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Scapular Dyskinesis and Physical Activity in Healthy College Students

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A Research Project Entitled

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By:

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Abstract

The primary purpose of this study was to quantify healthy college students' scapula movement through the use of the Scapular Dyskinesis Test (SDT) and physical activity levels through the use of the International Physical Activity Questionnaire (IPAQ). The secondary purpose was to determine if there was a relationship between SDT and IPAQ scores. The investigators used a prospective, quantitative design and gathered data from 54 participants. Results showed that more than half of the participants had normal scapular ratings and high physical activity levels; however, more than 40% showed asymptomatic subtle or obvious dyskinesis in one or both of the scapula. Total hours of daily sitting exceeded hours that students were active. There were no significant relationships between the SDT and IPAQ. Sitting hours were similar among SDT and IPAQ scores. Participants were predominantly female graduate occupational therapy (OT) and physical therapy students; the majority of participants were employed. Participants could be at an increased risk for musculoskeletal disorders (MSD) and impaired occupational performance due to asymptomatic scapular dyskinesis. Participants with high IPAQ scores may misperceive that physical activity ensures normal scapulohumeral rhythm. Although the IPAQ can yield objective measures of physical activity, it is not a measurement of specific muscle function that impacts scapular dyskinesis. Clinicians and researchers can use the SDT as a screening tool to determine the presence of scapular dyskinesis in healthy college students.

Keywords: scapulohumeral rhythm, International Physical Activity Questionnaire (IPAQ), fatigue, range of motion (ROM), sedentary lifestyle

Scapular Dyskinesis and Physical Activity in Healthy College Students

The scapula is a stable base for glenohumeral (GH) joint mobility in a healthy shoulder (Kanik et al., 2017). The serratus anterior (SA), upper trapezius (UT), lower trapezius (LT), and middle trapezius (MT) are the most important muscles for positioning of the scapula and are the main contributors to scapular movement during scapulohumeral rhythm (Castelein, Cagnie, Parlevliet, & Cools, 2016a; Castelein, Cools, Parlevliet, & Cagnie, 2016; Fedorowich, Emery, Gervasi, & Côté, 2013). Scapulohumeral rhythm is the combination of GH motion and scapular upward rotation resulting from muscle contraction at the GH and scapulothoracic (ST) joints during shoulder elevation (Greene & Roberts, 2015, Chapter 8). Normal scapulohumeral rhythm occurs when the scapula remains stable during the first 30° to 60° of humerothoracic elevation, smoothly upwardly rotates during elevation, and downwardly rotates during humerothoracic lowering (McClure, Tate, Kareha, Irwin, & Zlupko, 2009). Shoulder kinematics related to GH abduction, GH rotation, and scapula upward rotation and anterior tipping contribute to participation in activities of daily living (ADLs), including "feeding, combing hair, reaching overhead, and washing contralateral axilla and back" (Rundquist, Obrecht, & Woodruff, 2009, p. 627).

Scapular dyskinesis is the abnormal movement and positioning of the scapula in relation to the thorax and GH joint (Cools et al., 2014; Kibler & McMullen, 2003). McClure et al. (2009) defined scapular dyskinesis as winging, dysrhythmia, or both. Dysrhythmia was defined as "the scapula [demonstrating] premature or excessive elevation or protraction, nonsmooth or stuttering motion during arm elevation or lowering, or rapid downward rotation during arm lowering" and winging was defined as "the medial border and/or inferior angle of the scapula [being] posteriorly displaced away from the posterior thorax" (McClure et al., 2009, p. 162). Scapular

dyskinesis can result from a slouched posture, muscle strength imbalance, fatigue of the ST muscles, and stiffness of the soft tissue that surrounds the scapula (Andersen, Andersen, Zebis, & Sjøgaard, 2014; Cools et al., 2014; Lee et al., 2016). Problems that result from scapular dyskinesis include shoulder and neck pain, predisposition to shoulder impingement syndrome, and disruption of shoulder and scapular movements, leading to greater risk of injury of the ST joint (Castelein et al., 2016a; Castelein et al., 2016; Cools et al., 2014; Escamilla, Hooks, & Wilk, 2014). As noted by Cooper (2014), dysfunction of scapulohumeral rhythm can result in significant impairment of the entire upper extremity (UE) and occupational performance limitations due to pain and reduced motor control (p. 219).

For individuals whose occupational performance includes sustained overhead tasks, there is a greater risk of developing musculoskeletal pathologies when endurance of ST and GH muscle is impaired (Chopp-Hurley, O'Neill, McDonald, Maciukiewicz, & Dickerson, 2016; Grassi, Rossiter, & Zoladz, 2015; Kozina, Repko, Ionova, Boychuk, & Korobeinik, 2016). Muscle endurance was defined as the time limit of work produced by a muscle at a given strength or speed of muscle contraction (Kozina et al., 2016; Manske, 2015). Fatigue occurs when there is reduced muscle power and strength (Grassi et al., 2015), and can result in impaired movements, reduced ability to maintain static postures, and compensation patterns (Lee et al., 2016; Sheard, Elliott, Cagnie, & O'Leary, 2012).

According to *Healthy People 2020*, more than 80% of adolescents do not meet the guidelines for aerobic physical activity and more than 80% of adults do not meet the recommended guidelines for aerobic and muscle strengthening activities (Office of Disease Prevention and Health Promotion [ODPHP], 2014). Melton, Bigham, Bland, Bird, and Fairman (2014) reported the average general technology usage of 578 college students to be 808.05

minutes per week. Lepp, Barkley, and Karpinski (2015) suggested that cell phone use alone distracts students from participating in physical activity, resulting in a more sedentary lifestyle (Smith, 2015). Sedentary behavior was defined as expending small amounts of energy and not meeting physical activity guidelines (Sedentary Behavior Research Network [SBRN], 2012). The increase in technology use and sedentary behavior in college students places them at risk for disorders and dysfunction of scapulohumeral rhythm and ST muscle function (Lepp et al., 2015; ODPHP, 2014; Smith, 2015).

McClure et al. (2009) developed the SDT to identify abnormalities in scapular motion including winging, dysrhythmia, or both. The SDT requires individuals to repeatedly lift loads through shoulder flexion and shoulder abduction, reflecting loads lifted during ADLs (McClure et al., 2009). In addition to the SDT, researchers have used fatigue protocols to study scapula muscle endurance in healthy participants (Chopp-Hurley et al., 2016; Kanik et al., 2017). In a systematic review, Hickey, Solvig, Cavalheri, Harrold, and Mckenna (2018) found that asymptomatic athletes with scapular dyskinesis, as measured by visual dynamic assessments and physical landmarks, were 43% more likely to develop shoulder pain. Athletes' time to fatigue and ST muscle endurance have been studied but scapular dyskinesis in a healthy college student population has not been described (Eraslan, Gelecek, & Genc, 2013; Zabihhosseinian, Holmes, Howarth, Ferguson, & Murphy, 2017). The purpose of this study was to quantify college students' scapula movement using the SDT and physical activity using the IPAQ, and to determine if there was a relationship between the SDT and IPAQ scores.

