance in handwriting-related skills to determine a student's ability level and allow for comparison to same-aged peers. This may also allow for comparison to a given standard ability, and assist in deciding if intervention is necessary.

# CHAPTER 2: LITERATURE REVIEW

## Components of Handwriting

Handwriting is complex. Successful handwriting requires a seamless integration of cognition, fine motor control, in-hand manipulation, visual motor integration, motor planning, visual perception, and sustained attention. (Feder & Majermer, 2007; Rosenblum, et al., 2003). Puranik and Lonigan (2009) assert that handwriting develops in a linear pattern for preschool children. First, children learn the universal features of handwriting, which includes understanding the basic attributes of writing. Children start out by writing in scribbles and lines, knowing that the scribbles stand for something. After learning the universal features, children can begin to learn the language-specific features of handwriting. This includes learning letters and beginning to write them. Therefore, children must first master the universal features of handwriting before they can successfully be taught the language-specific features.

Since handwriting requires a combination of several different motor and cognitive skills, it is beneficial to see what mechanisms work together to predict the quality of handwriting in students with handwriting difficulties and those students without handwriting difficulties. Volman, van Schendel, and Jongmans (2006) found that the best predictor of quality of handwriting in students without handwriting problems was fine motor coordination; for students with handwriting difficulties, the best predictor of quality of handwriting was visual-motor integration. This indicates that students with handwriting difficulties appear to be especially related to visual-motor integration deficits. Tseng and Chow (2000) compared the performance of slow handwriters and handwriters with normal speed. They found that the two groups were significantly different, in that the two groups responded to handwriting demands in different ways. For the slow writers, visual motor integration and visual processes played an important

role in handwriting, while for the normal speed writers, motor components played an important role, including upper-limb speed and dexterity.

Other studies found that there is a strong relationship between visual-motor integration and the ability to copy letters in a legible manner (Daly, Kelley, & Krauss, 2003) and that visual-motor control correlates with writing legibility and speed (Atasavan Uysal & Aki, 2012). Kaiser, Albaret, and Doudin (2009) found that hand-eye coordination, associated with visual-motor integration, is the best predictor of quality of handwriting. Visual-motor skills have also been found to be important to handwriting readiness in kindergarten students (Marr, Windsor, & Cermak, 2001). The research provides strong evidence that that visual-motor integration and motor skills are important in handwriting.

**Handwriting Readiness**

Kindergarten is a time when students are often referred to occupational therapy for poor handwriting (Marr & Cermak, 2003); however, students are expected to have already obtained academic skills prior to beginning kindergarten (Elliott & Olliff, 2008), including skills related to handwriting. Young children make deliberate written marks to communicate meaning long before writing actual letters (Kissel, Hansen, Tower, & Lawrence, 2011). The North Carolina preschool standards indicate that preschool students will begin to write letters and master the letterforms, write their own names, and then also attempt to connect sounds in a word to its letterforms (Work, 2004). Nearly two- thirds of kindergarteners recognize letters by the time they enter kindergarten (Zill & West, 2001).

Several handwriting prerequisites have been identified that should be mastered before a child can be successful at completing the skill of handwriting. Pre-requisites for handwriting include ability to cross midline, ability to recognize letters of the alphabet, established hand

dominance, functional pencil grasp, ability to copy geometric shapes, hand-eye coordination, and proper sitting posture (Feder & Majnemer, 2007; Marr, Windsor, & Cermak, 2001; Rosenblum, et al., 2003). Helping students master these skills in preschool and teaching them developmentally appropriate handwriting skills early can help better prepare them for elementary school.

There are large differences between students in their early handwriting skills and knowledge of writing when entering elementary school (Blatchford, 1991). Handwriting is related to writing skills in elementary school-age students (Blatchford, 1991; Graham, Harris, Fink, 2000). Medwell and Wray (2012) assert that "handwriting, and in particular the automaticity of letter production, appears to facilitate higher-order composing processes by freeing up working memory to deal with the complex tasks of planning, organising, revising and regulating the production of text" (p. 14). A basic level of handwriting competence is required before a child can compose a written work that they can be read back and understood by a wider audience (Dunsmuir & Blatchford, 2004). And specifically, when students are in kindergarten, their handwriting and spelling has been shown to make statistically significant contributions to composing written work (Puranik & AlOtaiba, 2012), which displays the importance of early handwriting skills, even before students enter kindergarten.

Handwriting has also been identified as a contributor to letter recognition for preschoolers. This is because the process of handwriting involves a visual-motor experience that may strengthen the neural systems used for letter recognition (James, 2010), emphasizing the usefulness of handwriting to learn letters, even before kindergarten. James and Atwood conclude that "our experience in writing letters may contribute to the development of functional specialization for letters" (2008, p. 16). Functional specialization of the brain means that

different areas of the brain are specialized for different functions, therefore showing the importance of performing handwriting to enhance learning of letters.

It is evident that handwriting skills have been linked to the ability to compose written work and can aid in enhanced letter recognition. It is also important to identify students with problems early because deficits in handwriting skills can become more complicated in students' later years (Engel-Yeger, et al., 2009). Early identification and attention to students' needs may significantly reduce delayed development (High, 2008); therefore it is important that students are adequately prepared for kindergarten and that early identification and intervention of handwriting problems be provided.

Ultimately, there are several skills that students must master before being successful in handwriting and there is support for exposing children to letters and handwriting early. It is also important to identify those students who are struggling so that they can get the help they need to be successful.

**Handwriting in Schools**

Handwriting is an essential part of a student's school day. In fact, fine motor activities make up 30% to 60% of the activities completed daily by an elementary student, while 36% to 66% of a kindergartener's day is spent on fine motor activities. Within those fine motor activities identified, handwriting is the predominant skill (McHale & Cermak, 1992; Marr, Cermak, Cohn, & Henderson, 2003). For elementary school students, handwriting is the principal way that they communicate their knowledge in all academic subjects (Case-Smith, 2002). If students are struggling with handwriting, it can impact all aspects of their school learning and can make success in school more difficult to attain (Feder & Majnemer, 2007).

Those students who do face difficulties in handwriting may not get the extra help that they need from their teachers and not all teachers make adaptations for students who are struggling with handwriting (Graham, Harris, Fink-Chorzempa & MacArthur, 2003). Students with Autism Spectrum Disorders are at a higher risk to experience handwriting difficulties due to impairments in fine motor control and visual motor integration (Kushki, Chau, & Anagnostou, 2011). Students struggling with handwriting are not as likely to share their writing with others, help their peers, choose their own writing topics, or complete writing assignments at a comfortable pace (Graham, Harris, & Larsen, 2001). A student with handwriting difficulties compares his or her performance to the performance of his or her peers in class, which may negatively affect the student's sense of self-efficacy in handwriting (Engel-Yeger, et al., 2009).

There is consistency of handwriting skills as children age. Marr and Cermak (2003) found that elementary school students exhibit a moderately consistent pattern of handwriting performance. The study examined the consistency of students' handwriting skills from kindergarten to first grade using students' scores on a handwriting assessment and then assigning the students to the lowest, middle, or upper performing group. They found that in first grade, the lowest performing group continued to score significantly lower than the middle and upper performing groups; therefore indicating that those students with the lowest handwriting skills in kindergarten continued to display the lowest handwriting skills into first grade as well. Bouwien, et al. (1997) conducted a similar study with students in grades two, three, and four, and found that poor psychomotor skills persisted for those students over the one year course of the study. It is clear that learning appropriate handwriting skills has been shown to be very important for students' success in school and problems with handwriting difficulties can be long lasting.

**Handwriting and Socioeconomic Status**

Handwriting difficulties can have a negative impact on school performance; however, there is evidence that socioeconomic status (SES) also has an influence on development and school performance. Family income is a strong predictor of early school success (Pati, Hashim, Brown, Fiks, & Forrest, 2009). Low SES predicts lower levels of school achievement and lower scores on tests that measure intelligence and cognitive functioning (McLoyd, 1998). Also, dependence on welfare (as a marker of family poverty) has been identified as a risk factor associated with poor academic performance in school-aged students (Zill & West, 2001). In a meta-analytic review of journal articles that focused on SES and academic achievement and were published between 1990 and 2000, Sirin (2005) found that parents' position in the socioeconomic structure has a substantial impact on students' achievement.

Another study found that a sample of minority students from a Head Start population were two and half to three times more likely to meet criteria of Sensory Modulation Disorder compared to typically developing young, Caucasian students (Reynolds, Shepard, & Lane, 2008). West, Denton, and Garmino-Hausken (2000) found that Head Start students had significantly lower fine motor skills in kindergarten compared to students from higher income families who did not attend Head Start.

When looking directly at handwriting skills, preschool students within a higher SES group have been shown to have higher visual-motor integration skills, as well as larger hand size and strength, compared to students from a lower SES group (Bowman & Wallace, 1990). Also, students who attended schools located in "marginalized, socio-economically deprived communities" were found to have lower-than-average handwriting speed (O'Mahoney, Dempsey, & Killeen, 2008, p.168). This shows that on some tests used by occupational therapy

practitioners, students from a higher SES group may function at a higher developmental level than those students from a lower SES group, which is important to be aware of when assessing students. Overall, it is clear that SES can have an impact on school success and handwriting abilities.

**Assessing Handwriting Skills**

From the research, a difference of handwriting skills is expected across varying SES groups. Giroux, Woodall, Weber, and Bailey (2012) found that school-based occupational therapists rated visual motor integration, motor planning, eye-hand coordination, and review of work samples and direct observation of a student as the highest competency items when conducting a handwriting evaluation and planning intervention. When evaluating a student's handwriting skills, it is important to observe the student in the classroom, consult with the student's teacher, and to also use a valid and reliable tool that is standardized (Feder & Majnemer, 2007). However, a standardized way of measuring students' handwriting skills is lacking. Rosenblum, et al., (2009) assert that there is no applicability of handwriting scales to different populations or subgroups of writers. Feder and Majnemer (2003) reviewed five popular handwriting evaluations and concluded that a standardized handwriting evaluation tool is needed to ensure school students' handwriting skills are properly assessed.

The *Shore Handwriting Screening* (SHS) was created by an occupational therapist to assist in the screening of students to determine handwriting problems (Shore, 2003). The SHS is a non-standardized assessment tool used to determine the possible causes of handwriting dysfunction in students who are learning to write; therefore, it can be used to assess students in preschool to third grade. It consists of classroom observation of the student, a screening of the student, and obtaining a handwriting sample from the student's teacher. The screening is a

checklist-style tool that examines functional skills that students complete daily, including postural control, hand control, pre-writing skills, letter and number formation, and bilateral hand skills (Shore, 2003). The SHS comes with a response booklet but does not have numerical values for the observations made during the screening. However, it does allow the practitioner to make recommendations for further evaluations of the student, if needed. The items on the SHS were developed based on research; however, little to no research has been conducted on the SHS itself. A scoring sheet has been created by researchers to quantify the students' handwriting skills on the SHS, this scoring sheet has not yet been proven to be valid or reliable and it had only been used on a federally-funded pre-kindergarten population.

Since handwriting is so important for young writers and because many students are referred to school occupational therapists for handwriting problems, it would be beneficial if a standardized handwriting assessment was available for occupational therapists to assess the handwriting skills of those young students referred to them. Within the current available evaluations, there are different scoring systems, which do not allow comparisons across studies. There is generally no consensus on how to measure students' handwriting skills (Rosenblum, et al., 2009; Puranik & Lonigan, 2009). Examining the SHS for its potential to become a valid handwriting measure can be accomplished by comparing pre-kindergarten students' scores on the SHS, using the SHS Score Sheet, to their scores on a standardized fine motor assessment measure, the *Bruininks-Oseretsky Test of Motor Proficiency*, Second Edition (BOT-2).

**Summary**

Through a review of the research, it is evident that adequate handwriting skills are needed for students to fully succeed in school. It is also apparent that a standardized handwriting assessment for young writers does not presently exist. Examining the SHS along with the

scoring sheet that has been created, as compared to the pre-kindergarten students' scores on portions of a standardized fine motor assessment, BOT-2, provided a better picture of whether the SHS is an appropriate tool to measure handwriting abilities in pre-kindergarten students. Testing the SHS in two SES groups gave an opportunity to examine if the SHS is valid across a broad range of pre-kindergarten students.

There are two research questions that were addressed in this study:

- Is there a relationship between pre-kindergarten students' scores on the *Shore Handwriting Screening* and the fine manual control/manual coordination portions of the *Bruininks-Oseretsky Test of Motor Proficiency,* Second Edition?
- How do pre-kindergarten students' scores on the *Shore Handwriting Screening* and *Bruininks-Oseretsky Test of Motor Proficiency*, Second Edition compare across two different SES groups?

# CHAPTER 3: METHODOLOGY

## Design

This was a correlational study that used a quantitative design, and sought to determine if the SHS and the SHS Score Sheet provide an appropriate measure of handwriting skills in pre-kindergarten students by comparing students' scores on the SHS to their scores on four subtests of the BOT-2. This design was selected because it allowed an investigation of handwriting skills across socioeconomic (SES) groups. The research design allowed the students to be tested in their naturalistic school environment while also allowing an examination of students from two different SES groups. It was not possible to randomly select and assign pre-kindergarten students from the population, but this design allowed scores to be obtained from students from at least two different SES groups.

