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Capstone Project:  Evidence Table

PICO:  In adults with a primarily sedentary occupation, would an exercise program designed to counteract the effects of sitting on the spine decrease the prevalence of back pain with six (6) months after implementation?

Slump Sitting=SS, Lumbo-Pelvic Upright Sitting=LPUS, Thoracic Upright Sitting=TUS.  Cervical Erector Spinae=CES.  Thoracic Erector Spinae=TES.  MA=Muscle Activity, SLM=Superficial Lumbar Multifidus, IO=Internal Oblique, EO=External Oblique, IL=Iliocostalis Lumborum Pars Thoracis.  TrA=Transverse Abdominus, CV=Craniovertebral

| **Author, Year, Journal, Title** | **Purpose, Design** | **Subjects** | **FES or PT Intervention** | **Outcome Measures** | **Results (P<0.05)** | **Application to PICO Question** | **Comparison/Notes** |
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| **Caneiro JP et al.  2010** ***Manual Therapy***<br><br>**The influence of different sitting postures on head/neck posture and muscle activity** | Investigate whether three different thoraco-lumbar postures affect head/heck posture and cervico-thoracic muscle activity | n-20<br>10M 10F<br><br>Males: height 183.2±9.2cm, Mass 81.0±2.9 kg, Age 25.7±3.5 years<br><br>Females: Height 166.3±5.6cm, Mass 62.5±9.5kg, Age 24.5±4.2 yr | Subjects instructed to sit in slump sitting, lumbo pelvic upright sitting, or thoracic upright sitting<br><br>3 trials of each posture for 5 sec | Neck-shoulder stabilizers muscle activity measured with EMG in three different thoraco-lumbar postures<br><br>Tested for 3 trials of 5 sec. | TUS ↑ thoracic flexion and lumbar ext v LPUS. TUS↓ thoracic flexion and ↑lumbar ext v. SS. SS↑ thoracic flexion and lumbar flexion v LPUS. LPUS ↑neck/head flexion relative to C7 and a trend towards greater anterior translation v. TUS.  SS↑ head/neck flexion and anterior translation v TUS. SS↑ neck/head flexion and ant translation v. LPUS.  TUS ↓CES and↑TES v LPUS. SS↑CES and ↓TES v TUS. | LPUS has ↓ cervical ext and anterior translation compared to SS and LPUS resulted in ↓ activation of TES compared to SS and TES and ↓ of CES compared to SS. LPUS ↓ forward head and requires minimal muscle activation. | Supports need for training in postural positions that place decreased load on the spine.<br><br>Supports training for LPUS.<br><br>More research is needed in this area. |

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| | | | | | SS ↑CES and ↑TES v LPUS. | | |
| **O'Sullivan et al. 2006. *Spine*.**<br><br>**Effect of different upright sitting postures on spinal-pelvic curvature and trunk muscle activation in a pain-free population** | Investigate spinal-pelvic curvature, pelvic angle, and trunk muscle activation in these two upright postures and compare these postures to slump sitting | N-22<br>13 M 9F<br>Mean age=32 (SD±13)<br>Mean height=172cm (SD±10)<br>Mean weight=71 kg (SD±11) | Subjects were instructed to perform three postural positions for 5 seconds: TUS, SS, LPUS | Spinal pelvic curvature was collected using a motion tracking system (3Space Fastrak). Surface EMG was used to collect trunk muscle activity | TUS↑thoracic ext, ↓lumbar extension, and ↓ant pelvic tilt v. LPUS. TUS ↑lumbar ext, thoracic ext, and ant pelvic tilt v. SS. LPUS↑ thoracic ext, lumbar ext, ant pelvic tilt v SS. TUS↓MA of SLM, IO and ↑TES v LPUS. TUS↑IO, EO, TES, and IL v SS. LPUS↑MA of LM, IO, IL v SS. | LPUS encourages use of lumbar stabilizers (IO, SLM) v. TUS and SS which encourages uses of the prime movers of the spine (TES, EO). In order to activate the lumbar stabilizers, a LPUS postures must be implemented. | Supports training of IO and SLM for endurance during LPUS.<br><br>LPUS is the proper posture. |
| **O'Sullivan et al. 2002. *Spine*.**<br><br>**Effect of different standing** | Determine whether there is a difference in electromyographic activation of specific | N=20<br>10M 10F<br>Mean age=27.8 with a range of 21-37<br>Mean height of 174 cm | Subjects were asked to assume four different postures: erect standing, | EMG measured MA. Postural position was measured using an | ↓SLM, IO, and TES MA in sway standing v erect standing and the rectus femoris was more active. ↓in SLM, IO, and TES MA in sway sitting v erect sitting. | Erect sitting (TUS/LPUS) activates the spine stabilizers (SLM, IO, TES) compared to SS. Endurance of the SLM, IO, and | Supports endurance strengthening of SLM, IO, TES for maintaining LPUS or TUS postures. |