Literature Review

Researchers have described multiple methods of assessing scapula movement, with no single method identified as superior. According to researchers' reports, the testing procedures for

scapular movement can be categorized by their primary methodology: isometric exercises, shoulder flexion and abduction elevation exercises, fatigue protocols, and slouched posture positioning.

Researchers have studied ST muscle activity using different static positions of the shoulder range of motion (ROM) arc with varied amounts of resistance applied and time sustained (Eraslan et al., 2013; Ha et al., 2012; Miyasaka et al., 2016; Peterson, Domino, & Cook, 2016). Ha et al. (2012) measured muscle activity during a series of shoulder elevation isometric exercises, including wall facing arm lift (WAL), prone arm lift (PAL), backward rocking arm lift (BRAL), and backward rocking diagonal arm lift (BRDAL) (Ha et al., 2012). Subjects maintained each position for 6 s with maximal effort against manual resistance (Ha et al., 2012). Ha et al. (2012) showed that during the BRAL exercise, the SA was significantly greater in maximal voluntary isometric contraction (MVIC) = 60.04 compared to PAL = 38.21, WAL = 43.33, and BRDAL = 43.48. Eraslan et al. (2013) similarly examined muscle endurance by instructing participants to flex their shoulders and elbows to 90°, hold a digital dynamometer, and externally rotate their shoulders until 1-kg of resistance was attained. Muscle endurance was determined by the length of time the position and resistance were maintained (Eraslan et al., 2013). Eraslan et al. (2013) determined that decreased scapular endurance caused deviations in scapular mechanics and led to an increased risk of injury.

In order to prescribe appropriate ST exercise for clients, researchers have measured ST muscle activity during shoulder elevation and abduction exercises (Castelein, Cagnie, Parlevliet, & Cools, 2016b; Nakamura, Tsuruike, & Ellenbecker, 2016). Castelein et al. (2016b) measured UT, MT, LT, and SA activity during elevation in the scapular plane, towel slide against a wall, and elevation with external rotation of a Thera-Band. Researchers concluded that elevation with

resisted external rotation enhanced MT and LT activity and elevation in the scapular plane produced increased UT, MT, LT, and SA muscle activity (Castelein et al., 2016b). Similarly, Nakamura et al., (2016) measured muscle activity of the UT, LT, and SA during 12 sets of five repetitions of the robbery exercise in two positions: 20° shoulder abduction and 90° shoulder abduction. Nakamura et al. (2016) found SA, UT, and LT activity increased during exercises conducted in a position of 90° abduction, which may have been due to the presence of scapular dyskinesis. This led researchers to conclude that posture and shoulder positions impacted muscle activity (Nakamura et al., 2016). During elevation exercises in the scapular plane, Castelein et al. (2016) determined that participants with neck pain and scapular dyskinesis showed lower MT activity compared to the control group.

Fatigue protocols have been used by researchers with and without added resistance to assess ST muscle activity during shoulder elevation (Calvin, Keir, & McDonald, 2016; Chopp-Hurley et al., 2016; Kvist & Bang, 2016). Kvist and Bang (2016) and Chopp-Hurley et al. (2016) used resistance during repetitive shoulder elevation to study muscle fatigue. In both studies, researchers found altered positioning or movement of the scapula resulting from fatigue of ST muscles, which can impair scapulohumeral rhythm and induce pain (Chopp-Hurley et al., 2016; Kvist & Bang, 2016). Fedorowich et al. (2013) and Calvin et al. (2016) examined fatigue during repetitive pointing and work-related tasks without added resistance. Similar to studies in which researchers used resistance, fatigue caused by work-related tasks resulted in pain and substitution patterns of neighboring scapula muscles (Calvin et al., 2016). The results of these studies indicate that kinematic compensatory strategies emerge as muscles fatigue with repetitive tasks

(Chopp-Hurley et al., 2016). In contrast to others' findings, the researchers determined there were gender differences with respect to fatigue of periscapular muscle.

Researchers have studied ST muscle activity utilizing different postures during arm elevation (Lee et al., 2016; Malmström, Olsson, Baldetorp, & Fransson, 2015). Lee et al. (2016) measured the effects of slouched posture on LT, MT, and SA muscle activity. Participants abducted their shoulders to 90° in the scapular plane and held the position for 10 s (Lee et al., 2016). Participants then abducted their shoulders to 90° in a slouched posture to examine the effects of poor posture (Lee et al., 2016). Malmström et al. (2015) examined muscle activity of the UT, LT, and SA in an upright posture and slouched posture with an emphasized thoracic curve. In both postures, participants completed one arm elevation exercise with their arms and elbows extended (Malmström et al., 2015). The evidence from both studies indicated LT activity increased during slouched postures (Lee et al., 2016; Malmström et al., 2015). In addition, Lee et al. (2016) found increased activity of the MT and Malmström et al. (2015) found increased activity of the UT and SA in slouched postures. Authors of both studies concluded that slouched postures can lead to shoulder pain or injury as a result of increased muscle fatigue (Lee et al., 2016; Malmström et al., 2015).

Calik, Yagci, Gursoy, and Zencir (2014) studied the effects of computer use on the UE of 871 students with pain and discomfort of the neck, shoulders, upper back, and lower back. The researchers determined that musculoskeletal system discomforts of the neck, shoulders, and upper back, were correlated with the time spent on computers (Calik et al., 2014). The findings of Calik et al. (2014), Lee et al. (2016), and Malmström et al. (2015) support the need for researchers to investigate the influence of sedentary behavior on the dynamics of shoulder function and mobility.

Hyperactivity of ST muscles affects scapular kinematics and contributes to conditions like subacromial impingement syndrome and scapular dyskinesis. Dysfunction associated with these conditions can result in increased pain in the neck and shoulder regions (Castelein et al., 2016a; Chopp-Hurley et al., 2016; Lee et al., 2016). Likewise, individuals with scapular dyskinesis or shoulder or neck pain have been shown to have abnormal UT, MT, LT, and SA activity (Casetlein et al., 2016a; Castelein et al., 2016b; Ersalan et al., 2013; Hanvold et al., 2013; Peterson et al., 2016). Proper functioning of the ST musculature decreases the risk of discomfort in MT and LT and/or the development of scapular dyskinesis (Lee et al., 2016).