## Subjects

For participation in this study, subjects were selected from a convenience sample, therefore non-probability sampling was used. There were 47 possible students from two federally funded pre-kindergarten classrooms in Eastern North Carolina (lower-income group) and a sample of 16 students from a private pre-kindergarten classroom in Eastern North Carolina (higher-income group). The lower-income group was a preschool program for students from low-income families. It served students from families who are at or below the federal poverty line, which was $23,050 for a family of four during 2012 (2012 HHS Poverty Guidelines, 2012). The higher-income group was from a private school, in which the family tuition expense was annually $6500 per pre-kindergarten student during 2012 (Financial Information, n.d.).

Lower-income group students were from a previous study by the East Carolina University Occupational Therapy department, conducted in the fall of 2010. From the lower-income group sample, students under the age of 48 months were excluded from the study (n = 8)

because the BOT-2 only measures motor scores for ages four and above. The students whom did not complete the SHS were also excluded from the data (n = 2). Lastly, one participant was excluded during the data analysis because the student was an outlier. This left a total of 36 students from the lower-income group classrooms. The subjects from the higher-income group consisted of 14 students from the pre-kindergarten classroom at a private school, as two students did not receive parental consent. Through the use of a parental consent form, an explanation of the study and an assurance of confidentially and anonymity was made prior to the data collection (Appendix A).

The students from the lower-income group ranged in age from 48 months to 60 months, with an average age of 54.5 months (SD = 3.98), while the students from the higher-income group ranged in age from 50 months to 60 months, with an average age of 54.9 months (SD = 4.01). There were nineteen females and seventeen males in the study from the lower-income group classroom and eight females and six male participants in the higher-income group. These two groups of students allowed comparison between two different SES groups.

**Instrumentation**

**Shore Handwriting Screening**. The *Shore Handwriting Screening* (SHS) is a non-standardized, checklist-style screening tool, which includes observation of a student completing tasks related to handwriting. It has not been tested for validity and reliability. The SHS requires the administrator to observe a student's postural control, hand dominance, pencil grasp, in-hand manipulation skills, bilateral hand skills, ability to copy shapes, letters, and numbers, color a balloon, draw a person, and cut out a square, which are all functional tasks that students often complete in a typical school day.

The SHS includes two sections based on age: one section for three- to five-year-olds and one section for students who are age six and older. For example, to measure pre-writing skills, for students ages three to five years of age, the task is to copy rows of four basic shapes after the examiner demonstrates them, while for the students six years of age and older, the task is to copy rows of eight shapes that includes shapes that are more advanced, without demonstration from the examiner (Shore, 2003).

The SHS Score Sheet was created to assign a score to a student's handwriting-related skills. The student may score between zero and four points on most of the handwriting tasks, with a maximum possible score of forty-seven for either the three- to five-year-old or the six-year-old and above section. The more advanced a student's handwriting skills, the higher the score will likely be. The SHS Score Sheet allows for scoring of either age section of the SHS or a composite score of all tasks. Only the scoring of the three- to- five-year-old section was used in this study.

**Bruininks-Oseretsky Test of Motor Proficiency, Second Edition**. The *Bruininks-Oseretsky Test of Motor Proficiency*, Second Edition (BOT-2) is a standardized tool used to evaluate motor performance. It measures fine manual control, manual coordination, body coordination, and strength and agility (Bruininks & Bruininks, 2005). The full assessment includes eight subtests, which make up four composite scores that can all be added together to create a total motor composite. However, this study will only be using two of the four composites: the Fine Manual Control composite, which consists of two subtests, Fine Motor Precision and Fine Motor Integration, and the Manual Coordination composite, which consists of two subtests, Manual Dexterity and Upper-Limb Coordination.

The first subtest, Fine Motor Precision, has tasks that require specific control of finger and hand movements. It is made up of seven activities that the student must complete, which are not timed. These include filling in a circle, filling in a star, drawing a line through a crooked path, drawing a line through a curved path, connecting dots, folding paper, and cutting out a circle. Fine Motor Integration is the second subtest, which is also not timed. It consists of eight items in which the student has to copy geometric shapes that become increasingly complex. These include copying a circle, a square, overlapping circles, a wavy line, a triangle, a diamond, a star, and lastly, copying overlapping pencils. This subtest also measures visual-motor integration because the student has to reproduce the drawings without any guidelines or visual aids. The Manual Dexterity subtest is timed and measures fine motor control of a student's arm and hand movements. It is made up of five activities, including making dots in circles, transferring pennies, placing pegs in a pegboard, sorting cards, and stringing blocks. Lastly, the Upper-Limb Coordination subtest is not timed and is made up of seven activities that measure visual tracking with coordinated hand and arm movements. These activities include dropping and catching a ball with one hand, and with two hands; catching a tossed ball with one hand, and with two hands; dribbling a ball with one hand, and alternating hands; and throwing a ball at a target (Bruininks & Bruininks, 2005)

It was expected that students' scores on the SHS would correlate with three out of four subtests of the BOT-2 (Fine Motor Precision, Fine Motor Integration, and Manual Dexterity) because these subtests measure skills that have been shown to be important aspects of handwriting, including visual integration skills, as well as students' ability to control specific finger, hand, and arm movements. (Volman, et al., 2006; Tseng & Chow, 2000; Daly, et al., 2003; Kaiser, et al., 2009; Marr, et al., 2001). These skills are also important components in the

*Shore Handwriting Screening*. It was expected that the SHS would not strongly correlate with the Upper-Limb Coordination subtest as this subtest requires more gross motor movements, which are not assessed by the SHS.

The BOT-2 has shown evidence of reliability and validity. The BOT-2 has been tested for three kinds of reliability (Bruininks & Bruininks, 2005). It shows internal consistency ( ≥ .93 for the Total Motor Composite for all age groups) , test-retest reliability ( ≥ . 80 for Total Motor composite and Short Form) and inter-rater reliability ($r$ > .90 for all subtests except for Fine Motor Precision, $r$ = .86). The BOT-2's validity has also been tested through four sources of evidence. The first test of validity was the test content, which showed that the BOT-2 measures the domain of behaviors it is supposed to measure. Next, the internal structure shows that the BOT-2 composite subtests correlate and relate as expected. Clinical groups showed that the BOT-2 differentiates between the clinical groups (for which the instrument will most likely be used) and the non-clinical population.

Lastly, the BOT-2 was tested for its relationship with three other measures. It displays a relationship with the previous version of the BOT-2, the Bruininks-Oseretsky Test of Motor Proficiency (BOTMP), the Peabody Developmental Motor Scales, Second Edition (PDMS-2), and the Test of Visual Motor Skills-Revised (TVMS-R). The correlation between the BOTMP and BOT-2 was moderate ($r$ = .60) for the Fine Motor composite of the BOTMP and the Fine Manual Control composite of the BOT-2. Correlations between the BOT-2 and PDMS-2 subtests were moderate to strong ($r$ =. 51 to $r$ = .75). The Fine Motor Integration subtest of the BOT-2 displayed a correlation of $r$ =. 74 with the TVMS-R Visual-Motor Skills composite (Bruininks & Bruininks, 2005). The BOT-2 is standardized, so there are norm tables within the

BOT-2 manual, which include a representative sample of 1,520 participants between the ages of four and twenty-one (Bruininks & Bruininks, 2005).

Further review of the BOT-2 found that it exhibits construct validity and its norms reflect the demographics of the United States (Deitz, Kartin, & Kopp, 2007). Wuang and Chwen-Yng (2009) found the BOT-2 to be a reliable tool to measure motor proficiency and concluded that the BOT-2 has excellent internal consistency ($\alpha = 0.92$) and test-retest reliability ($r = 0.99$) when assessing students who were between the ages of four and twelve. A systematic review of twelve standardized tests concluded that the BOT-2, along with one other assessment, had the best results on psychometric properties and that the fine motor part of the BOT-2 should be part of an evaluation of writing readiness (Van Hartingsveldt, De Groot, Aarts, & Nijhuis-Van Der Sanden, 2011).

**Procedure**

This study was conducted under procedures approved by the Institutional Review Board at East Carolina University (Appendix B). The lower-income group's parental consent for data collection was obtained prior to this study. For both the lower and higher-income groups, the study was acknowledged and approved and signed parental consent was obtained prior to students participating in the study. One participant from the lower-income group did not receive parental consent, while two participants did not receive parental consent in the higher-income group, so they did not participate in the study. Overall, there was a high participation rate in the study.

Each participant was assigned a number so that his or her name was not used during data collection and data analysis. This allowed privacy and confidentiality. The test administrators received training in the administration of the SHS and BOT-2 prior to the beginning of the study.

The lower-income group data was collected in the fall of 2010 by previous researchers and was approved for use in this study. The current researchers collected the higher-income group data in the fall of 2012. The SHS and BOT-2 were administered to students of the lower-income group and the higher-income group in the hallway of their respective schools.

All students from the higher-income group were tested over a two-and-a-half week period. Two students completed the assessments simultaneously. The two test administrators and two students were present for the assessments, and another researcher was present to observe a portion of the assessments. One administrator conducted the SHS and the Upper-Limb Coordination subtest of the BOT-2, while the other administered the Fine Motor Precision, Fine Motor Integration, and Manual Dexterity subtests of the BOT-2. Students were taken out of the classroom in pairs and while completing the assessments, the two students sat at an appropriate-sized table, across from each other. The students completed the SHS and the four subtests of the BOT-2 in various sequences to minimize effects the sequence of the particular tests may have had on performance. It took approximately 15 minutes for students to complete the SHS and approximately 30 minutes for students to complete the four BOT-2 subtests. Data was collected on the SHS while the administrator observed each student complete the handwriting tasks featured on the screening. An administrator completed the SHS screening form that is within the SHS screening booklet, while observing the student completing the SHS handwriting tasks. Data collection for the BOT-2 was conducted during observation of the student completing the tasks of the BOT-2 assessment using the BOT-2 record form, within the BOT-2 test kit. Data collection for the lower-income group participants had also occurred in a very similar manner.

After all of the higher-income group assessments were completed, one researcher completed a SHS Score Sheet for each participant from the higher-income group by transferring

information from the SHS screening form to the SHS Score Sheet. The lower-income group assessments had been scored by other trained researchers prior to the administration to higher-income group. To assess whether there was sufficient inter-rater reliability among scorers, the current researcher scored three previous SHS score sheets from the lower-income group. The current and previous researcher's scoring of the SHS score sheets were similar on the three score sheets; however, this was very limited data. Different researchers administering and scoring the assessments presented a large limitation in this study.

In order to organize the data from the initial assessments, all data for the BOT-2 was entered into the BOT-2 Assistant Scoring and Reporting System. Data was then exported from the BOT-2 Assistant Scoring and Reporting System to SPSS 19, and the SHS scores were added to the data, along with the data from the lower-income group students.

**Ethical Issues**

There were no ethical considerations identified in this study. The East Carolina University Institutional Review Board deemed the study as less than minimal risk. All of the subjects obtained parental consent to participate in the study and the activities present in the assessments are activities that any typical pre-kindergarten student would participate in daily at school.

**Data Analysis**

Data was analyzed to determine if there was a relationship between scores on the SHS and scores on the BOT-2 within both the lower-income group and higher-income group of students and also between the two groups of students. The SHS scores were compared to each of the four selected subtests of the BOT-2, including Fine Motor Precision, Fine Motor Integration, Manual Dexterity, and Upper-Limb Coordination. The scores on each of the BOT-2 subtests are

broken down into total point score (TPS) and scale score (SC), and compared to the SHS percentage scores. TPS is the sum of points that the student scored on each task within each subtest. The SC is obtained when the TPS is converted to normative data; therefore, each student's TPS was converted to a SC based on combined (male and female) norms for his or her age (Bruininks & Bruininks, 2005). The SC identified how far an examinee's TPS was from the mean TPS of examinees of the same age. Next, the composite scores of the BOT-2 were also compared to the SHS. The composite scores are calculated by combining the SC of the subtests within that composite. The Fine Motor Precision subtest SC and the Fine Motor Integration subtest SC combined to form the Fine Manual Control standard score (SS), and the Manual Dexterity SC and Upper-Limb Coordination SC combine to form the Manual Coordination SS. Similar to the SC for each subtest, the SS measure the student's level of proficiency within the composite areas and tell how far the student's score is from the mean score of examinees of the same age (Bruininks & Bruininks, 2005).

# CHAPTER 4: RESULTS

This study sought to determine if the *Shore Handwriting Screening* (SHS), used with the SHS Score Sheet, relates to the fine motor subtests of the BOT-2 by comparing pre-kindergarten students' scores on four BOT-2 subtests to students' scores on the SHS. This may allow future researchers to begin to address if the SHS and SHS score sheet is an accurate measure of pre-kindergarten students fine motor and handwriting skills and allow for continued research on the SHS and SHS score sheet. The researchers also wanted to explore how higher socioeconomic students' scores on the BOT-2 subtests and SHS compared to students' scores from a lower socioeconomic status. A brief overview of the results will be provided, followed by a more detailed explanation.

