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BACKGROUND

- Cycling is an aerobic and low-impact method of exercise with inherent risks of overuse injuries in the lumbar spine.
- The pathomechanics and association of risk factors of lumbar spine overuse injuries in cycling are not clearly understood.
- Approximately 23 million people who regularly cycle, developing at least one overuse injury in their lifetime in the USA[1].
- Up to 22% of cyclists experiencing time loss from activity reported low back overuse injuries to be the cause[2].
- Hypothesized mechanisms behind the pathomechanics of LBP in cyclists include: mechanical creep, disc ischemia, muscle fatigue, over-activation of back extensors, and flexion-relaxation phenomenon[3].
- Furthermore, incorrect bike fitting resulting in poor body positioning on the bicycle has a strong association with LBP in cyclists[3,4,5,6].

OBJECTIVES

- To determine if relationships exist between body positioning, spinal kinematics, and muscle activity in active cyclists with non-traumatic LBP.
- To explore variations in optimal positioning and bike set up in order to address variables associated with LBP in the physical therapy clinic.

METHODS

- PubMed, CINAHL, Ovid Medline, Scopus searched with narrowed focus on cyclists with non-traumatic low back pain.
- Inclusion criteria: factors relating to non-traumatic low back pain in cyclists deemed "biomechanical" in nature as agreed upon by group consensus.
- Exclusion criteria: articles referenced in previous literature review published by Marsden, et al. in 2007[3].
- Research quality assessed using Downs & Black quality assessment scale, with grading assigned based on group consensus.

Database search of Pubmed, CINAHL, Ovid Medline, and Scopus: July 2015 n=434

→ Titles screened: n= 79

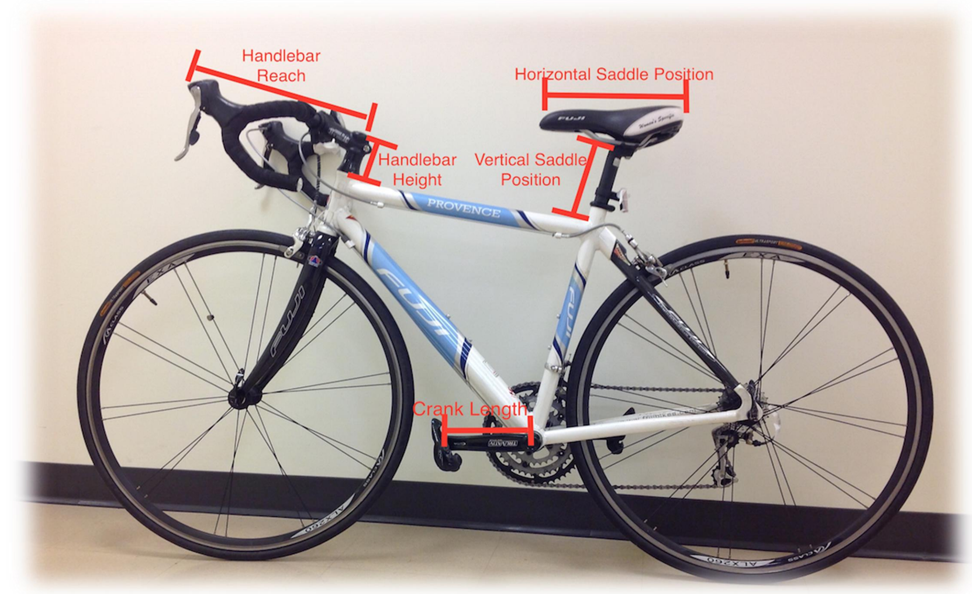
→ Duplicates excluded: n= 50 → Irrelevant non-biomechanically based research excluded based on abstract: n=34

→ Full text sources reviewed: n=16 → Articles overlapped in Marsden et al. review 2010 excluded: n=9

→ Total included: n=7

RESULTS

- Seven articles eligible for review; comparative and observational studies were selected based on our research question.
- 238 total subjects; all males ranging from ages 18 to 57, 120 to 160 lbs., and height of 5'3" to 6'1".
- Four within-participant study designs, two case-control study designs, and one single-case study.
- Average Downs and Black score = 10.5 out of 27; highest score = 15 out of 27.
  - Studies deemed to be of low to moderate quality[7].