Researchers have analyzed ST muscle activity in healthy subjects and compared them to subjects with a history of shoulder disorders, shoulder pain, or neck pain (Castelein et al., 2016a; Castelein et al., 2016b; Ersalan et al., 2013; Hanvold et al., 2013; Peterson et al., 2016). However, scapular dyskinesis can be found in those who do not suffer from shoulder pain (Plummer, Sum, Pozzi, Varghese, & Michener, 2017). Additionally, researchers have analyzed scapular kinematics in a healthy population that included predominantly male subjects, providing a limited representation of abnormal scapular kinematics (Calvin et al., 2016; Chopp-Hurley et al., 2016; Lee et al., 2016; Malmström et al., 2015; Miyaska et al., 2016; Nakamura et al., 2016). Ha et al. (2012) and Kvist and Bang (2016) studied healthy male and female participants but sample sizes were too small to generalize results. Only one study was found in the reviewed literature that included healthy college students (Nakamura et al., 2016). However, the sample was limited to males and the sample was too small to generalize results (Nakamura et al., 2016).

Although researchers have measured scapular dyskinesis in healthy persons, few have studied the healthy college student population or have taken into consideration students' activity participation. Time spent sitting, exercising, and types of exercises should be taken into

consideration when measuring scapular dyskinesis. Researchers have inconsistently used a single outcome measure for scapular kinematic dysfunction. The SDT can serve as a dynamic method of assessment with sound psychometric properties and clinical utility, as it can be administered within a few minutes, using free-hand weights that are typically available in most clinics. Despite the sound psychometric properties of the IPAQ, investigators found that it is not often utilized to determine an individual's activity level. In this study, investigators used the SDT to determine the presence of scapular dyskinesis and the IPAQ to quantify physical activity.

Method

The investigators used a prospective, quantitative design with a single cohort for this study; two instruments, the SDT and IPAQ, were utilized to measure scapular dyskinesis and physical activity, respectively.

Scapular Dyskinesis Test

The SDT is a visual assessment used to determine if scapular dyskinesis is present. Scapular dyskinesis is identified by alterations in movement and positioning of the scapulae, which are visually distinguished as scapular winging or asymmetry (Tate, McClure, Kareha, Irwin, & Barbe, 2009). The SDT is performed by completing five repetitions each of resisted bilateral shoulder abduction and flexion. The pace of the motions is 5 s for elevation and 5 s for return to start position. The test motions are conducted with either three pound or five pound dumbbells depending on the individual’s weight (McClure et al., 2009).

McClure et al. (2009) rated scapular movement as normal, subtle, or obvious dyskinesis based on researchers’ observations. A normal rating was defined as no abnormal scapular movements (McClure et al., 2009). Inconsistency of scapular movement indicated a rating of subtle (McClure et al., 2009; Tate et al., 2009). Obvious scapular dyskinesis was defined as

scapular winging or asymmetry (Tate et al., 2009). A final unilateral rating was reported as normal if either both flexion and abduction motions were rated as normal or if one motion was rated as normal and the other motion was rated as subtle (McClure et al., 2009). A final unilateral rating of subtle was reported if both flexion and abduction motions were rated as subtle (McClure et al., 2009). A final unilateral rating of obvious was reported if either flexion or abduction motions were rated as obvious (McClure et al., 2009). Right and left scapulae were scored separately (McClure et al., 2009). There are no normative data for the SDT.

To establish interrater reliability, McClure et al. (2009) conducted a study with 142 National Collegiate Athletic Association athletes who participated in sports that required overhead use of UEs, due to the higher incidence of shoulder injury in this population. The researchers focused on how the participants' scapulae were positioned on the thorax during flexion and abduction (McClure et al., 2009). McClure et al. (2009) showed the SDT to have moderate interrater reliability for researchers who filmed ($k_w = 0.57$) and rated scapular dyskinesis ($k_w = 0.54$) (McClure et al., 2009).

The SDT has also been established as a valid measure to identify scapular dyskinesis (Tate et al., 2009). Tate et al. (2009) conducted a study with 66 participants recruited from the McClure et al. (2009) study. Participants were instructed to refrain from any sport or demanding activity that could influence scapula/shoulder performance (McClure et al., 2009). Three-dimensional kinematic testing via electromyographic (EMG) was used to measure muscle activity during humeral elevation to observe scapular motion (Tate et al., 2009). Analyses showed that individuals with less scapula upward rotation also had obvious dyskinesis (Tate et al., 2009).

In the current study, investigators selected the SDT due to established psychometric properties, training materials and procedures, and practical clinical use. The investigators had participants perform five repetitions of resisted bilateral shoulder flexion and abduction during the SDT (Tate et al., 2009).

International Physical Activity Questionnaire

The IPAQ is a questionnaire that measures physical activity or inactivity to obtain health related quantitative information (Craig et al., 2003). Craig et al. (2003) recommended using the long version of IPAQ for research purposes. The long version of the questionnaire includes four activity domains that are scored independently. The four domains include, "leisure time physical activity, domestic and gardening (yard) activities, work-related physical activity, and transport-related physical activity" (International Physical Activity Questionnaire [IPAQ], 2005, p. 2). Participants rated their physical activity based on the previous seven days (Craig et al., 2003).

The IPAQ scores can be reported as a continuous value or a categorical value. The continuous score represents the median metabolic equivalent of task (MET) minutes for walking, moderate intensity activity, and vigorous intensity activity per week for each domain (IPAQ, 2005). A MET minute represents energy expenditure and is calculated by multiplying the MET score by the time (in minutes) spent on each activity. A total physical activity score is calculated by summing the MET minutes from each domain (IPAQ, 2005). The categorical values represent low, moderate, or high levels of physical activity (IPAQ, 2005). The total time participants sit each day and week, per minute, is recorded and scored separately from the total weekly physical activity score (Craig et al., 2003; IPAQ, 2005).

Craig et al. (2003) established test-retest reliability of the long IPAQ form by administering the form twice within seven to ten days. Nonparametric Spearman correlation

coefficients were calculated to measure the relationship of scores between the two administrations. Test-retest reliability ranged from 0.79-0.82 for the long form and 0.70 for the sitting recall portion. The categorical data were then used to calculate the percentage agreement and an overall high percentage agreement was calculated as 0.84 to 1.0 (Craig et al., 2003).

Craig et al. (2003) established validity from the participants' reported activity levels and monitor data, which were stored and summed in one-minute intervals. There were similar correlations when comparing the sitting data from the IPAQ and the sitting estimate from the accelerometer, indicating an agreement between objective and subjective sedentary behavior measures. The frequency, duration, and intensity of physical activity, along with the assessment of sedentary behavior showed the IPAQ to have a concurrent validity range between 0.42 to 1.0 and criterion validity range between 0.05 and 1.0 (Craig et al., 2003).