Several scatterplots and boxplots were created and reviewed to determine if outliers were present and to assist in visualizing the data. Only those scatterplots that exhibited a roughly linear pattern with no outliers could be used for analysis in correlation and linear regression. After reviewing the scatterplots, one subject from the lower-income group was excluded from analysis because the subject scored much higher on the SHS compared to all other lower-income group students. Appendix C displays the scatterplot comparing the SHS scores and BOT-2 scores with the outlier present. After removing the outlier, the remaining points could be summarized by correlation and linear regression for four out of the ten scatterplots in the lower-income group. For the higher-income group, four out of ten scatterplots also met criteria for correlation and linear regression. Each group had differing scatterplots that met the criteria, with the exceptions of Fine Motor Precision TPS and Manual Dexterity TPS.

Correlations between the students' scores on the SHS and the BOT-2 were assessed. All correlation for data showing a roughly linear pattern with no outliers were statistically significant

except for the correlation between the SHS and Manual Dexterity SC in the lower-income group. There were moderate to strong correlations ($r$ = .551 to .783; $p \leq .05$) between the SHS and the BOT-2 for three out of four of the BOT-2 subtests, displaying that there is a linear relationship between pre-kindergarten students' scores on the SHS and the BOT-2.

Linear regression was used to determine the best linear relationship on the scatterplots that exhibited at least a roughly linear pattern and had no outliers. Therefore, linear regression was used to determine if students' scores on the SHS could predict scores on the BOT-2. It was expected that both the lower- and higher-income groups scores would have similar estimated slopes for those items for which linear regression was appropriate in both groups. However, linear regression did not reveal conclusive results that scores obtained on the SHS could predict scores obtained on the BOT-2 because of how different the estimated slopes were between the lower-income group and higher-income group.

Lastly, the scores of the lower-income group students were compared to the scores of the higher-income group of students. Using descriptive statistics and visualization of the data through boxplots, it is evident that students from the higher-income group obtained higher mean scores than students from the lower-income group on the SHS and on three out of four of the BOT-2 subtests. Independent t-tests revealed that there was a statistically significant difference between the higher-income group students and the lower-income group student scores on four out of the ten BOT-2 scores assessed, as well as the SHS.

**Pearson's correlation coefficient**

Pearson's correlation coefficient was used to assess the association between the students' scores on the SHS and the BOT-2 (see Table 4.1). The data from the lower-income group of students found correlations ranging from moderate to strong between the SHS and the Fine

Motor Precision subtest, Manual Dexterity subtest, and the Fine Motor Control SS. There was a weak correlation between scores on the SHS and the Manual Dexterity SC. For the higher-income group of students, correlations ranged from moderate to strong between the SHS and the Fine Motor Precision, Fine Motor Integration, and Manual Dexterity subtests. In both groups of students, the Fine Motor Precision TPS and the SHS had the strongest, statistically significant, correlations at $r = .783$ ($p = .001$), and $r = .756$ ($p = .001$) for the lower-income group and higher-income group, respectively. The correlation of the SHS with Fine Motor Precision SC was $r = .551$ ($p = .005$) for the higher-income group. The Fine Motor Integration TPS also had moderate correlations with the SHS, at $r = .596$ ($p = .005$) for the higher-income group. Lastly, the SHS moderately correlated with Manual Dexterity TPS in both groups of students at $r = .635$ ($p = .001$) for the lower-income group, and $r = .638$ ($p = .005$) for the higher-income group.

As predicted, students' scores on the Upper Limb Coordination subtest did not meet criteria for correlation with scores on the SHS, across both student groups because the scatterplots displayed no linear pattern, with points scattered. This was expected, since the SHS does not assess tasks that the Upper-Limb Coordination subtest assesses.

**Table 4.1**

*Pearson correlation coefficient of SHS and BOT-2 in Lower-income group and Higher-income group students*

| | **SHS** | |
|---|---|---|
| **BOT-2** | **LI group** (n = 36) | **HI group** (n = 14) |
| FM Precision TPS | .783** | .756** |
| FM Precision SC | - | .551* |
| FM Integration TPS | - | .596* |
| Fine Manual Control SS | .655** | - |

| | | |
|---|---|---|
| Manual Dexterity TPS | .635** | .638* |
| Manual Dexterity SC | .147 | - |

Note: ** = Correlation is statistically significant at 0.01 level (2-tailed)
* = Correlation is statistically significant at 0.05 level (2-tailed)

**Linear Regression**

In order to complete linear regression, one assessment had to be assigned as the independent variable, while the other had to be assigned as the dependent variable. The SHS was selected as the independent variable and the BOT-2 was selected as the dependent variable. This selection was made because the SHS examines the whole picture of student skills, and assesses a more functional use of the skills needed for handwriting, while each of the BOT-2 subtests look at specific skill sets. Therefore, if a student obtains a higher score on a test that looks at the whole picture of handwriting skills—the SHS, then it would be likely that the student would also do well on a test that looks at the specific skills sets—the BOT-2 subtests. After making scatterplots to visualize the data to determine if the data was roughly linear and no outliers were present, four scatterplots were identified as fitting the needs of linear regression in the lower-income group, as well as four scatterplots in the higher-income group.

**Lower-income group.** The scatterplots that met the criteria for linear regression were Fine Motor Precision TPS, Fine Manual Control SS, Manual Dexterity TPS, and Manual Dexterity SC (See Appendix D). The slope indicates that when we compare students that differ by one unit on the SHS score, the mean score for the BOT-2 subtest will increase by the number of units of the slope for the students with the higher SHS score. For example, for Scatterplot 1, in Appendix D, a slope of $b = 1.488$ indicates that as students in the lower-income group increase their score on the SHS by one unit, their scores on Fine Motor Precision TPS increases by 1.488

units. The slope for Fine Manual Control SS was $b = 1.651$ ($p = .000$). The slope for Manual Dexterity TPS was $b = .583$ ($p = .000$), while for Manual Dexterity SC, the slope was $b = .138$; however it was not statistically significant ($p = .392$). The slope for each regression line, along with the p-values and confidence intervals are provided below (see Table 4.2).

**Higher-income group.** Four scatterplots also met criteria for linear regression from the higher-income group. (See Appendix D). Those were Fine Motor Precision TPS, Fine Motor Precision SC, Fine Motor Integration TPS, and Manual Dexterity TPS. The slope for Fine Motor Precision TPS was $b = .469$ ($p = .002$), for Fine Motor Precision SC the slope was $b = .246$ ($p = .041$), the slope for Fine Motor Integration TPS was $b = .404$ ($p = .025$), and the slope for Manual Dexterity TPS was $b = .202$ ($p = .014$).

**Table 4.2**

*Linear Regression*

| | **Slope** | **Significance** | **95% Confidence Interval** | |
|---|---|---|---|---|
| | ***b*** | ***p*** | **Lower** | **Upper** |
| **LI group: Fine Motor Precision TPS** | 1.481 | .000 | 1.077 | 1.900 |
| **LI group: Fine Manual Control SS** | 1.651 | .000 | .988 | 2.315 |
| **LI group: Manual Dexterity TPS** | .583 | .000 | .336 | .831 |
| **LI group: Manual Dexterity SC** | .138 | .392 | -.186 | .463 |

| | | | | |
|---|---|---|---|---|
| **HI group: Fine Motor Precision TPS** | .469 | .002 | .213 | .724 |
| **HI group: Fine Motor Precision SC** | .246 | .041 | .011 | .480 |
| **HI group: Fine Motor Integration TPS** | .404 | .025 | .061 | .747 |
| **HI group: Manual Dexterity TPS** | .202 | .014 | .049 | .355 |

**Comparison of student scores across SES**

Descriptive statistics was used to compare the lower-income group scores with higher-income group scores. The mean scores for the higher-income group of students was higher than the mean scores for the lower-income group of students on the SHS and all of the subtests of the BOT-2, except for the Upper-Limb Coordination subtest, including TPS and SC scores (see Tables 4.3 and 4.4).

**Independent t-test.** Boxplots were created to visualize the data and discover if any outliers were present before conducting t-tests (see Appendix E). The boxplots showed that there was one outlier on the Fine Manual Control SS, but it was not so extreme as to exclude it from analysis. There were also outliers found in the Upper Limb Coordination TPS and SC, but it was not expected that there would be significant difference between the two groups of students, so those outliers were also left in the analysis. By examining the boxplots and the data of the students' scores on the SHS and BOT-2, it is clear that the students from the higher-income group obtained higher scores on the SHS and all of the subtests of the BOT-2, except for the Upper-Limb Coordination subtest.

In order to determine if there was a statistically significant difference between the higher-income group of student scores and the lower-income group of student scores, independent t-tests were conducted. The results showed that the scores on the SHS were significantly different between the lower-income group and higher-income group ($p$ = .0000; See Appendix F for the 95% confidence intervals). For the BOT-2 subtests, four scores were found to be statistically significant between the two groups. The Fine Motor Precision SC ($p$ = .035), Fine Motor Integration TPS ($p$ = 0.031), Fine Motor Integration SC ($p$ = 0.012), and the Fine Manual Control SS ($p$ = 0.012) were statistically significantly different between the two groups. The

Manual Dexterity and Upper Limb Coordination subtests were not found to be statistically significantly different between the two groups of students (See Appendix F). The difference of means for the Fine Motor Precision SC was 3.190, while for the Fine Motor Integration TPS, Fine Motor Integration SC, and Fine Manual Control SS, the differences were 4.794, 4.194, and 8.401, respectively. The 95% confidence intervals display the interval of the difference in means, with 95% confidence. For example, the 95% confidence interval for the Fine Manual Control SS is 2.007 to 14.794, meaning that if the true difference were outside this interval, then the data we observed were unusual, happening by chance with probability at most 0.05.

**Table 4.3**

*Lower-income group student scores on the BOT-2 subtests and the SHS, including minimum scores, maximum scores, mean, and standard deviation*
(n= 36)

| | **Minimum** | **Maximum** | **Mean** | **Standard Deviation** |
|---|---|---|---|---|
| **FM Precision TPS** | 0 | 26 | 9.75 | 7.50 |
| **FM Precision SC** | 1 | 20 | 9.17 | 5.11 |
| **FM Integration TPS** | 0 | 19 | 6.78 | 6.76 |
| **FM Integration SC** | 2 | 17 | 9.31 | 4.02 |
| **Fine Manual Control SS** | 22 | 56 | 37.03 | 9.94 |
| **Manual Dexterity TPS** | 3 | 19 | 10.61 | 3.63 |
| **Manual Dexterity SC** | 6 | 23 | 12.97 | 3.72 |
| **UL Coordination TPS** | 0 | 39 | 12.17 | 11.6 |
| **UL Coordination SC** | 6 | 35 | 18.11 | 7.32 |
| **Manual Coordination SS** | 28 | 60 | 51.69 | 12.86 |

| | | | | |
|---|---|---|---|---|
| **SHS** | 48 | 60 | 54.42 | 3.95 |

Note: FM= Fine Motor; TPS= Total Point Score; SC = Scaled Score; SS= Standard Score; UL= Upper Limb

**Table 4.4** *Higher-income group student scores on the BOT-2 subtests and the SHS, including minimum scores, maximum scores, mean, and standard deviation*
(n = 14)

| | **Minimum** | **Maximum** | **Mean** | **Standard Deviation** |
|---|---|---|---|---|
| **FM Precision TPS** | 6 | 26 | 13.07 | 6.03 |
| **FM Precision SC** | 8 | 23 | 12.36 | 4.34 |
| **FM Integration TPS** | 0 | 23 | 11.57 | 6.61 |
| **FM Integration SC** | 4 | 22 | 13.50 | 5.07 |
| **Fine Manual Control SS** | 31 | 68 | 45.43 | 9.80 |
| **Manual Dexterity TPS** | 7 | 16 | 11.93 | 3.01 |
| **Manual Dexterity SC** | 7 | 19 | 14.21 | 3.73 |
| **UL Coordination TPS** | 5 | 23 | 10.21 | 4.92 |
| **UL Coordination SC** | 14 | 24 | 17.57 | 2.68 |
| **Manual Coordination SS** | 20 | 69 | 53.00 | 7.01 |
| **SHS** | 57 | 89 | 72.29 | 9.73 |

Note: FM= Fine Motor; TPS= Total Point Score; SC = Scaled Score; SS= Standard Score; UL= Upper Limb

# CHAPTER 5: DISCUSSION

## Selection of Assessments

The SHS was originally created to screen students for handwriting problems while the SHS Score Sheet was created to quantify preschool (and elementary school) students' handwriting skills since there is a lack of handwriting assessments available for preschool-age students. The SHS was selected for this study because it measures many aspects of handwriting readiness and it is also a functional handwriting assessment.