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| **and sitting postures on trunk muscle activity in a pain-free population .** | lumbopelvic muscles with the adoption of common postures in a pain-free population. | and mean weight of 67.7 kg. | sway standing, erect sitting, and SS. | image processing system and landmarks placed on bony landmarks Frequency : 3 seconds x 3 for each postural position | | TES is necessary to maintain TUS/LPUS posture for prolonged periods of time. | More research is necessary. |
| **Reeve et al. 2009. *Manual Therapy*.** <br><br> **Effects of Posture on the thickness of the transversus abdominus in pain-free subjects.** | Use ultrasound to examine the changes in thickness of TrA in slouched sitting and sway standing, which are commonly adopted poor standing and sitting | 20 healthy subjects. 10M 10F. Mean age of 29 yr with a range of 20-51. | Subjects were asked to maintain 5 different postures (supine lying – erect sitting – slouched sitting – erect standing – sway back standing | TrA MA was measured using US imaging system. Outcome measures were taken at the end of inspiration 2x | 39.5%↑ in TrA thickness in erect standing v. sway. 24.3%↑in TrA thickness in erect sitting v sway. | TrA activation is associated with erect sitting and standing. | Supports endurance strengthening for the TrA in order to improve sitting posture. |

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| | postures, and compare these to erect lumbo-pelvic neutral standing and sitting postures | | | | | | |
| **Black et al. 1996. *Spine*.**<br><br>**The influence of different sitting positions on cervical and lumbar posture.** | Evaluate the changes in head, cervical, lumbar, and pelvic postures in different sitting positions and also determine if there is a relation between lumbar posture and cervical posture during | 30 subjects. 23F 7M. Mean age was 28yr with a range of 22-45. Mean height of 168.2 with range of 152.4-190.5cm. Mean weight of 63.1kg with range of 45.5-88.6kg | Four sitting postures were evaluated: Comfortabl e/Natural, Slouch, Erect, Forward Inclination | Postural position was measured using a computeri zed, 3-D digitizer | Correlation between cervical extension and lumbar flexion. Correlation between cervical flexion and lumbar extension. | ↓Lumbar flexion ↓ cervical extension/forw ard head | Supports need to focus on correcting lumbar posture to decrease cervical extension/for ward head. |

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| | sitting. | | | | | | |
| **Silva AG et al. 2009. *Arch Phys Med Rehabil*.**<br><br>**Head posture and neck pain of chronic nontrauma tic origin.** | Determine whether participants with chronic non traumatic NP and a more forward head posture than pain-free participants. | In each group there were 6 M and 34F. Mean age 50.2±7.9. Pain Participants: Mean height 159.0±7.0cm Mean weight 69.0±11.0kg. Pain Free: Mean height 160.0±8.2cm Mean weight 65.5±12.7kg | Subjects' head posture was measured | Head posture was assessed by measuring three anatomic angles using a video camera – which, in one second, took 25 shots | Neck pain participants under 50 years old were found to have more forward head posture.<br><br>Forward head posture is not correlated with neck pain in those over 50 years old. | Forward head is associated with neck pain for subjects under 50 years old. | Supports exploring all options to decrease forward head posture (especially in sitting) for those with neck pain complaints under 50 years old. |
| **Falla D at al. 2007. *Physical Therapy*.**<br><br>**Effect of neck exercise on sitting posture in patients** | To compare change in cervical and thoracic spine posture during distracting task between subjects with chronic | 58F subjects with neck pain. Mean age=37.9 yr. 10 pain free subjects matched in age. Pain subjects had non-severe neck pain >3 months. <15 | Cervical and thoracic spine posture were monitored while subjects played a computer game of | A camera, 0.8m laterally from the subject, took pictures of the subject while they performed the task with | The neck pain group demonstrated a significant increase in forward head over time compared to the pain free group.<br><br>Both groups experienced an increase in thoracic kyphosis over time, but the pain free group difference was not significant. | With increased time sitting, subjects with neck pain demonstrate ↑ forward head. | Supports need for postural endurance training for decreased forward head for those with neck pain that sit for prolonged periods of time. |