Participants

Inclusion criteria included enrollment as a student at the university and the ability to move both scapulae through normal movements during the SDT. Exclusion criteria included shoulder surgery within the past year, pain in shoulder or scapulae, and injury to the shoulders, arms, or back within the past month. Recruitment for this study was completed through electronic mail and flyers distributed campus wide at a private university in the Midwest. Investigators distributed the informed consent to each participant and answered questions before obtaining signed consent forms.

Procedures

The investigators submitted their study to the Human Research Protections Program and were approved as exempt. They completed the Collaborative Institutional Training Initiative program courses, Human Subjects Research and Healthy Related Research Course Learner

Group with a score of at least 80%. The investigators underwent standardized training via a self-instructional slide presentation designed by McClure et al. (2009) to administer and score the SDT. They also completed a training session to learn how to use the video camera and how to save and remove the films of the SDT to a hard drive.

Data Collection

The investigators administered and scored the SDT according to McClure et al. (2009) three times with the first six participants, 48 hours in between sessions, in order to determine intra-rater and test-retest reliability. The SDT was completed one time for remaining participants. In addition to procedures established by McClure et al. (2009), investigators assured full viewing of the scapula by having participants wear a towel wrap and use a shower cap; shower caps also disguised participants' identities. To remove potential bias, investigators gave participants assigned numbers for all data gathered; films of the SDT were saved and rated by two investigators not involved in the filming. Participants completed a questionnaire that included the IPAQ. Demographic information included their age, gender, height, weight, activity level (participation in sports or time spent exercising), and type of academic degree.

Data Analysis

Intra-rater, test-retest, and inter-rater reliability of the SDT were established from the first six participants using percent agreement (Portney & Watkins, 2009). SDT scores were analyzed using descriptive statistics to report frequencies of normal scapula movement, obvious dyskinesis, and subtle dyskinesis. SDT and IPAQ scores were analyzed using a chi-square test to determine the relationship between scapular dyskinesis and low, moderate, and vigorous physical activity level. To determine if there were differences in sitting and BMI among the SDT and IPAQ scores, a one-way ANOVA was used. Interrater reliability was calculated using the kappa

coefficient and percent agreement after the SDT data collection was completed. Body mass index (BMI) was calculated from participants' height and weight and was included in descriptive statistics (Centers for Disease Control and Prevention, 2017). Demographic data were analyzed using descriptive statistics. The SPSS version 25.0 software was used for statistical analysis and a significance level set at $p < .05$. To determine if the current sample of participants met the Centers for Disease Control (CDC) and American College of Sports Medicine (ACSM) guidelines of 150 minutes of physical activity per week, the total weekly physical activity in minutes was calculated for comparison (Craig et al., 2003; Pate et al., 1995; U.S. Department of Health and Human Services, 2018).

Results

After the first six participants were filmed, investigators observed inconsistencies in participants' speed and ROM arc completion during the SDT. In order to standardize performance of the SDT, the investigators used a metronome to create a voice recording of an investigator counting out the pace for the five repetitions of shoulder flexion and abduction. This recording was played for all participants in this study to increase the consistency and accuracy of the SDT. The data of the original six participants of this study were removed from data analysis and another six participants were filmed to determine test-retest reliability. Following the adaptations, investigators gathered data from 58 participants; data from four participants were removed due to incomplete IPAQ information and/or lack of full ROM during the SDT. The final sample of 54 were predominantly female graduate OT and physical therapy students, who were employed and had a normal BMI as shown in Table 1.

Percent agreement for the primary investigator (rater 1) and student rater (rater 2) were 100% and 69%, respectively, for intra-rater and test-retest reliability of the SDT for the first six

analyzed participants. When comparing ratings of the SDT of rater 1 and rater 2, percent agreement for the left scapula was 61% and for the right scapula was 72% (n = 54) for the entire sample. Correction for chance agreement using Cohen's kappa for the left scapula was .323 (p = .001) and for the right scapula was .403 ($p < .0005$), showing fair agreement between the primary investigator and student rater for the sample (n = 54). Only scores of the SDT rated by the primary investigator were included in the data set for analyses of the entire sample. Scores from only the first session of the first six participants were included in the data set for analyses of the entire sample.

More than half of the participants had normal scores for the SDT with more than 40% showing either subtle or obvious dyskinesis as shown in Table 2. The student investigator results are identified in Table 3. There were no significant relationships between the SDT and IPAQ, x^2 (4, N = 54) = 6.151, p = .188, left, and x^2 (4, N = 54) = 4.719, p = .317, right. There were no significant differences in BMI among the IPAQ categories, ANOVA F (2, 51) = .915, p = .407 or in sitting hours among the IPAQ categories, ANOVA F (2, 51) = 1.924, p = .156. There were no significant differences in BMI among the SDT ratings, ANOVA F (2, 51) = .769, p = .469, left, or ANOVA F (2, 51) = 1.813, p = .173, right. No significant differences were found in sitting hours among the SDT ratings, ANOVA F (2, 51) = .580, p = .564, left, or ANOVA F (2, 51) = 1.813, p = .173, right. As shown in Figure 1, participants' sitting hours, on average, exceeded their activity hours. Students reported daily averages of 6.84 hours of sitting and 2.33 hours of physical activity, as defined by the IPAQ. Results of total sitting per week and total sitting per day are listed in Table 4. Participants more often scored in the high IPAQ category, shown in Table 4, with additional IPAQ results. According to the CDC-ACSM, 86.79% of the participants met either moderate or vigorous intensity guidelines for activity.

Discussion

The investigators found that healthy college students more frequently had SDT scores classified as normal however, when the categories of subtle and obvious were combined, the sample showed more than 40% had either subtle or obvious scapular dyskinesis in one or both of the scapula. The SDT scores of normal may under represent participants who have subtle scapular dyskinesis because a unilateral rating of normal is assigned if flexion and abduction motions are rated as normal or if one motion is rated as normal and the other motion is rated as subtle. Likewise, the SDT scores of subtle may under represent participants who have obvious scapular dyskinesis. A unilateral rating of obvious is assigned if flexion and/or abduction are rated as obvious for three out of five ratings. In the presence of subtle or obvious dyskinesis, a clinician may decide to intervene regardless of the SDT rating (Tate et al., 2009). Obvious dyskinesis is a stronger reason for intervention, whereas the decision to intervene with subtle dyskinesis is more dependent on clinical judgement (Tate et al., 2009).