The BOT-2 was selected as a comparison to the SHS in this study because it is an assessment commonly used by school-based occupational therapists (Feder, Majnemer, & Synnes, 2000) and has been recommended as a standardized test to be used as part of an assessment of handwriting readiness (Van Hartingsveldt, et al., 2011). The BOT-2 also assesses several pre-requisites for handwriting, including, ability to cross midline, bilateral hand skills, understanding of directional terms, ability to identify similarities and differences in shapes and forms, established hand dominance, ability to copy shapes and lines, and hand-eye coordination. The three-to-five year old section of the SHS also looks at these items, in addition to functional pencil grasp, proper sitting posture, and orientation to print.

## Interpretation of Results

This was an initial study examining the Shore Handwriting Screening, along with the SHS Score Sheet's relationship to the BOT-2. The first research question asked if there was a relationship between pre-kindergarten students' scores on the SHS and the fine manual control/manual coordination portions of the BOT-2. This question was addressed by using correlation and linear regression to compare students' scores on the SHS to their scores on the BOT-2.

Correlation between students' scores on the SHS was compared to their scores on the subtests of the BOT-2. The findings showed moderate to strong correlation between the SHS and the majority of the subtests of the BOT-2, including Fine Motor Precision, Fine Motor Integration, and Manual Dexterity if we looked across both groups. Fine Motor Precision and Manual Dexterity displayed consistently moderate to strong relationships in both Lower-income group and Higher-income group showing that these two subtests may most accurately reflect the items that the SHS measures. However, within the lower-income group, the correlation between the Fine Manual Control SS and SHS was moderate, which is the combination of the Fine Motor Precision and Fine Motor Integration subtests. These two subtests had strong correlations with the SHS in the higher-income group. This may show that Fine Motor Integration also relates with the SHS. There was little to no correlation between the SHS and the Upper-Limb Coordination subtest, which was as expected as that subtests measures items that are not measured on the SHS. These results provide initial evidence that the SHS and SHS Score Sheet relates with the fine motor portion of the BOT-2.

When looking at linear regression, it is difficult to draw conclusions because of how different the estimated slopes were between the lower-income group and higher-income group for those scores that met linear regression for both groups. For example, in the lower-income group, the slope for Fine Motor Precision TPS was $b = 1.481$, while for the higher-income group, the Fine Motor Precision TPS slope was only $b = .469$. This is also the case for Manual Dexterity TPS. For the lower-income group, the slope was $b = .583$, while for the higher-income group it was $b = .202$. This may have been because of the difference in sample sizes between the two groups and the fact that overall they were small sample sizes. Larger sample sizes may have provided better results.

The second research question looked at examining how students' scores on the SHS and the BOT-2 compared across SES. Independent t-tests consistently showed that students from the higher SES group obtained scores that were higher than students from the lower SES group on the SHS ($p = .000$) and most sections of the BOT-2 ($p \leq .035$). These finding was expected and supports previous research (McLoyd, 1998; Sirin, 2005; West, Denton, & Garmino-Hausken, 2000; Zill & West, 2001), in that students from higher income families often do better on academic tests compared to students from lower income families.

**Clinical Application**

There are several reasons why the researchers wanted to determine if the SHS can accurately measure handwriting abilities, which can also provide knowledgeable information for school-based occupational therapy practitioners. First of all, early identification of student problems is important (High, 2008), therefore finding a standardized test for pre-kindergarten student is important. Additionally, school-based occupational therapy practitioners spend time working with students with handwriting problems in schools. Also, excessively high caseloads affect between approximately one in three occupational therapists in schools, including a high number of referrals (Holtzinger & Hight, 2005, as cited in Asher, 2006). The three- to five-year-old section of the SHS takes approximately fifteen minutes to administer, making it a practical assessment for occupational therapists to administer to students who are referred to them for handwriting problems and also for occupational therapy practitioners working in preschool environments. Also, pre-kindergarteners often have short attention spans and the SHS is quick to administer, which makes it more likely that a child will be able to pay attention for the entire assessment. Since the screening also includes an observation of the student in the classroom environment, it includes a look at the student within the natural environment that he or she works

in each day.

The SHS is also relatively inexpensive, and costs under $120.00 to purchase the manual and 25 initial scoring forms, while the BOT-2 kit and 25 scoring forms costs over $800.00 (Pearson Education, Inc., 2012). The SHS requires only a small amount of supplies, including crayons, pencil, scissors, and the screening form, while the BOT-2 requires several supplies that are enclosed in a bag that must be transported to wherever a child is completing the assessment.

**Limitations**

There are limitations to this study. The first limitation is that the sample size is small, so the results cannot be generalized to a larger population. Also, the sample sizes were not the same in each group. Another limitation is that the participants in the study were not randomly selected, but were selected by convenience. A future study featuring a larger sample and random selection of participants would be beneficial.

Another limitation presents itself in regards to administering and scoring the assessments. The students from the lower-income group and higher-income group completed the assessments in similar environments—both in the hallways of their respective schools; however, at each school, different researchers administered the assessments. This may have impacted the students' performance on the assessments. Also, students' performance on the screenings may have been impacted by the time of the day that they took the assessments, and any distractions that were present (such as other students walking by or noise from a nearby classroom).

Lastly, a large limitation is that different researchers scored the lower-income group students' assessments and higher-income group students' assessments. This could have affected the scores that the students received, and could account for the large difference in scores between the lower-income group and the higher-income group on the SHS. The same researcher trained

all individuals who administered and scored the assessments in both income groups. Ultimately, this was still a serious limitation that was present in this study because different researchers did administer and score the assessments. Future studies should ensure that there is appropriate fidelity.

**Future Research**

Future research should be conducted to strengthen the ability to distinguish if the SHS and SHS Score Sheet is an appropriate measure of handwriting skills in pre-kindergarten students. Expanding the population assessed to a wider variety and greater number of pre-kindergarten students could strengthen the claim that the SHS is accurately measuring handwriting skills. It would also be beneficial to assess students who are in preschool, kindergarten, first grade, and second grade, as the SHS and the SHS Score Sheet also have portions of the screening devoted to those age groups. Also, participants should be randomly selected, if possible. A further way to strengthen the claim that the SHS and SHS Score Sheet can accurately assess handwriting skills is to complete validity and reliability testing on the SHS to ensure that it has adequate psychometric properties.

Ultimately, this study provides evidence that the SHS relates to a fine motor assessment, the BOT-2, which strengthens the claim that the SHS is able to measure skills related to items on the BOT-2. Further research is needed to further validate the SHS and the SHS Score Sheet and determine if they can accurately measure students' handwriting abilities. Occupational therapists should continue to provide early identification and intervention to students with handwriting difficulties to ensure that students are adequately prepared to enter school.

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APPENDIX A: Parental Consent Form

*East Carolina University*

# Informed Consent to Participate in Research

Information to consider before taking part in research that has no more than minimal risk.

Title of Research Study: Assessing the Validity of the Shore Handwriting Screening Among Pre-Kindergarteners
Principal Investigator: Erin Schofield
Institution/Department or Division: East Carolina University/Occupational Therapy
Address: Department of Occupational Therapy, Health Sciences Building, Greenville, NC 27834
Telephone #: 507-459-1113

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Researchers at East Carolina University (ECU) study problems in society, health problems, environmental problems, behavior problems and the human condition. Our goal is to try to find ways to improve the lives of you and others. To do this, we need the help of volunteers who are willing to take part in research.

## Why is this research being done?

The purpose of this research is to test a handwriting screening, the Shore Handwriting Screening (Shore), along with a scoring sheet that has been created on the pre-Kindergarten population, a population where handwriting assessments are lacking. This will be accomplished by comparing the preschool students' scores on a standardized fine motor assessment, in comparison to the Shore**.** The decision to take part in this research is yours to make. By doing this research, we hope to learn whether the Shore scoring sheet is valid and appropriate for measuring handwriting abilities in preschool children.

## Why am I being invited to take part in this research?

You are being invited to take part in this research because your child is a pre-Kindergarten student. If you volunteer to take part in this research, your child will be one of about 20 children to do so.

## Are there reasons I should not take part in this research?

There are no foreseen reasons in which your child should not take part in this research. Participation in this study is voluntary. You can choose not to participate in this study.

## What other choices do I have if I do not take part in this research?

You can choose not to participate in the research. Your child's school performance is not affected by participation in this research study.

## Where is the research going to take place and how long will it last?

The research procedures will be conducted at The Oakwood School during school hours. Your child will complete the assessment during a day when s/he is in attendance at the school. The total amount of time your child will be asked to volunteer for this study is approximately 45 minutes during one day in Fall 2012.

## What will I be asked to do?

Your child is being asked to do the following:

Your child will participate in one study session, which will consist of two handwriting-related tests. The first test is the Shore Handwriting Screening, which includes the researcher observing your child as he or she completes tasks related to handwriting. The tasks include various writing, drawing, and cutting tasks. This will take approximately 15 minutes to complete. The second test is the Bruininks-Oseretsky Test of Motor Proficiency, Second Edition. The items on this test include tasks such as coloring, drawing lines, cutting, folding paper, manipulating small objects such as pegs and blocks, and catching, dribbling, and throwing a tennis ball. This test will take approximately 30 minutes to complete. The results of these tests will only be used for research purposes and are in no way related to your child's academics.

**What possible harms or discomforts might I experience if I take part in the research?**
It has been determined that the risks associated with this research are no more than what you would experience in everyday life.

**What are the possible benefits I may experience from taking part in this research?**
We do not know if you will get any benefits by taking part in this study. This research might help us learn more about trends in performance on the Shore Handwriting Screening to determine if it is an appropriate measure of handwriting skills. This will benefit occupational therapists who work with students on handwriting skills. There may be no personal benefit from your participation but the information gained by doing this research may help others in the future.

**Will I be paid for taking part in this research?**
We will not be able to pay you for the time you volunteer while being in this study.

**What will it cost me to take part in this research?**
It will not cost you any money to be part of the research.

**Who will know that I took part in this research and learn personal information about me?**
To do this research, East Carolina University and the people and organizations listed below may know that you took part in this research and may see information about you that is normally kept private. With your permission, these people may use your private information to do this research:

- Any agency of the federal, state, or local government that regulates human research. This includes the Department of Health and Human Services (DHHS), the North Carolina Department of Health, and the Office for Human Research Protections
- The University & Medical Center Institutional Review Board (UMCIRB) and its staff, who have responsibility for overseeing your welfare during this research, and other ECU staff who oversee this research.

**How will you keep the information you collect about me secure? How long will you keep it?**
Data will be stored in a locked office. Once the study is completed, data will remain on file until it is confirmed no other comparisons will be made. Then, the data will be destroyed. There will be no identifying information stored with the data.

**What if I decide I do not want to continue in this research?**
If you decide you no longer want to be in this research after it has already started, you may stop at any time. You will not be penalized or criticized for stopping. You will not lose any benefits that you should normally receive.

## Who should I contact if I have questions?

The people conducting this study will be available to answer any questions concerning this research, now or in the future. You may contact the Principal Investigator, Erin Schofield, at 507-459-1113, Monday-Friday, between 1 pm and 5 pm.

If you have questions about your rights as someone taking part in research, you may call the Office for Human Research Integrity (OHRI) at phone number 252-744-2914 (days, 8:00 am-5:00 pm). If you would like to report a complaint or concern about this research study, you may call the Director of the OHRI, at 252-744-1971

## I have decided I want to take part in this research. What should I do now?

The person obtaining informed consent will ask you to read the following and if you agree, you should sign this form:

- I have read (or had read to me) all of the above information.
- I have had an opportunity to ask questions about things in this research I did not understand and have received satisfactory answers.
- I know that I can stop taking part in this study at any time.
- By signing this informed consent form, I am not giving up any of my rights.
- I have been given a copy of this consent document, and it is mine to keep.

| **Participant's Name (PRINT)** | **Signature** | **Date** |
|---|---|---|

**Person Obtaining Informed Consent**: I have conducted the initial informed consent process. I have orally reviewed the contents of the consent document with the person who has signed above, and answered all of the person's questions about the research.

| **Person Obtaining Consent (PRINT)** | **Signature** | **Date** |
|---|---|---|

| **Witness (PRINT)** | **Signature** | **Date** |
|---|---|---|

| **Legally Authorized Representative (PRINT)** | **Signature** | **Date** |
|---|---|---|

APPENDIX B: Institutional Review Board Permission for Research

**EAST CAROLINA UNIVERSITY**
**University & Medical Center Institutional Review Board Office**
4N-70 Brody Medical Sciences Building· Mail Stop 682
600 Moye Boulevard · Greenville, NC 27834
Office **252-744-2914** · Fax **252-744-2284** · **www.ecu.edu/irb**

# Notification of Initial Approval: Expedited

From: Social/Behavioral IRB
To: Erin Schofield
CC:
Denise Donica
Date: 7/30/2012
Re: UMCIRB 12-000868
Assessing the Validity of the Shore Handwriting Screening Among Pre-Kindergarteners

I am pleased to inform you that your Expedited Application was approved. Approval of the study and any consent form(s) is for the period of 7/29/2012 to 7/28/2013. The research study is eligible for review under expedited category #4 and 5. The Chairperson (or designee) deemed this study no more than minimal risk.