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| **with chronic neck pain.** | neck pain and control subjects | on NDI. Avg 4.1 on VAS. Palpable cervical tenderness | solitaire for 10 minutes using the dominant hand on the mouse. | anatomical landmarks placed on the tragus of the ear, C7 and T7. | Change in cervical angle in pain group: 4.4 deg and for pain-free group: 2.2 deg. | | |
| **Horton SJ et al. 2010. Spine.**<br><br>**Changes in head and neck posture using an office chair with and without lumbar roll support.** | Investigate change in sagittal alignment of head and neck posture in response to adjustments of an office chair with and without a lumbar roll in situ. | 30M. Healthy. Age range 18-30 years. Mean age 21.73±3.32 years. Mean weight 77.37±13.5kg. Mean height 178.17±7.74 cm. Mean BMI 24.27±3.53kg/m$^2$ | Subjects assumed (8) different positions (1) seat level, backrest 90 deg (2) seat level, backrest inclination 100 deg (3) seat level, backrest inclination to 100 deg (4) seat tilted backward 7 degree, backrest inclination 90 deg (5) seat level, backrest 90 deg, lumbar roll in situ (6) seat level, backrest inclination 100 deg (7) seat level, backrest | Craniovertiebral angle was evaluated in each position using the Modified Schober Index for the L-spine and the CROM for the C-spine. Pictures were taken using a 3.2 megapixel camera. | CV angle was most significantly affected by backrest angle and lumbar support. The greatest difference in CV angle existed with no lumbar support and backrest at 110deg (5.25 deg difference from backrest at 90deg). CV angle also changed significantly with lumbar roll in situ with backrest at 90 deg to 110 deg compared to the same degree and and no lumbar roll in situ (2.32 deg) | Adding a lumbar roll – thus resisting lumbar flexion – significantly increased the CV angle/decreased forward head posture. | Supports need for more postural training that can maintain a lumbar spine posture in neutral/no flexion in order to decrease forward head posture.<br><br>More research is needed in this area. |

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| | | | inclination 110 deg, lumbar roll in situ (8) seat tilt backward 7 deg, backrest inclination 90 deg, lumbar roll in situ. | | | | |
| **Lis et al. 2007. Eur Spine J. Association between sitting and occupational LBP.** | Assemble and describe evidence of research on the association between sitting and presence of LBP. Systemic Review | 24 articles were included for review. | Studies were included if they described the presence and/or occurrence of LBP in occupational groups in which the major physical requirement is sitting (sitting for more than ½ the day) | LBP was self reported. Exposure described or at least graded. Statistical measure of association (OR or Risk Ratio) | Prevalence rate compared to average of annual prevalence rate of 38%. Overall the average OR for LBP in the occupations reviewed was 1.99 but over half were not significant (P>.05). | For occupations where sitting is a requirement for at least half the day, LBP is not a risk. | It is unclear what "half the day" means? Does that mean greater than four hours of sitting? Or does that mean 12 hours of sitting? The exact amt of sitting should have been calculated. In addition, although not significant, every occupation that required sitting had a |

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| | | | | | | | higher OR than the control. |
| **Sanchez-Zuriagia D et al. 2010. Spine.**<br><br>**Is activation of the back muscles impaired by creep or muscle fatigue?** | Determine how physiologic levels of creep and fatigue affect reflex activation of the back muscles in response to sudden loading. | 15 healthy subjects.<br>7 males/8 females. No history of LBP that required medical attention or time off work. Mean age M=36, F=38. Mean Weight (kg) M=84.6, F=62.1. Mean Height (m)=1.81, F=1.64. | Group 1: sit in SS in order to induce creep.<br>Group 2: perform the Beiring-Sorensen test in order to induce fatigue. | Before and after interventi on - reflex activation of the main trunk extensors muscles was assessed using EMG and | ICC values were between .60 and .94 (fair to excellent). Following creep, onset latency of the reflex muscle activation was increased (P<0.001). No significant changes in any of the measured parameters for the fatigue intervention. | Increased sitting delays the onset of reflex muscle activation of the thoracic and lumbar erector spinae in response to sudden perturbation. | Prolonged periods of sitting (>1 hour), decreases the ability of the spine to stabilize during perturbations. Prior stretching of the muscle desensitizes the spindles so that a greater degree of stretch is then required to initiate spindle firing (reflex). |
| **Shin G et al. 2009. Spine.**<br><br>**Creep and fatigue** | To identify the occurrence of creep and muscle fatigue developmen | 20 subjects. No acute or chronic LBP reported. Age: 20-35 yr old. 10 M/10F. | 2 hour experiment on a single day. MVC EMG of trunk extensors | EMG measured the Maximum Voluntary Contractio n of the | Flexion-relaxation phenomena of the lumbar erector spinae increased 11.0% after static flexion and full flexion angle was also significantly greater – 3.3% increase. (P<0.05) | Creep in the low back can be developed during static flexion. This might produce laxity in the | This particular study looked at the effects of spinal flexion in standing and not in sitting. Although the |