The findings of this study contrast with those of Akodu, Akinbo, & Young (2018), who found that health science college students more frequently presented with abnormal scapular dyskinesis. Only indirect comparisons can be made to the results of Akodu et al. (2018) because the researchers used the SICK scapula static measurement that yielded presence or absence of scapular dyskinesis. Scapular dyskinesis was defined as asymmetry of the scapulae as participants stood in a static position (Akodu et al., 2018). In the current study, investigators rated unilateral scapula movement as normal, subtle dyskinesis, or obvious dyskinesis, as recommended by McClure et al. (2009).

Investigators in the current study found no association between the IPAQ categories and scapular dyskinesis. Sedentary behavior can lead to generalized weakness, which has been

shown to place students at increased risk for dysfunction and disorders of ST muscle function (Lepp et al., 2015; ODPHP, 2014; Smith, 2015). Conversely, researchers have found that UE exercise training can improve kinematic function of the scapula and prevent the development of shoulder pathologies (Andersen et al., 2014; Cho, Lee, Kim, Hahn, & Lee, 2018). Only indirect comparisons from the literature can be made to the current study because participants did not report specific exercise routines. Although sedentary individuals can have risk for dysfunction and disorders of ST muscle function, active individuals who do not exercise ST muscles could also be at risk. High levels of activity as measured by the IPAQ do not necessarily involve exercises for the ST muscles. Participants in the current study were asymptomatic and could incorrectly assume that their physical activity will prevent scapular dyskinesis. Moreover, the inability to visualize their own scapulae presents another reason for a lack of awareness of scapular dyskinesis. Therefore, it is imperative to consider function of ST musculature during screenings and assessments by clinicians.

Healthy college students in this study more frequently had IPAQ scores of high because the IPAQ classifies high physical activity as either a minimum of 1500 MET/minutes per week of vigorous-intensity activity or a minimum of 3000 MET/minutes per week of a combination of walking, moderate-intensity, or vigorous-intensity activity (IPAQ, 2005). Participants were meeting or exceeding these requirements, however, the IPAQ results showing high activity levels can be misleading because the total physical activity is not inclusive of how the rest of the time is spent, including time spent sitting. Although participants met the weekly physical activity guidelines, daily sitting exceeded daily active hours, comprising 28% of the students' day for the latter. The CDC and Prevention has indicated that increasing physical activity and decreasing time spent sitting can reduce overall health risks, however no recommendations for daily or

weekly maximum time spent sitting have been established (Pate et al., 1995; U.S. Department of Health and Human Services, 2018). A possible explanation for high IPAQ scores is that the majority of the participants were health-science majors. The findings of this study are consistent with Haddock and Gaines (2013) who found that kinesiology students reported healthier exercise behaviors and greater motivation to exercise than did non-kinesiology students.

All participants in the current study had BMIs classified as normal. This may be explained by those with lower BMIs choosing to participate in the study due to having greater comfort in exposing their anatomy and reporting body weight on the questionnaire. These findings are consistent with those of Akodu et al. (2018); the healthy college aged sample with students in the physiotherapy department had a mean BMI score of 23.6, which is classified as normal. However, Osborn, Naquin, Gillan, and Bowers (2016), reported that 49% of college age sample had BMIs that were classified as overweight or obese. Sedentary lifestyle in a collegiate population may be related to the increased time spent completing academic requirements which could contribute to higher BMIs.

In professional practice clinicians who use the SDT as a screening tool for shoulder pain or disorders should also utilize other methods of evaluations (Hickey et al., 2018; McClure et al., 2009). The prevalence of scapular dyskinesis is relatively equal between persons with and without pain (Kibler et al., 2013). Therefore, it is important that clinicians screen for scapular dyskinesis in both symptomatic and asymptomatic populations (Hickey et al., 2018; Kibler et al., 2013). Clinicians should consider the impact of scapular dyskinesis when working with clients that experience difficulty during ADLs (Rundquist et al., 2009). Scapulohumeral rhythm has a significant impact on the functional ability to bathe, comb hair, reach overhead, and bring utensils to the mouth while eating (Rundquist et al., 2009). Appropriate shoulder kinematic

function significantly impacts an individual's ability to perform ADLs that require the use of overhead UE movements (Rundquist et al., 2009).

Because of the expertise of the primary investigator, only the ratings of the primary investigator were used in analyses of the SDT. Ratings of the SDT of the student rater and clinician rater showed only fair agreement which is in contrast to McClure et al. (2009). This finding can be explained by McClure et al. (2009) using raters that were athletic trainers and physical therapists to view and determine SDT in 1 or 2 viewings of videotaped participants. Completion of educational programs required for entry into professional practice and clinical experience of the athletic trainers and physical therapists could have contributed to better agreement in rating. The student rater in the current study had completed only two of five semesters of an entry-level OT curriculum that included fieldwork settings of outpatient pediatrics, acute care, and community-based at the time of rating the SDT. Student ratings in the current study may have shown better agreement with the clinician ratings if the data collection and analysis had occurred after additional course completion that focused on assessments or if fieldwork had included clients with shoulder conditions. Additionally, the student's ratings may have shown better agreement with the primary investigator if training had been supplemented beyond those of McClure et al. (2009). Uhl, Kibler, Gecewich, and Tripp (2009) found that rating of the SDT was more accurate when raters used the "yes/no" method to indicate presence or absence of scapular dyskinesis, however a portion of those participants that were rated also had a shoulder injury. It could be that the SDT rating system that allows 3 ratings creates more variability among raters. It could also be that forced choice with limited viewings improves interrater reliability in contrast to researchers viewing unlimited times to rate scapula movement

in the current study. Moreover, it could be that accuracy is greater when rating symptomatic shoulders in contrast to asymptomatic shoulders in the current study.

Limitations

Data collection was conducted in a single building of health science programs on a Midwestern college campus, which contributed to a lack of diversity among participants. Therefore, the results are not applicable to the general college student population. Potential participants may have eliminated themselves from participation due to the discomfort of exposing their scapulae and identifying their body weight during dumbbell weight selection. Participants may not have used the appropriate dumbbell weight during the SDT due to not knowing or wanting to share their weight. Some participants were filmed more than once within the same session because of their unsuccessful attempts to complete full ROM during shoulder flexion and abduction. These participants completed more repetitions than other participants, potentially causing fatigue.

A recording of a researcher counting from one to five throughout the performance of the SDT should be completed before data collection so that participants perform the SDT consistently. Providing a film of a researcher completing the SDT for participants to follow, would improve precision and accuracy in the performance of SDT. In order to ensure video quality is clear for viewing, researchers should make sure lighting is adequate and consistent throughout recordings. If multiple researchers perform the SDT, interrater reliability should be established prior to participants completing the SDT. If students are rating, it is suggested that students should receive additional training from an experienced clinician to ensure accuracy of ratings and the potential to achieve moderate or better interrater reliability.