Changes to this approved research may not be initiated without UMCIRB review except when necessary to eliminate an apparent immediate hazard to the participant. All unanticipated problems involving risks to participants and others must be promptly reported to the UMCIRB. The investigator must submit a continuing review/closure application to the UMCIRB prior to the date of study expiration. The Investigator must adhere to all reporting requirements for this study.

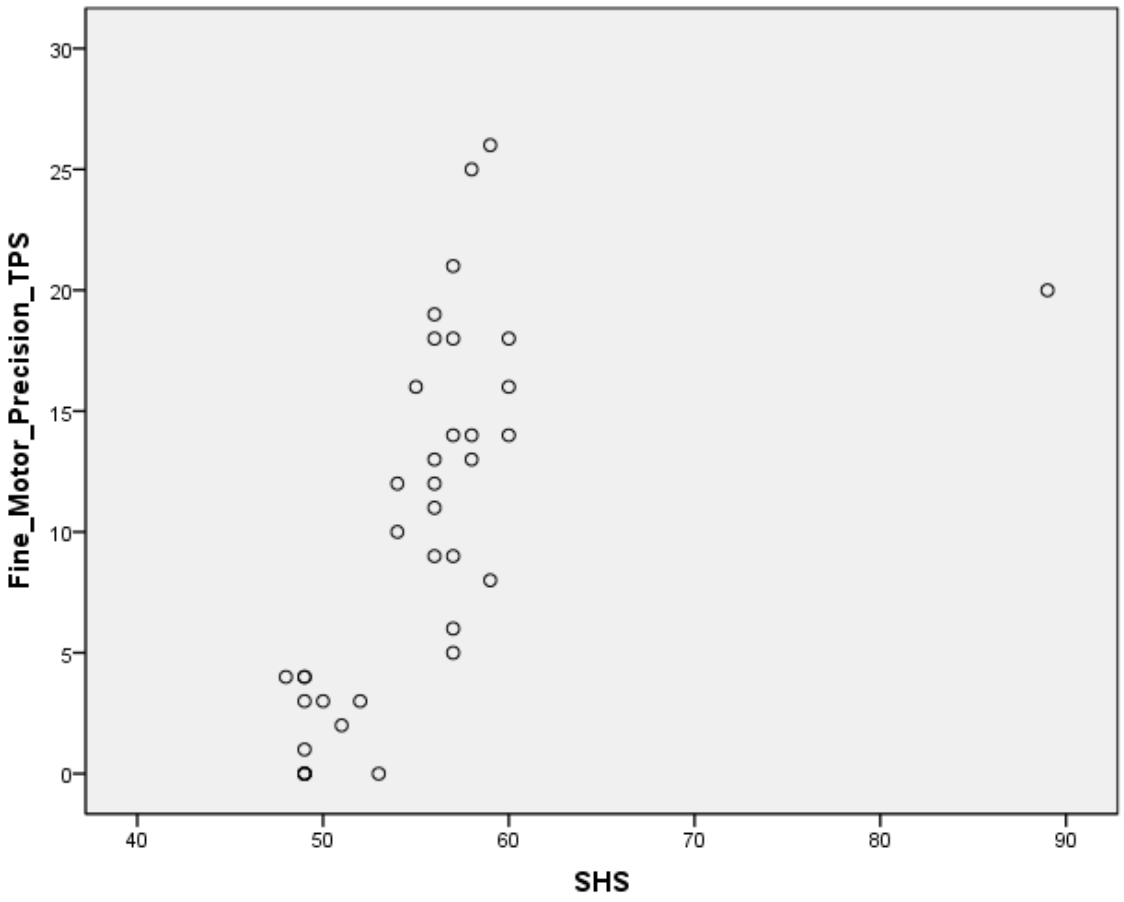
The approval includes the following items:

| Name | Description |
|---|---|
| BOT 2.pdf \| History | Standardized/Non-Standardized Instruments/Measures |
| Consent Form \| History | Consent Forms |
| Schofield Research Proposal \| History | Study Protocol or Grant Application |
| Shore_Handwriting_Screening[1].pdf \| History | Standardized/Non-Standardized Instruments/Measures |

The Chairperson (or designee) does not have a potential for conflict of interest on this study.

APPENDIX C: Outlier

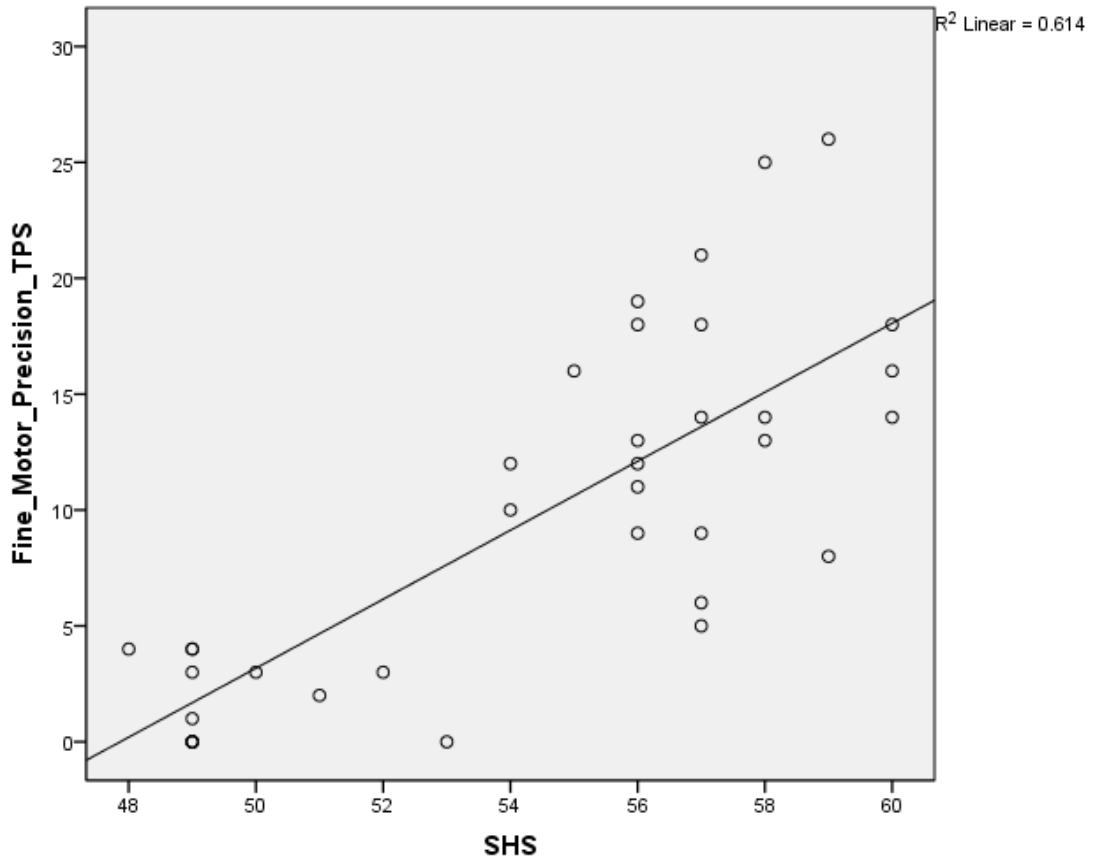
Lower-income group: Scatterplot of SHS and Fine Motor Precision TPS with outlier present