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| **developme nt in low back in static flexion.** | t in the low back during static upper body deep flexion that resembled above ground work posture | Mean Height (M) M=1.65, F=1.63. Mean Weight (kg) M=62.9, F=62.1. | were taken at 60 deg trunk flexion. 2 isometric trunk sagittal ext measureme nts were taken. Isokinetic trunk sagittal flexion measureme nt was taken. All done before and after 5 minutes of static flexion | trunk extensors and the isokinetic sagittal flexion. Dynamom eter measured the isometric trunk sagittal extension. | Static flexion, isometric extension exertion and gender affected EMG results. Trunk flexion angle increased from 93.5 deg to 96.0 deg during static flexion. | spine and decreased resistance to bending. The end result Is decreased spinal stability | flexion of the spine is the same, the pulling force is different thus making it difficult to draw a direct correlation between this type of spinal flexion and the type of spinal flexion seen in sitting. |
| **Dunk NM et al. 2009. Clin Biomech.**<br><br>**Evidence of** | To determine if the lower intervertebr al joints of the lumbo-sacral spine | 27 subjects. 13 M/14F. Mean age 29.2M, 26.7F. Mean Height (m) 1.78M, 1.65F. Mean | 5 postures were imaged in this study: Upright standing, half flexion, | Lumbar spine x-rays | Total standing ROM for L3/S1 was similar in both males and females. L4/5 had a higher ROM than both L3/4 and L5/S1. In the half-flexion posture, the L5/S1 joint was at a | SS stretches the IVJs the most out of the five postures examined. A strategy to keep from going into | Upright sitting postures will transition passive stretch from L4/5 to L5/S1 and demonstrates |

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| **a pelvis-driven flexion pattern: are the joints of the lower lumbar spine fully flexed in seated postures?** | approach their end ragnes of motion in seated postures. | Weight (kg) 78.5, 63.2). All free of self-reported LBP for 12 months prior to testing. No pregnancy, occupational exposure to radiation, no annual occurrence of radiological procedures | full flexion, upright sitting, slumped sitting. | | smaller percentage ROM than the other two intervertebral joints (IVJs). Upright sitting demonstrated L5/S1 at 60% of its ROM, L4/L5 and 50%, and L3/L4 and 35%. SS demonstrated greater than 80% of IVJs ROM for all. In four of the five positions, the L4/L5 IVJ contributed to 40% of lumbar spine flexion. But, in the upright sitting position, L5/S1 contributed more than L4/5. | SS is ideal. Upright sitting posture takes the pressure off of L4/5. SS uses less of the ROM of the IVJs compared to half flexion and full flexion, but uses more compared to upright sitting. | the least amount of ROM disturbances in the IVJs compared to SS and standing in half flexion and full flexion. |
| **Beach TA. 2005. Spine.**<br><br>**Effects of prolonged sitting on the passive flexion stiffness of the in vivo lumbar** | Quantify time-varying changes in the passive flexion stiffness of the lumbar spine with exposure to prolonged sitting and to link these | 12 subjects. 6M/6F. Mean age 24.5 M, 23.3 F. Mean height (m) 1.77M, 1.62 F. Mean mass (kg) 76.8 M, 58.6 F. No low back pain at time of | Passive flexion stiffness (PFS) was measured initially, after 1 hour of sitting, after two hours of sitting. | EMG was used over the muscle bellies of lumbar and erector spinae groups. A force transducer was used to | PFS increases over time (transition slopes were significantly different across testing sessions P=.0053). Maximum lumbar flexion angles were significantly different between men and women after sitting (p=.0237) and men had decreases in lumbar flexion angles with increased sitting time | In men, prolonged sitting increased stiffness of the lumbar spine. Therefore, exercises to counteract this stiffness are necessary to avoid injury of the low back. | Results were not significant for women in this study possibly due to the small sample size and possibly due to women generally being more flexible than men. Therefore, a |