Providing a scale for participants to weigh themselves privately prior to documenting weight and selecting a dumbbell, would verify accurate selection of weight for the SDT. Researchers who study healthy college students should recruit a more diverse sample.

Conclusion

Scapulohumeral rhythm has an important role in how one functions and participates in daily tasks and occupations. Shoulder kinematics are crucial to ADLs and instrumental activities of daily living that involve crossing midline to reach the opposite extremity or reaching overhead (Rundquist et al., 2009). The SDT can be a useful tool to identify healthy college students who exhibit scapular dyskinesis and would benefit from further assessment and intervention to restore normal scapular motion. Our study found that 40% of healthy college students had either subtle or obvious scapular dyskinesis in one or both of their scapulae, indicating the necessity to include the SDT in clinical screenings. The percentage may under represent those who have subtle or obvious scapular dyskinesis due to how the ratings are finalized. It is suggested that any abnormalities should be documented, even if the finalized SDT ratings are normal, as a part of the evaluation.

Abnormalities in scapulohumeral rhythm can be asymptomatic, indirectly related to poor posture or sedentary lifestyle, and can result from muscle imbalance leading to development of MSD. Measurements of physical activity level and time spent sitting in college students are necessary to determine the influence of posture and sedentary lifestyle that could impact scapulohumeral rhythm. OT practitioners should consider the potential impact of scapular dyskinesis on occupational performance in asymptomatic student populations.

References

Akodu, A. K., Akinbo, S. R., & Young, Q. O. (2018). Correlation among smartphone addiction, craniovertebral angle, scapular dyskinesis, and selected anthropometric variables in physiotherapy undergraduates. *Journal of Taibah University Medical Sciences*, *13*(6), 528-534. doi:10.1016/j.jtumed.2018.09.001

Andersen, C. H., Andersen, L. L., Zebis, M. K., & Sjøgaard, G. (2014). Effect of scapular function training on chronic pain in the neck/shoulder region: A randomized controlled trial. *Journal of Occupational Rehabilitation, 24*(2), 316-324. doi:10.1007/s10926-013-9441-1

Calik, B.B., Yagci, N., Gursoy, S., & Zencir, M. (2014). Upper extremity and spinal musculoskeletal disorders and risk factors in students using computers. *Pakistan Journal of Medical Sciences*, *30*(6), 1361-1366. doi:10.12669/pjms.306.5022

Calvin, T. F., Keir, P. J., & McDonald, A. C. (2016). Adaptations to isolated shoulder fatigue during simulated repetitive work. Part I: Fatigue. *Journal of Electromyography and Kinesiology, 29*, 34-41. doi:10.1016/j.jelekin.2015.07.003

Castelein, B., Cagnie, B., Parlevliet, T., & Cools, A. (2016a). Scapulothoracic muscle activity during elevation exercises measured with surface and fine wire EMG: A comparative study between patients with subacromial impingement syndrome and healthy controls. *Manual Therapy*, *23*, 33-39. doi:10.1016/j.math.2016.03.007

Castelein, B., Cagnie, B., Parlevliet, T., & Cools, A. (2016b). Superficial and deep scapulothoracic muscle electromyographic activity during elevation exercises in the scapular plane. *Journal of Orthopaedic & Sports Physical Therapy*, *46*(3), 184-193. doi:10.2519/jospt.2016.5927

Castelein, B., Cools, A., Parlevliet, T., & Cagnie, B. (2016). Are chronic neck pain, scapular dyskinesis and altered scapulothoracic muscle activity interrelated?: A case-control study with surface and fine-wire EMG. *Journal of Electromyography and Kinesiology, 31,* 136-143. doi:10.1016/j.jelekin.2016.10.008

Centers for Disease Control and Prevention. (2017). About Adult BMI. Retrieved from https://www.cdc.gov/healthyweight/assessing/bmi/adult_bmi/index.html

Cho, J., Lee, K., Kim, M., Hahn, J., & Lee, W. (2018). The effects of double oscillation exercise combined with elastic band exercise on scapular stabilizing muscle strength and thickness in healthy young individuals: A randomized controlled pilot trial. *Journal of Sports Science and Medicine, 17,* 7-16. Retrieved from https://www.jssm.org/

Chopp-Hurley, J. N., O'Neill, J. M., McDonald, A. C., Maciukiewicz, J. M., & Dickerson, C. R. (2016). Fatigue-induced glenohumeral and scapulothoracic kinematic variability: Implications for subacromial space reduction. *Journal of Electromyography and Kinesiology, 29,* 55-63. doi:10.1016/j.jelekin.2015.08.001

Cools, A. M. J., Struyf, F., De Mey, K., Maenhout, A., Castelein, B., & Cagnie, B. (2014). Rehabilitation of scapular dyskinesis: From the office worker to the elite overhead athlete. *British Journal of Sports Medicine, 48,* 692-697. doi:10.1136/bjsports-2013-092148

Cooper, C. (2014). Fundamentals of hand therapy, (2nd ed.). St. Louis: Mosby.

Craig, C. L., Marshall, A. L., Sjorstrom, M., Bauman, A. E., Booth, M. L., Ainsworth, B. E., … & Oja, P. (2003). International Physical Activity Questionnaire: 12-country reliability and validity. *Medicine and Science in Sports and Exercise*, *35*(8), 1381-1395. doi:10.1249/01.MSS.0000078924.61453.FB

Eraslan, U., Gelecek, N., & Genc, A. (2013). Effect of scapular muscle endurance on chronic shoulder pain in textile workers. *Journal of Back and Musculoskeletal Rehabilitation, 26*(1), 25- 31. doi:10.3233/BMR-2012-0346

Escamilla, R. F., Hooks, T. R., & Wilk, K. E. (2014). Optimal management of shoulder impingement syndrome. *Open Access Journal of Sports Medicine, 5,* 13-24. doi:10.2147/OAJSM.S36646

Fedorowich, L., Emery, K., Gervasi, B., & Côté, J. (2013). Gender differences in neck/shoulder muscular patterns in response to repetitive motion induced fatigue. *Journal of Electromyography and Kinesiology, 23,* 1183-1889. doi:10.1016/j.jelekin.2013.06.005

Grassi, B., Rossiter, H. B., & Zoladz, J. A. (2015). Skeletal muscle fatigue and decreased efficiency: Two sides of the same coin? *Exercise and Sport Sciences Reviews, 43*(2), 75-83. doi:10.1249/JES.0000000000000043

Greene, D. P., & Roberts, S. L. (2015). The proximal upper extremity. *In kinesiology: Movement in the context of activity* (pp. 109-127). St. Louis, MO: Elsevier Health Sciences.