APPENDIX D: Scatterplots

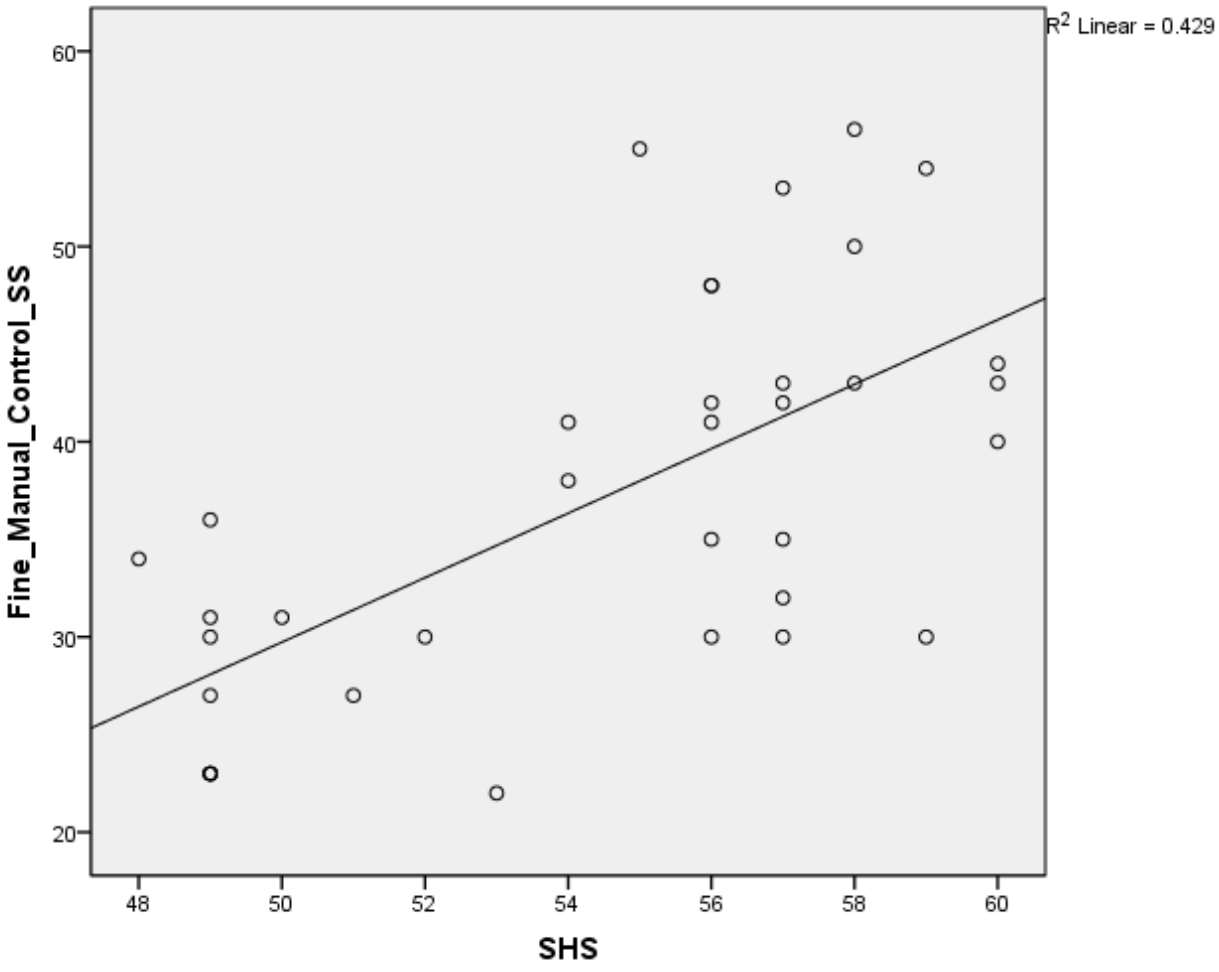
**Scatterplot 1**

**Lower-income group:** Scatterplot of SHS and Fine Motor Precision TPS with fit regression line



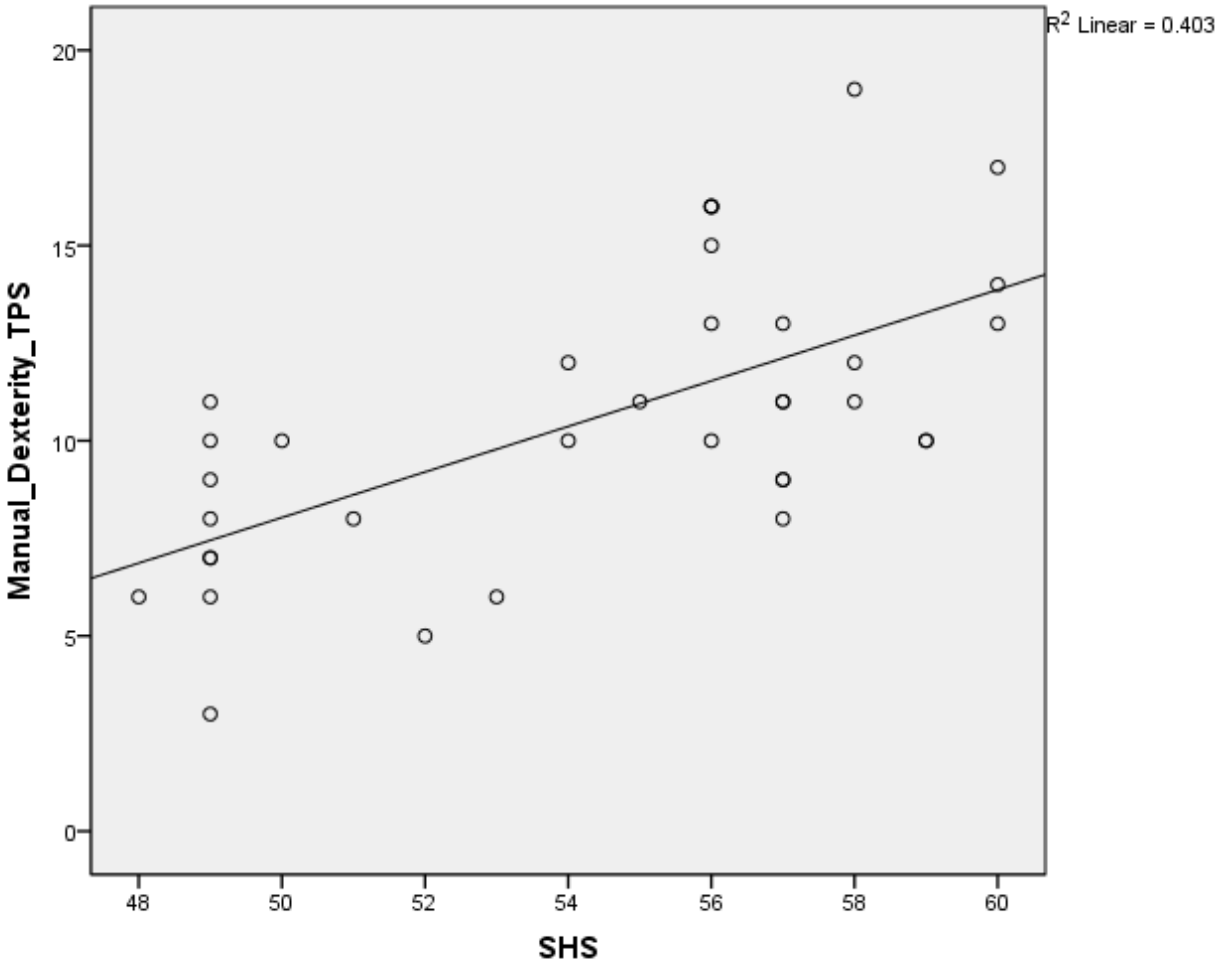
**Scatterplot 2**

Lower-income group: Scatterplot of SHS and Fine Manual Control SS with fit regression line



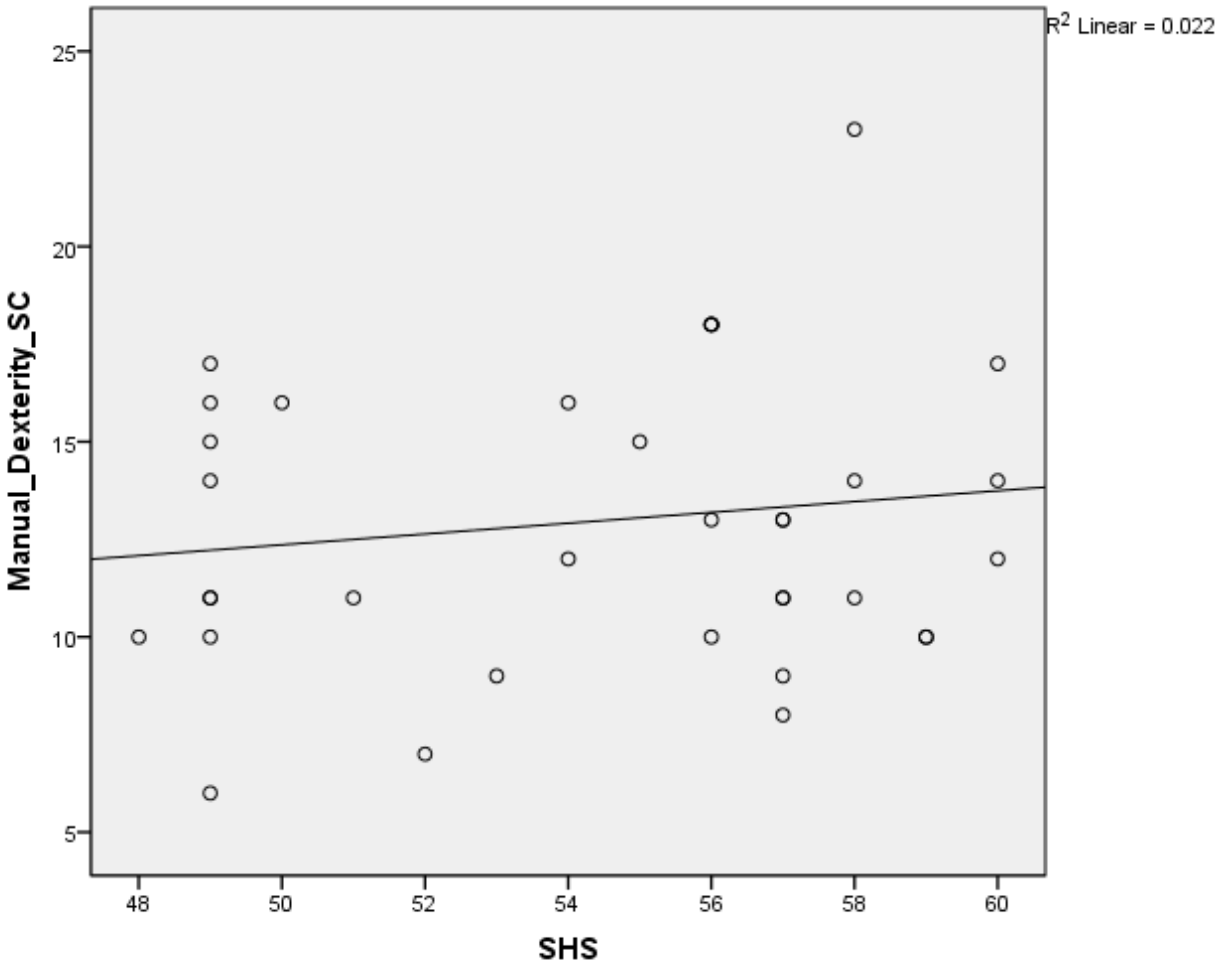
**Scatterplot 3**

Lower-income group: Scatterplot of SHS and Manual Dexterity TPS with fit regression line



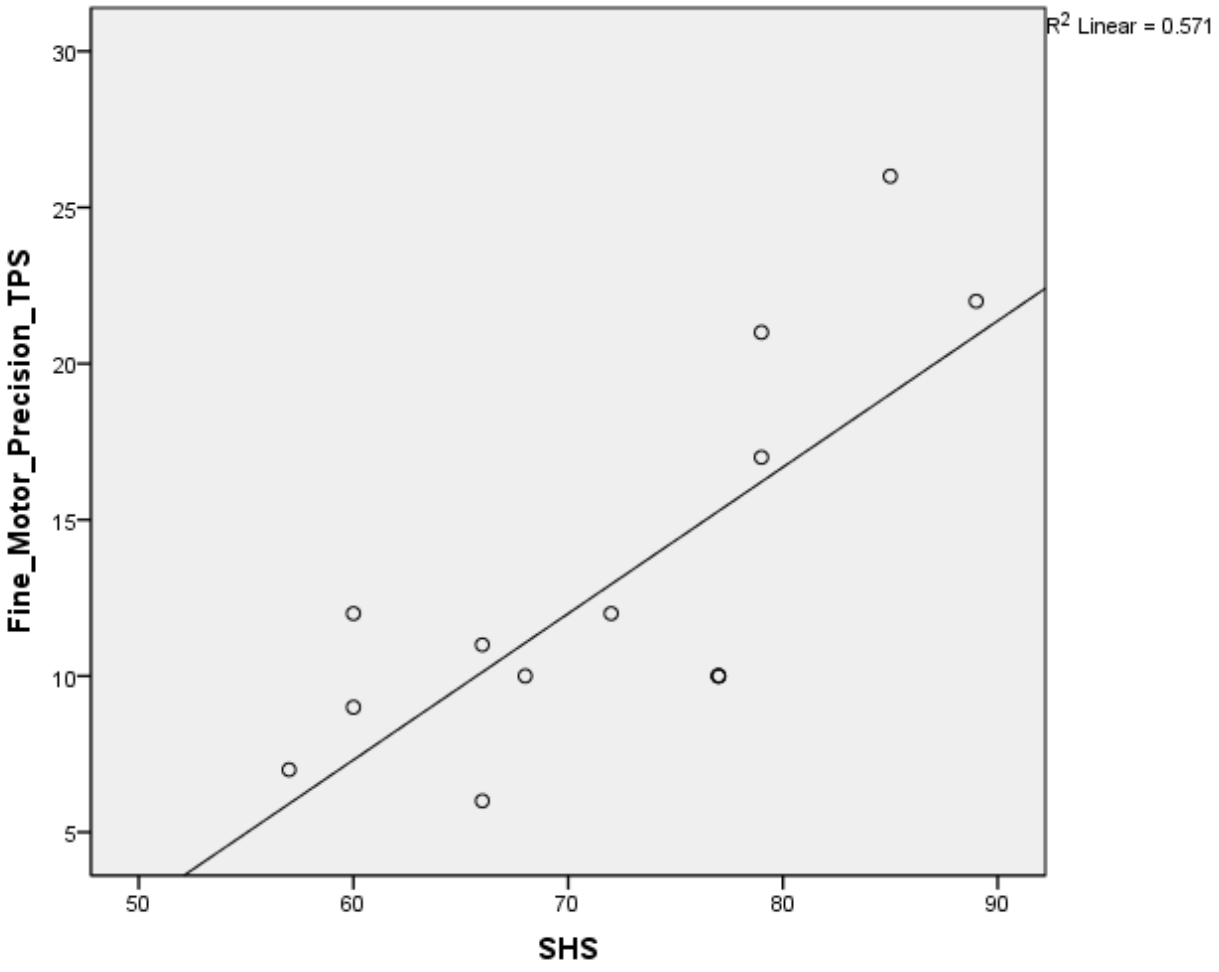
**Scatterplot 4**

Lower-income group: Scatterplot of SHS and Manual Dexterity SC with fit regression line



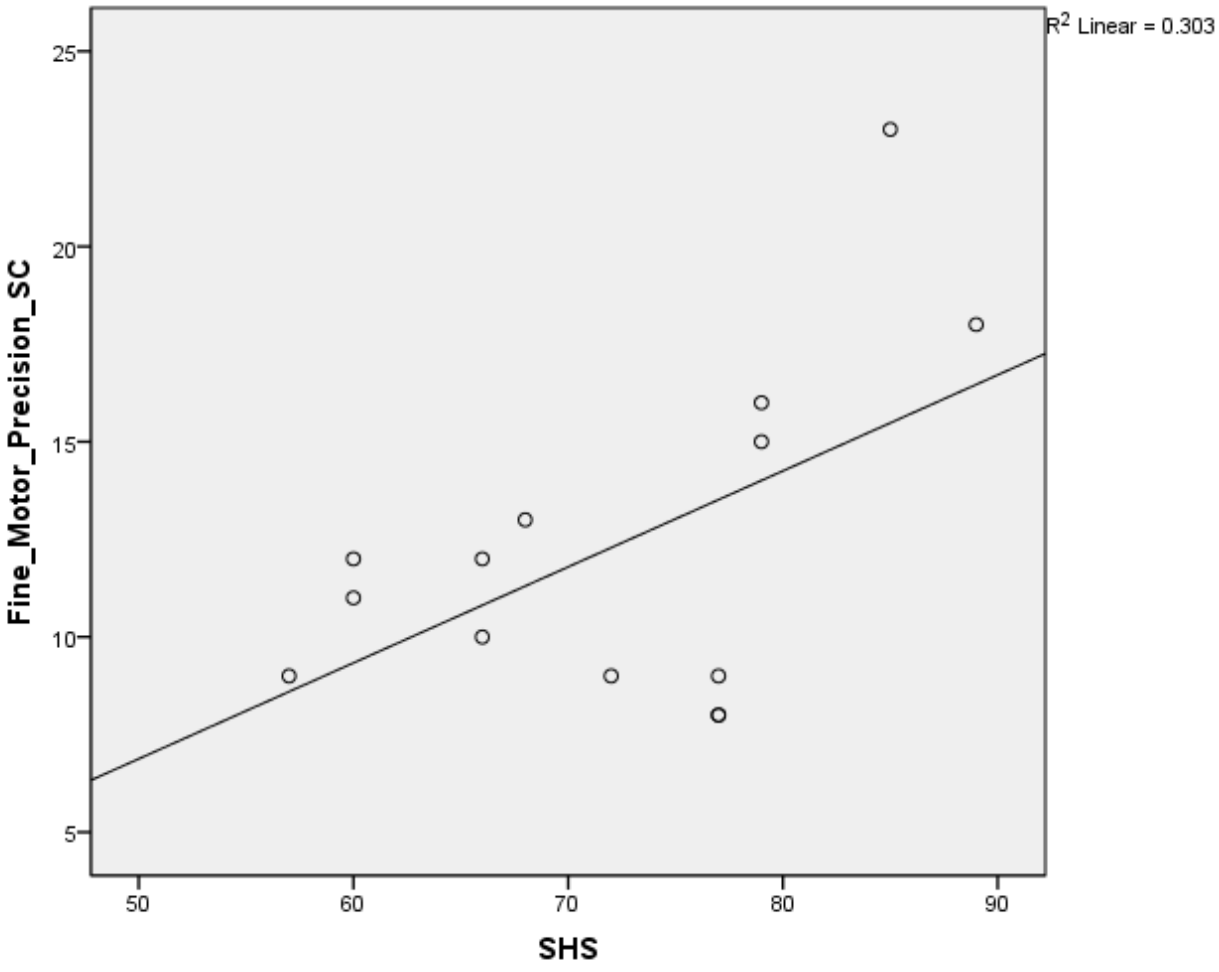
**Scatterplot 5**

Higher-income group: Scatterplot of SHS and Fine Motor Precision TPS with fit regression line