Study, Year	Subjects	Sample Size	Variables	Experimental Protocol	Results	Conclusion
Balasubramanian et al., 2008	Male cyclists with and without LBP	13 (6 in LBP group, 7 in control)	• Pain • EMG to measure MPF: - Latissimus dorsi - Trapezius - Erector spinae - Biceps brachii	• Aerobic cycle for 30 minutes at average speed of 25-30 km/h	• Greater sEMG activity in L biceps brachii of LBP group vs. control (p<0.05) • Both groups: Linear regression reported significant fatigue in left medial biceps, right medial trapezius, right and left medial latissimus dorsi, and right erector spinae • No statistical difference between groups; (p<0.1) significance LBP R and L biceps brachii and both groups R medial trapezius	• Trend for muscle fatigue greater in LBP group vs. control • Raises questions about upper extremity fatigue in LBP group, potentially due to compensation
Balasubramanian et al., 2013	Male volunteers familiar with standard handlebar and racing handlebar configurations	12	• Bicycle design • EMG of medial trapezius, medial latissimus, erector spinae, extensor carpi radialis • MVC • RBG pain score	• Three cycles ridden (rigid frame, suspension, sports) in randomized order for 30 minutes per cycle at constant speed	• Sports frame: increased fatigue in right erector spinae and medial latissimus dorsi in MVC test (p<0.05) • Rigid and sports frames: significant fatigue in left ECR • No significant difference in muscle groups between suspension and sports frame	• Substantially higher muscle fatigue in UE & low back muscle groups with sports bike • Suspension bike prevents muscular fatigue & vibration-induced LBP • Consideration for ergonomics design of bike can be inferred
Chen and He, 2012	Male participants	26	• Handlebar height • External lumbosacral angle • Trunk angle • Cervical spine extension angle	• 20-minute bicycling test with 5 handlebar height positions (16, 8, 0, -8, and -16 cm)	• Reduced lumbo-sacral angles and increased cervical extension in lower handlebar heights (p<0.05) • Trunk inclination negatively and positively correlated with lumbo-sacral angle (r=-0.620, p<0.001)	• Lower handlebar heights caused: - Limited lumbar lordosis - More cervical extension - Overall, more spinal stress • Bikes with higher handlebar heights recommended
Muyor et al, 2011	Elite and master male cyclists with 2-4 hours of daily training, 3-6 days/week of training, and at least 4 years of experience	120 (60 elite, 60 master)	• Thoracic spine, lumbar spine, & pelvic tilt angles • Standing, upper, middle, & lower handlebar positions	• Cycle for 5 minutes at 90 revolutions/min on cycling trainer at moderate intensity on BORG scale for each of 3 handlebar-hand positions	• Significant difference in thoracic, lumbar, and pelvic angles (p<0.05) • Master cyclist presented increased lumbar lordosis in standing, elite cyclists presented increased kyphosis in standing • Large effect sizes in both groups regarding reduced lumbar lordosis in sitting (d = 0.99) • Lower handlebar heights increased intervertebral flexion • Small effect sizes in both groups regarding pelvic tilt (elite cyclist: d = 0.1 and 0.2, master cyclist: d = 0.3) • Elite cyclists showed greater lumbar flexion, anterior pelvic tilt for all postures evaluated than master cyclists (p<0.05)	• Standing spinal posture may not be significantly affected by spine positioning on bicycle • Thoracic spine posture is more neutral while seated on bike than in standing • Lumbar flexion and pelvic tilt is increased with lower handlebar height • No significant morphological changes in spinal positioning found between elite and master cyclists
Muyor et al., 2015	Male professional cyclists with experience of 17.22 ± 6.16 (mean±SD) years, 6.52 ± 0.51 days/week training, and 3.78 ± 0.61 hours/day training	28	• Handlebar-hands position • Thoracic & lumbar sagittal spinal curvature • Pelvic tilt	• Cycle for 5 minutes at 90 revolutions/min on personal bicycle at moderate intensity on BORG scale for each of 4 handlebar-hand positions (upper, middle, lower, aerodynamic)	• Aerodynamic handlebar-hands position showed greatest lumbar flexion and anterior pelvic tilt (all p values <0.05) • Significant difference in thoracic, lumbar, pelvic tilt in all evaluated postures (p<0.005)	• Passively maintained thoracic spine straighter on bike than standing due to handlebar-hands support • Farther and lower handlebar positions relative to seat increases anterior pelvic tilt and lumbar spine flexion
Rostami et al., 2014	Male professional competitive off-road cyclists who have competed in national and international cross-country mount bicycle races within 12-month period, total cycling distance >100 km/week, off-road cycling distance >25 km/week	38 (14 cyclists, 24 controls)	• Diameter of transverse abdominis, internal obliques, & external obliques in hook-lying relaxed & abdominal draw-in maneuver • CSA of lumbar multifidi at rest & during contraction • Sit-and-reach flexibility • Endurance & maximal strength by dynamometer	• Thickness of lateral abdominal muscles measured in hooklying position, positioned on standard mountain bicycle in 4 different crank positions • Flexibility measured by box sit-and-reach test • Back extensors: dynamometer held at 50% maximum strength until to failure	• **Hook-lying position** (resting and abdominal drawing-in maneuver): • LBP Group: - Significantly lower CSA of left TrA - Decreased thickness of left LM at rest, right LM during contraction (p<0.001) - Significantly decreased mean thickness/CSA of bilateral TrA & LM in all 4 positions (p<0.05) - Significantly decreased endurance time (p<0.016) • No significant difference in HS flexibility or max strength of back extensors between groups	• Decreased thickness in TrA, CSA of LM in LBP group • Decreased back muscle endurance in LBP group
Van Hoof et al., 2011	Male competitive cyclist; cycled 5 days/week for average distance of 400 km/week; 6 years of cycling experience	1	• Lumbo-pelvic angle • Pain • Sitting comfort level	• 2-hour outdoor cycling task on personal race bicycle before and after CFT intervention	• Total lumbo-pelvic flexion improved from 82.2% to 56.6% with CFT intervention (p<0.001) • Pain reduced with from 7/10 during task to 0/10 after task (p=0.001)	• CFT intervention, including biofeedback can: - Change lumbo-pelvic positioning - Reduce LBP during cycling