Ha, S. M., Kwon, O. Y., Cynn, H. S., Lee, W. H., Park, K. N., Kim, S. H., & Jung, D. Y. (2012). Comparison of electromyographic activity of the lower trapezius and serratus anterior muscle in different arm-lifting scapular posterior tilt exercises. *Physical Therapy in Sport, 13*(4), 227-232. doi:10.1016/j.ptsp.2011.11.002

Haddock, E. L. & Gaines, S. A. (2013). Eating and exercise behaviors, and motivational differences between kinesiology majors and non-majors. *International Journal of Exercise Science, 2(*5). Retrieved from https://digitalcommons.wku.edu

Hanvold, T. N., Waersted, M., Mengshoel, A. M., Bjertness, E., Stigum, H., Twisk, J., & Veiersted, K. B. (2013). The effect of work-related sustained trapezius muscle activity on the development of neck and shoulder pain among young adults. *Scandinavian Journal of Work, Environment and Health, 39*(4), 390-400. doi:10.5271/sjweh.3357

Hickey, D., Solvig, V., Cavalheri, V., Harrold, M., & Mckenna, L. (2018). Scapular dyskinesis increases the risk of future shoulder pain by 43% in asymptomatic athletes: A systematic review and meta-analysis. *British Journal of Sports Medicine, 52,* 1-10. doi:10.1136/bjsports-2017-097559

International Physical Activity Questionnaire (IPAQ). (2005). Guidelines for data processing and analysis of the International Physical Activity Questionnaire (IPAQ) [PDF File]. Retrieved from https://www.researchgate.net/.

Kanik, Z. H., Pala, O. O., Gunaydin, G., Sozlu, U., Alkan, Z. B., Basar, S., & Citaker, S. (2017). Relationship between scapular muscle and core endurance in healthy subjects. *Journal of Back and Musculoskeletal Rehabilitation, 30,* 811-817. doi:10.3233/BMR-150497

Kibler, W.B, Ludewig, P. M, McClure, P. W, Michener, L. A., Bak, K., & Sciascia, A. D. (2013). Clinical implications of scapular dyskinesis in shoulder injury: The 2013 consensus statement from the 'scapular summit.' *British Journal of Sports Medicine*. *47*(14), 877-885. doi:10.1136/bjsports-2013-092425

Kibler, B., & McMullen, J. (2003). Scapular dyskinesis and its relation to shoulder pain. *The Journal of the American Academy of Orthopaedic Surgeons, 11*(2), 142-151. doi: 10.5435/00124635-200303000-00008

Kozina, Z., Repko, O., Ionova, O., Boychuk, Y., & Korobeinik, V. (2016). Mathematical basis

for the integral development of strength, speed and endurance in sports with complex manifestation of physical qualities. *Journal of Physical Education and Sport, 16*(1), 70. doi:10.7752/jpes.2016.01012

Kvist, M., & Bang, E. H. (2016). *The effects of fatigue on scapulothoracic kinematics during total shoulder abduction*. Unpublished manuscript, Department of Health, Science, & Technology, Aalborg University, Aalborg, Denmark.

Lee, S. T., Moon, J., Lee, S. H., Cho, K. H., Im, S. H., Kim, M., & Min, K. (2016). Changes in activation of serratus anterior, trapezius and latissimus dorsi with slouched posture. *Annals of Rehabilitation Medicine, 40*(2), 318-325. doi:10.5535/arm.2016.40.2.318

Lepp, A., Barkley, J.E., & Karpinski, A.C. (2015). The relationship between cell phone use and academic performance in a sample of U.S. college students. *SAGE Open, 5*(1), 1-8. doi:10.1177/2158244015573169

Malmström, E. M., Olsson, J., Baldetorp, J., & Fransson, P. A. (2015). A slouched body posture decreases arm mobility and changes muscle recruitment in the neck and shoulder region. *European Journal of Applied Physiology*, *115*(12), 2491-2503. doi:10.1007/s00421-015-3257-y

Manske, R. C. (2015). *Fundamental Orthopedic Management for the Physical Therapist Assistant-E-Book*. St. Louis, MO: Elsevier Health Sciences.

McClure, P., Tate, A. R., Kareha, S., Irwin, D., & Zlupko, E. (2009). A clinical method for identifying scapular dyskinesis, part 1: Reliability. *Journal of Athletic Training*, *44*(2), 160-164. doi:10.4085/1062-6050-44.2.160

Melton, B. F., Bigham, L. E., Bland, H. W., Bird, M., & Fairman, C. (2014). Health-related behaviors and technology usage among college students. *American Journal of Health*

Behavior, *38*(4), 510-518. doi:10.5993/AJHB.38.4.4

Miyasaka J., Arai R., Ito T., Shingu N., Hasegawa S., Ibuki S., … Moritant T. (2016). Isometric muscle activation of the serratus anterior and trapezius muscles varies by arm position: A pilot study with healthy volunteers with implications for rehabilitation. *Journal of Shoulder and Elbow Surgery, 26*(7), 1160-1174. doi:10.1016/j.jse.2016.11.010

Nakamura, Y., Tsuruike, M., & Ellenbecker, T.S. (2016). Electromyographic activity of scapular muscle control in free-motion exercise. *Journal of Athletic Training, 51,* 195-204. doi:10.4085/1062-6050-51.4.10

Osborn, J., Naquin, M., Gillan, W., & Bowers, A. (2016). The impact of weight perception on the health behaviors of college students. *American Journal of Health Education, 47*(5), 287-298. doi:10.1080/19325037.2016.1204966

Office of Disease Prevention and Health Promotion. (2014). *Physical activity.* Retrieved from https://www.healthypeople.gov/

Pate, R. R., Pratt, M., Blair, S. N., Haskell, W. L., Macera, C. A., Bouchard, C., ... & Kriska, A. (1995). A recommendation from the Centers for Disease Control and Prevention and the American College of Sports Medicine. *Jama*, *273*(5), 402-7. doi: 10.1001/jama.273.5.402

Peterson, S. M., Domino, N. A., & Cook, C. E. (2016). Scapulothoracic muscle strength in individuals with neck pain. *Journal of Back and Musculoskeletal Rehabilitation, 29,* 549-555. doi:10.3233/BMR-160656

Portney, L. G., & Watkins, M. P. (2009). *Foundations of clinical research: Applications to practice*. Upper Saddle River, NJ: Pearson/Prentice Hall.

Plummer, H. A., Sum, J. C., Pozzi, F., Varghese, R., & Michener, L. A. (2017). Observational

scapular dyskinesis: Known-groups validity in patients with and without shoulder pain. *Journal of Orthopaedic & Sports Physical Therapy*, *47*(8), 530-537. doi:10.2519/jospt.2017.7268

Rundquist, P. J., Obrecht, C., & Woodruff, L. (2009). Three-dimensional shoulder kinematics to complete activities of daily living. *American Journal of Physical Medicine & Rehabilitation, 88*(8), 623-629. doi:10.1097/PHM.0b013e3181ae0733.