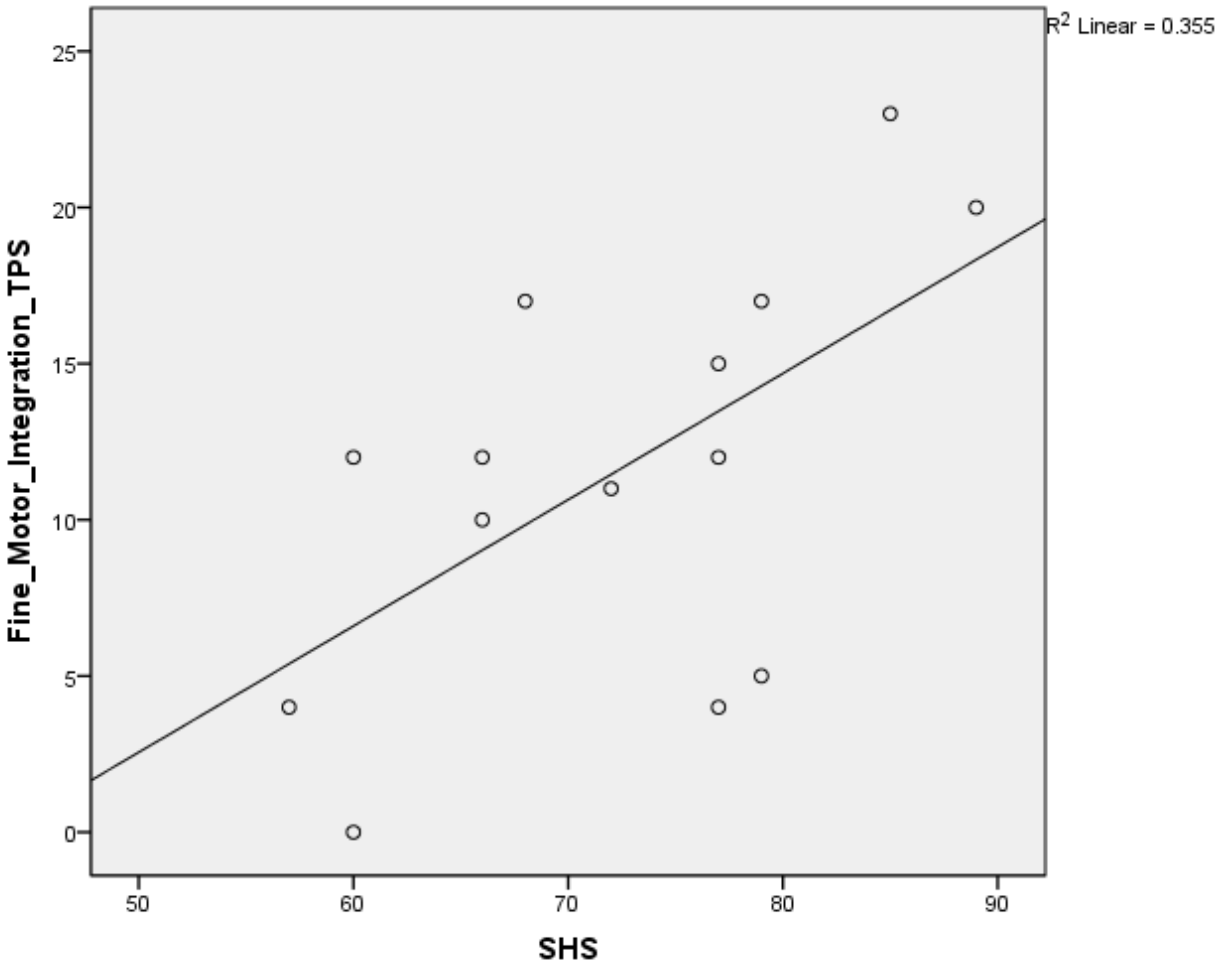
**Scatterplot 6**

Higher-income group: Scatterplot of SHS and Fine Motor Precision SC with fit regression line



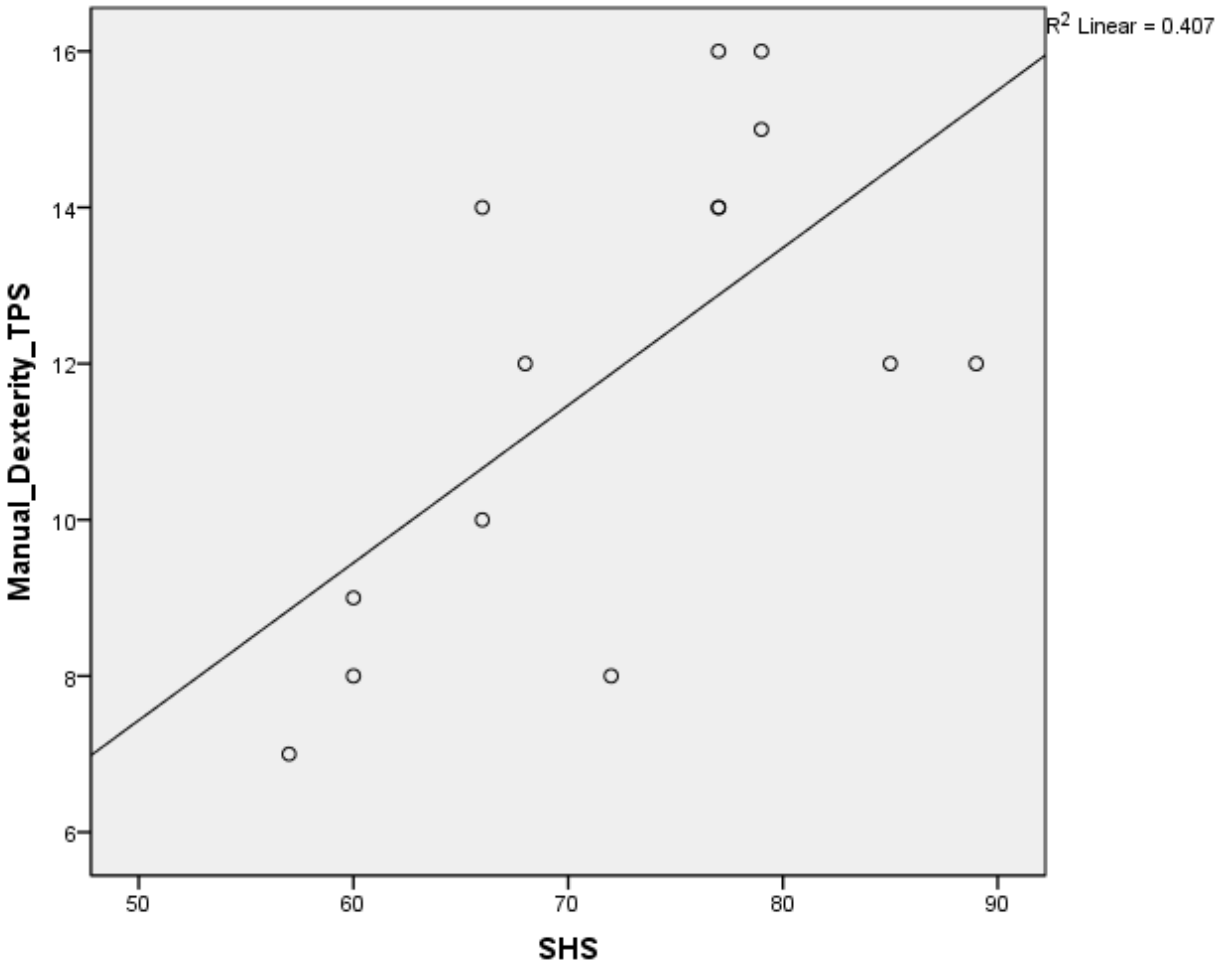
**Scatterplot 7**

Higher-income group: Scatterplot of SHS and Fine Motor Integration TPS with fit regression line



**Scatterplot 8**

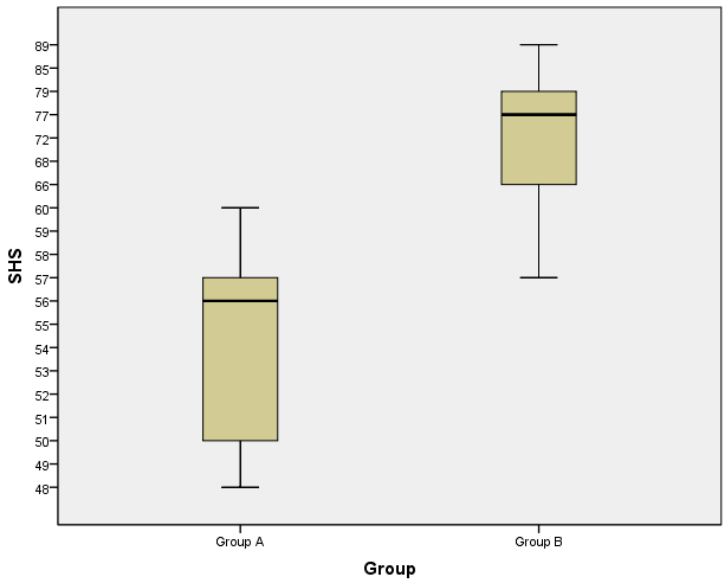
Higher-income group: Scatterplot of SHS and Manual Dexterity TPS with fit regression line



APPENDIX E: Boxplots

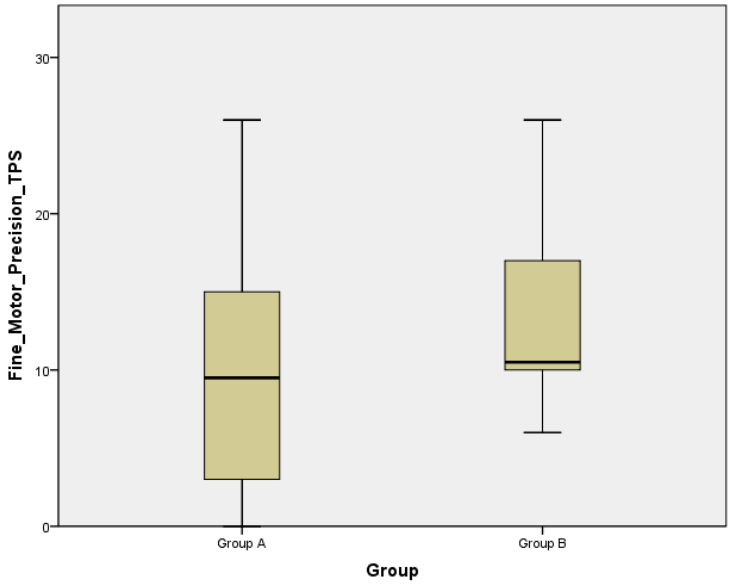
**Boxplot 1**

Boxplot comparing Lower-income group and Higher-income group scores on the SHS



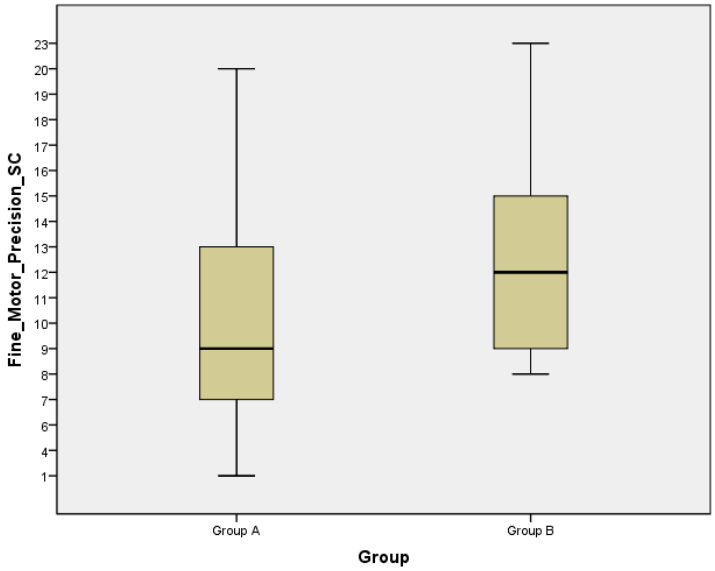

**Boxplot 2**

Boxplot comparing Lower-income group and Higher-income group scores on Fine Motor Precision Total Point Score