Abbreviations: Avg. = average, CFT = cognitive functional therapy, CSA = cross-sectional area, ECR = extensor carpi radialis, EMG = electromyography, HS = hamstring, LBP = low back pain, LE = lower extremity, LM = lumbar multifidi, MPF = mean power frequency, MVC = maximum voluntary contraction, RBG = Rehabilitation Bioengineering Group Pain Scale, SD = standard deviation, sEMG = surface electromyography, TrA = transverse abdominis, UE = upper extremity

CONCLUSIONS

- Direct pathomechanics of overuse low back pain in cyclists have yet to be elicited.
- The prevailing relationship stemming from this review is that spinal and core muscle activation imbalances in a prolonged flexed posture associated with cycling may lead to altered spinal kinematics contributing to overuse low back pain.

RECOMMENDATIONS FOR FUTURE RESEARCH

- Address the role of specific muscle activation imbalances in overuse low back pain in cyclists as the possible primary causal factor.
  - Lumbar multifidi, transversus abdominus, internal and external obliques, and erector spinae.
    - Further EMG studies between low back pain and control group.
- Correcting muscle imbalances and motor control while cycling through individualized biofeedback, internal and external cuing to determine relationship between motor control and spinal kinematics.
- Intervention studies that specifically target muscle imbalances and fatigue in cyclists with LBP are needed to determine if decreasing these impairments will decrease LBP.

LIMITATIONS

- Small sample sizes (only 3 studies where n > 30).
- Several measurement techniques (EMG, MVC, VAS, RBG).
- Populations (all male; trained/untrained).
- Varying areas of study focus (pain, ROM, bicycle design).
- Methodological differences between studies.

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