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| **spine.** | changes to lumbar postures and trunk extensor muscle activation while sitting. | collection. No disabling back pain the last year. | | measure cable tension. Lumbar flexion/extension angles were measured using a 3-SPACE Isotrak II system. Quantified changes in the shapes of the passive flexion moment-angle curves were the outcome msueares. | (p=.0072). Women did not display any significant changes in lumbar flexion angle throughout the trials. Muscle activation and change in postures in response to prolonged sitting was not statistically significant. | | second study where women are tested in sitting after longer periods of sitting (>4 hours) may be necessary. |
| **Shin G et al. 2007. Clin Biomech.** | Quantify the interplay between passive and active | 5 M/5 F. Mean age: 27.8 years. Age range 20-35 years. | Two experiments were performed: one | Lumbar flexion angle was measured using an | Full lumbar flexion angles significantly increased after a prolonged flexion moment in both the rest and no rest groups | During prolonged moments of flexion, the lumbar flexion | Again, it would be interesting to see how this translates to sitting. |

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| **An in vivo assessment of the low back response to prolonged flexion: interplay between active and passive tissues.** | extensor components as a function of creep. Evaluate the effects of a short break period on this response. | Without current or chronic low back pain/injury. | without a rest break and the other with a rest break. The experiemen t consistente d of a 10 min flexion phase and a 10 min standing recovery phase with intermitten t lifting of a weighted box. | electro-magnetic motion tracking system. Lumbar extensors activity was measured using EMG. | although the rest group's change in the full flexion angle was significantly smaller. During the flexion phase, the activity of the multifidi and erector spinae increased on average 35% to 40.9%. | angle increases decreasing the stability of the spine. In addition, the activity of the multifidus and erector spinae increase. Therefore, these changes can put the spine at risk for injury after prolonged sitting. | Prolonged flexion of the spine in standing v. sitting is not exactly the same thing, but the data can be extrapolated a bit. |
| **Park SY et al. 2011. J Physiol Anthropol.**<br><br>**Effects of a posture-sensing air seat device** | Determine the effects of a posture-sensing air seat device (PSASD) on the human musculoskel etal system by assessing | 11 subjects. Unknown genders. Mean age:23.8 years with a range of 20-27. Mean height: 175.4. Mean | Subjects performed 20 min of work using and not using a PSASD. | Trunk measurem ents were attained using a flexible electrogon iometer (EGM). Muscle | >Trunk flexion and lateral flexion was demonstrated when a subject was not using the PSASD. The erector spinae and internal obliques were more active when using the PSASD v not using the PSASD. | Postural awareness decreases the flexion load on the spine and increases the activation of the segmental stabilizers. This decreases the | This study would be ideal to do with a larger sample size over a longer period of time. |

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| **(PSASD) on kinematics and trunk muscle activity during continuous computer work.** | the kinematics of the lumbar region and trunk muscle activity during prolonged computer work. | weight 66.1 kg. Inclusion criteria included a job where the subject used a computer in a seated position for at least 8 hours a day. No history of upper or lower extremity injuries/dysf unction. | | activation data was obtained using EMG. | | creep effects on the passive structures of the lumbar spine therefore decreasing risk for injury with increased sitting. | |
| **Gregory DE et al. 2006. Hum Factors.**<br><br>**Stability ball versus office chair: compariso** | Compare the trunk muscle activation levels and the lumbar spine posture of individuals sitting on a stability ball and in an | 7 M/7 F. Mean age 25.4 M, 22.3 F. Mean mass (kg) 79.45 M, 59.64 F. Mean Height (m) 1.81 M, 1.63 F. All free of LBP for the | Sitting on a physioball or an office chair for one hour each. | Muscle activation levels were measured using EMG. Lumbar spine motion was measured | No significant differences in EMG results or co-contraction of muscles were found between the two sitting conditions. No significant differences in flexion or range of flexion were found between the two sitting conditions. Greater posterior pelvic tilt was noted using the office chair (23.3 deg) | Using a stability ball, in the same manner as this particular study, does not increase muscle activation and actually increases discomfort. But, the stability ball | Question sample size – too small? Question manner in which the stability ball was used for desk work – too passive.<br><br>Might be worth |

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| **n of muscle activation and lumbar spine posture during prolonged sitting.** | office chair for an extended period of time. | previous 12 months. | | using the Isotrak 3Space. Level of discomfort was rated using a VAS of 100 mm. | compared to the ball (18.3 deg). Significant increases in discomfort were noted during both sitting conditions with significantly worse discomfort noted with the stability ball (pain score of 17.5 mm compared to 9.1mm using the office chair) | does encourage anterior tilting of the pelvis, which has been associated with healthier postures. | investigating further. |