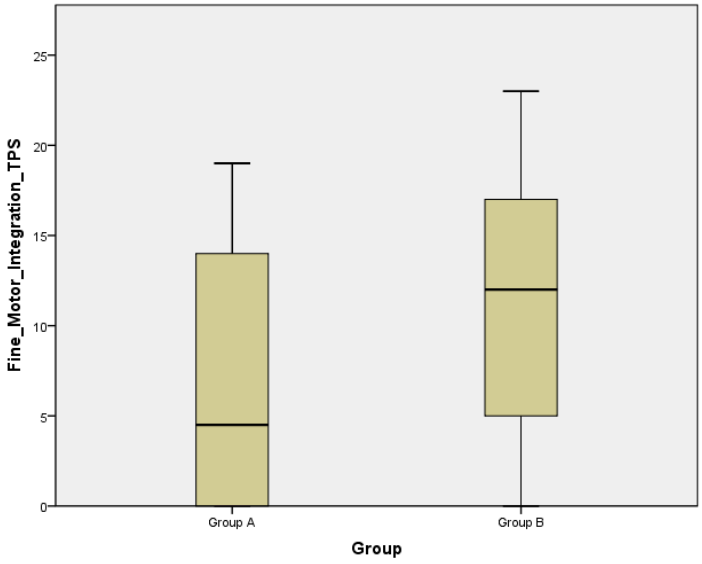
**Boxplot 3**

Boxplot comparing Lower-income group and Higher-income group scores on Fine Motor Precision Scale Score



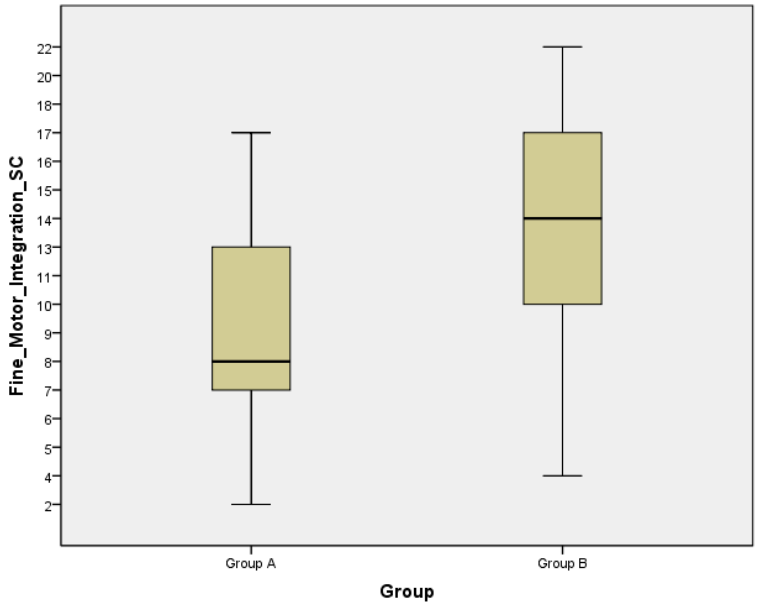

**Boxplot 4**

Boxplot comparing Lower-income group and Higher-income group scores on Fine Motor Integration Total Point Score



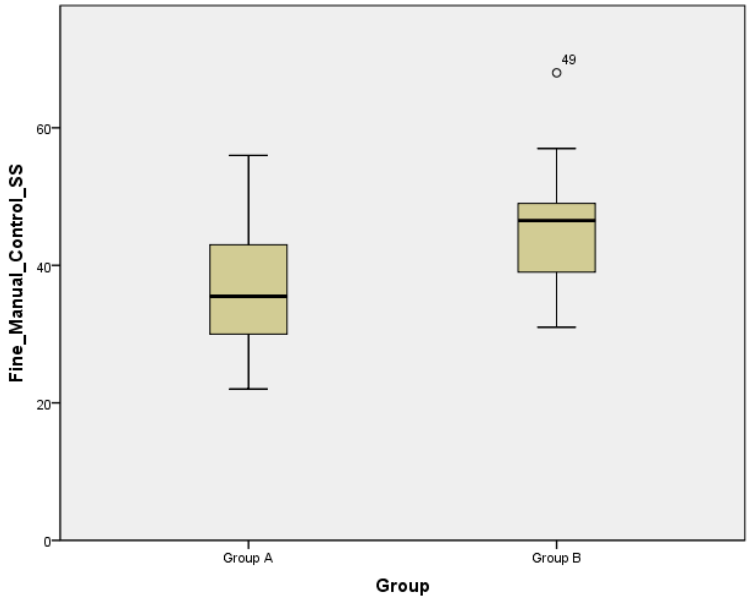
**Boxplot 5**

Boxplot comparing Lower-income group and Higher-income group scores on Fine Motor Integration Scale Score



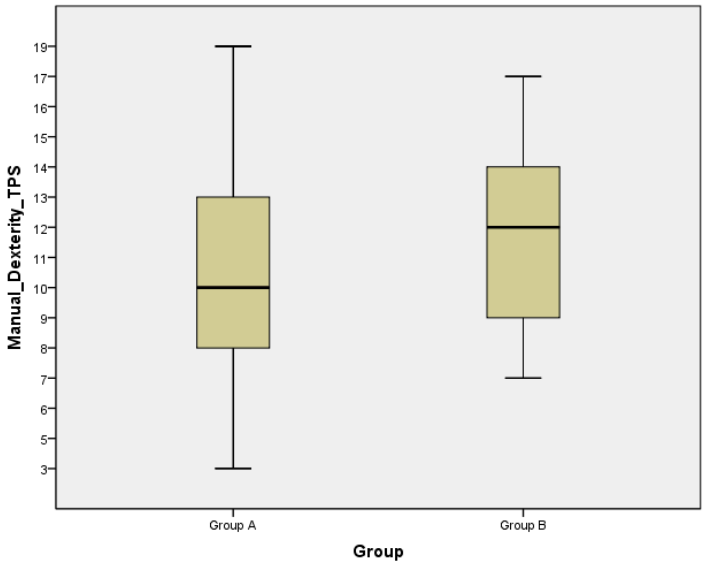

**Boxplot 6**

Boxplot comparing Lower-income group and Higher-income group scores on Fine Manual Coordination Standard Score



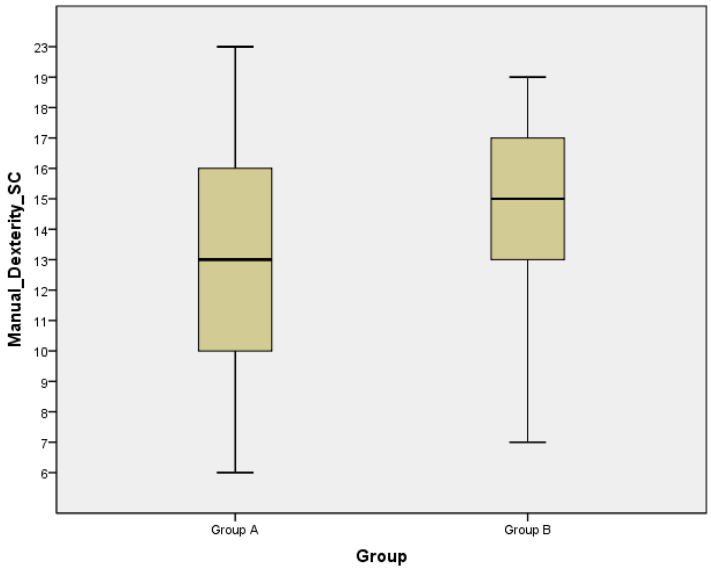
**Boxplot 7**

Boxplot comparing Lower-income group and Higher-income group scores on Manual Dexterity Total Point Score



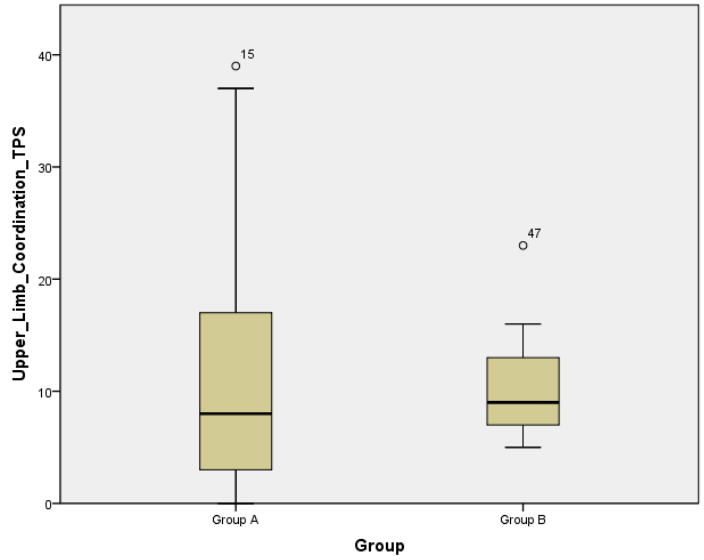

**Boxplot 8**

Boxplot comparing Lower-income group and Higher-income group scores on Manual Dexterity Scale Score



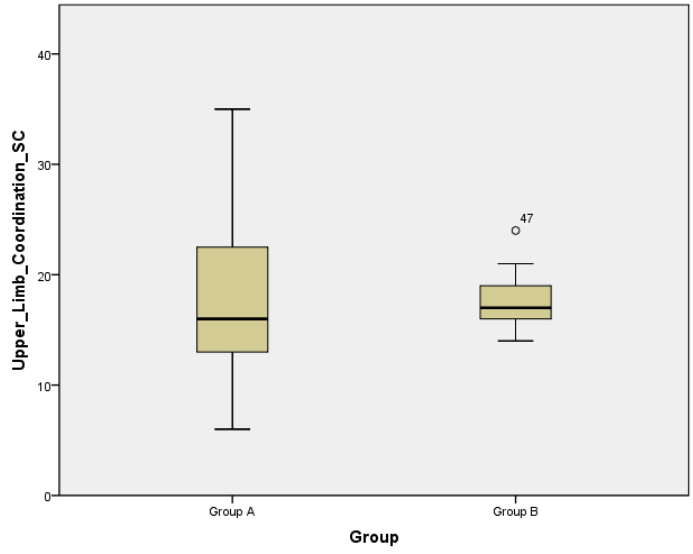
**Boxplot 9**

Boxplot comparing Lower-income group and Higher-income group scores on Upper Limb Coordination Total Point Score



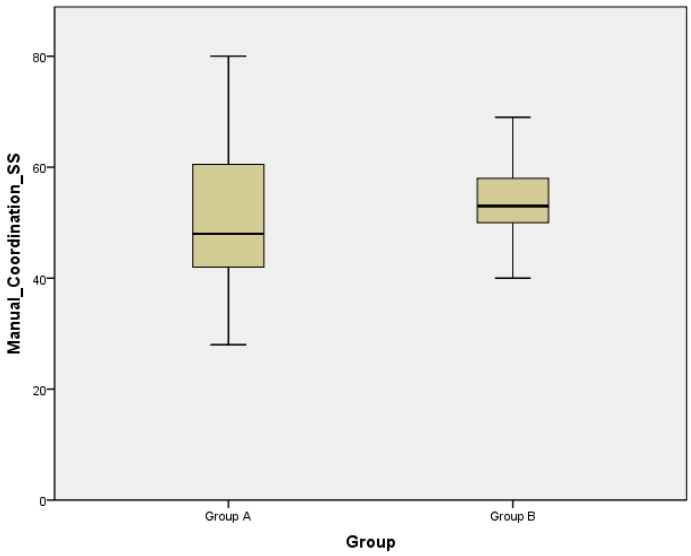

**Boxplot 10**

Boxplot comparing Lower-income group and Higher-income group scores on Upper-Limb Coordination Scale Score



**Boxplot 11**

Boxplot comparing Lower-income group and Higher-income group scores on Manual Coordination Standard Score



APPENDIX F: Independent T-Test

| | **t** | **Significance *p*** | **Mean Difference** | **Standard Error Difference** | **95% Confidence Interval** | |
|---|---|---|---|---|---|---|
| | | | | | **Lower** | **Upper** |
| FM Precision TPS | 1.629 | .114 | 3.321 | 2.039 | -.847 | 7.490 |
| FM Precision SC | 2.216 | .035 | 3.190 | 1.439 | .241 | 6.140 |
| FM Integration TPS | 2.288 | .031 | 4.794 | 2.095 | .473 | 9.115 |
| FM Integration SC | 2.777 | .012 | 4.194 | 1.510 | 1.041 | 7.348 |
| Fine Manual Control SS | 2.711 | .012 | 8.401 | 3.098 | 2.007 | 14.794 |
| Manual Dexterity TPS | 1.330 | .195 | 1.389 | 1.044 | -.755 | 3.532 |
| Manual Dexterity SC | 1.061 | .294 | 1.242 | 1.171 | -1.112 | 3.596 |
| UL Coordination TPS | -.829 | .411 | -1.957 | 2.361 | -6.707 | 2.793 |
| UL Coordination SC | -.380 | .706 | -.543 | 1.429 | -3.418 | 2.332 |
| Manual Coordination SS | .457 | .650 | 1.314 | 2.878 | -4.493 | 7.122 |
| SHS | 6.662 | .000 | 17.869 | 2.682 | 12.141 | 23.597 |