Sedentary Behavior Research Network. (2012). Letter to the editor: Standardized use of the terms “sedentary” and “sedentary behaviours”. *Applied Physiology, Nutrition & Metabolism, 37*, 540-542. doi:10.1139/H2012-024

Sheard, B., Elliott, J., Cagnie, B., & O'Leary, S. (2012). Evaluating serratus anterior muscle function in neck pain using muscle functional magnetic resonance imaging. *Journal of Manipulative and Physiological Therapeutics, 35*(8), 629-635. doi:10.1016/j.jmpt.2012.09.008

Smith, A. (2015). U. S. smartphone use in 2015. *Pew Research Center: Internet and Technology*. Retrieved from http://www.pewresearch.org/

Tate, A. R., McClure, P., Kareha, S., Irwin, D., & Barbe, M. F. (2009). A clinical method for identifying scapular dyskinesis, part 2: Validity. *Journal Of Athletic Training*, *44*(2), 165-173. doi:10.4085/1062-6050-44.2.165

Uhl, T., Kibler, B., Gecewich, B., & Tripp, B. (2009). Evaluation of clinical assessment methods for scapular dyskinesis. *Arthroscopy: The Journal of Arthoscopic & Related Surgery*, *25*(11), 1240-1248. doi: 10.1016/j.arthro.2009.06.007

U.S. Department of Health and Human Services. (2018). *Physical Activity Guidelines for Americans* (2nd ed.). Retrieved from https://health.gov/paguidelines/second-edition/pdf/

Zabihhosseinian, M., Holmes, M. W. R., Howarth, S., Ferguson, B., & Murphy, B. (2017). Neck muscle fatigue differentially alters scapular and humeral kinematics during humeral elevation in subclinical neck pain participants versus healthy controls. *Journal of Electromyography and Kinesiology, 33,* 73-82. doi:10.1016/j.jelekin.2017.02.002

Table 1

Participants' Demographics

	Frequency (%)
Gender ● Male ● Female	n=54 ● n=4 (7%) ● n=50 (93%)
College Major ● Occupational Therapy ● Physical Therapy ● Other	n=54 ● 36 (67%) ● 13 (24%) ● 5 (9%)
College Year ● Graduate ● Undergraduate	n=54 ● 49 (91%) ● 5 (9%)
Employed ● Yes ● No	n=54 ● 38 (70%) ● 16 (30%)
Median Age	n=53 ● 23
Mean BMI	n=53 ● 23.531 ● SD: (+/- 2.698)

Note. SD = standard deviation.

Table 2

Primary Investigator Scapular Dyskinesis Test Ratings

	Left SDT(%)	Right SDT(%)
Category:		
Normal	29 (54%)	30 (56%)
Subtle	13 (24%)	13 (24%)
Obvious	12 (22%)	11 (20%)
Total	54	54

Table 3

Student Investigator Scapular Dyskinesis Test Ratings

	Left SDT(%)	Right SDT(%)
Category:		
Normal	36 (67%)	46 (85%)
Subtle	10 (18%)	2 (4%)
Obvious	8 (15%)	6 (11%)
Total	54	54

Figure 1

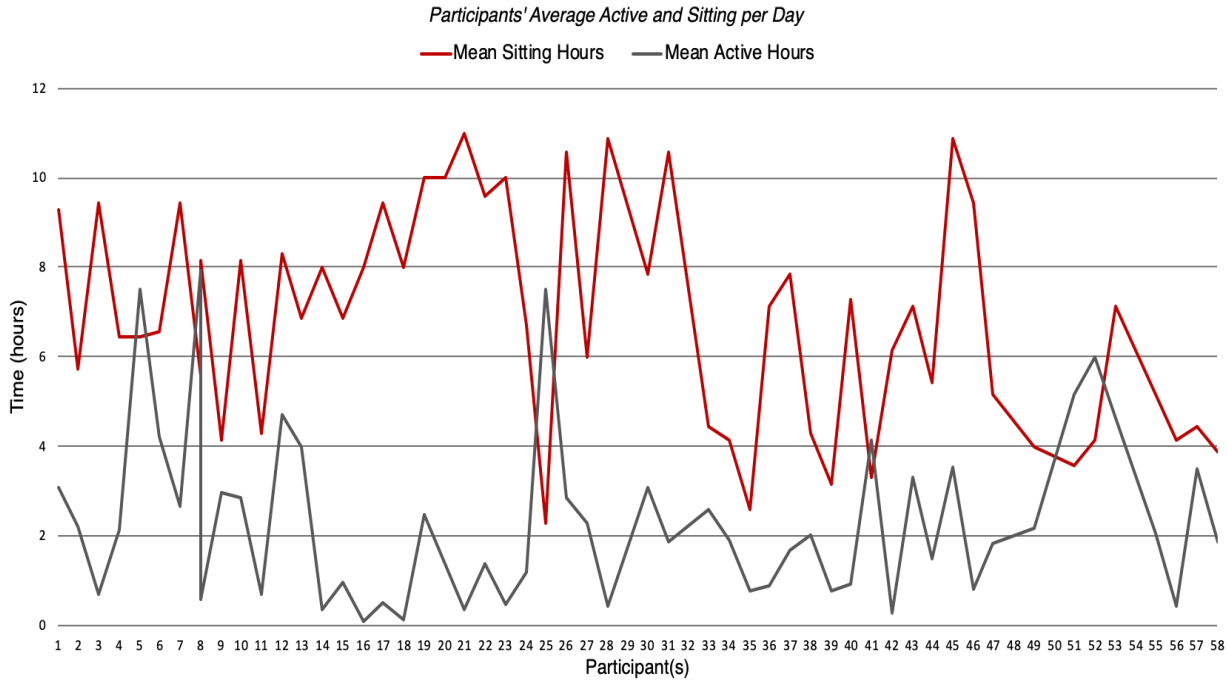
Participants' Average Active and Sitting per Day
Mean Sitting Hours
Mean Active Hours
Time (hours)
0
2
4
6
8
10
12
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51 52 53 54 55 56 57 58
Participant(s)

Table 4

International Physical Activity Questionnaire Results

	Weekly Sitting (minutes)	Daily Sitting (minutes)
Mean	2926.67	410.16
SD	+/-1005.39	+/-147.11
Range	1080 - 46.20	137.14 - 651.43
	IPAQ Categories (%)	
Low	4 (7%)	
Moderate	15 (28%)	
High	35 (65%)	
	IPAQ Total MET Score	
Median	4329	

Note. SD = standard deviation.