Topic: Biomechanical differences in children who are obese and those of normal weight.

Author	Purpose/ Subjects	Measurement	Outcomes	Limitations/Conclusions
McMillan (2010)	Purpose: To investigate the frontal and sagittal plane lower extremity biomechanics during drop jump landings in boys who were obese and boys who were of healthy weight.[1(p. 34)] Subjects: 12 males subjects, ages 10-12 yo[1(p. 35)] • Healthy Weight (HW) group (n=6): BMI = 16.8 (3.5) • Obese (OB) group (n=6): BMI = 40.5 (10.4)	Kinematic data collected using a motion analysis system and force data obtained with the use of a force plate.[(p. 35)] Subjects started in standing on a 6-inch platform with their right leg extended out in front of them above the force plate. They were then instructed to drop and land on 2 feet with only the right foot landing on the force platform.[1 (p. 35,36)]	Initial Contact: • OB landed in significantly more **knee valgus** than HW who landed in a slight varus position. • OB landed in significantly more **hip adduction**, HW landed in a slightly hip abduction position. • Frontal plane rearfoot position and sagittal plane rearfoot, knee, and hip position were not significantly different.[1(p. 36)] Significant differences were found for the timing of peak dorsiflexion and knee flexion, with the OB reaching **peaks later in the landing phase**. Overall, the OB group landed in and maintained a more **abducted knee** and **adducted hip** throughout the landing	Limitations: Drop height (6 in.) may not have been challenging enough to elicit significant differences in the measurement variables. Accurate placement of the motion analysis markers is more difficult with OB individuals because it's more difficult to locate bony prominences. Also, soft tissue movement with a jumping task may have altered the markers' placement. Small group size Conclusions: Children who are OB have significant differences in frontal and sagittal plane biomechanics when landing from a jump compared with children who are HW. These biomechanical differences could place children who are OB at greater risk for knee injuries when they engage in

			phase. Total excursion measurements were similar in both groups for all joints in both the sagittal and frontal planes.[1(p. 37)] Significant differences in timing of peak extension moment, timing of peak hip abduction moment, and peak abduction moment.[1(p. 37)] With the *exception of hip abduction*, the HW and OB group had **similar peak moments** in the sagittal and frontal plane.[1(p. 37)] The OB group **reached these peak moments later** in the landing phase.[1(p. 38)]	jump landing activities.[1 (p. 40)]

McMillan (2010)	Purpose: To compare frontal plane lower extremity biomechanics during walking in adolescent boys who were overweight (OW) versus healthy weight (HW).[2 (p. 187)] Subjects: 14 male subjects, ages 10-12 yo[2 (p. 188)] • Healthy Weight (HW) group (n=7): BMI = 17.0 (3.3) • Obese (OW) group (n=7): BMI = 40.5 (10.0)	Gait analysis Kinematic data collected using a 6-camera Qualysis Motion Analysis System[2(p. 188)] Subjects instructed to walk at normal pace. [(p. 189)]	No significant difference in gait velocity between groups. Kinematics: Significant group differences in timing of peak rearfoot eversion motion, amplitude of peak knee adduction and peak knee abduction motion, and timing of peak hip adduction motion. The OW group maintained **rearfoot inversion** and **knee abduction (valgus)** throughout stance, and maintained greater **hip adduction** throughout stance compared with boys who were HW. **Greater total excursion** in frontal plane motions in OW group. Significant group differences were found in timing of peak rearfoot inversion moment, timing of peak knee ad/abduction moment during later	Limitations: Small group size Only males included in the study reduces generalizability of the results The use of only right side data underestimates the effect of asymmetry or leg dominance. Conclusions: These results provide evidence that children and adolescents who are OW may not have typical frontal plane biomechanics during gait, and may be predisposed to lower extremity soft tissue and bony injuries.[2(p. 192)]

			stance, amplitude of peak hip abduction moments both in early and late stance, and timing of the later hip abduction moment peak. Kinetics: Higher rearfoot eversion moments in the OW group just after initial contact and at pushoff, though these differences were not significant. Knee moments were most disparate between groups at these same transition points, with boys who were OW **exhibiting peak knee adduction moments** versus abduction moments in HW boys. **Hip abduction moments were higher** in boys who were OW throughout stance, except at the moment of pushoff. [2(p. 189)]	

Schultz (2010)	Purpose: To determine if significant differences exist in the lower extremity joint powers across all planes in obese and normal-weight children during self- selected (SSP) and fast (FP) walking cadences.[3 (p. 248)] Subjects: 28 children, ages 8-12 yo[3(p. 248,249)] • Normal weight (NW) group (n=14): BMI = 17.03±1.26 • Obese (OW) group (n=14): BMI = 29.74±4.91	Three-dimensional kinematic and kinetic measures. 3D-motion analysis was conducted for 5 trials of barefoot walking at self-selected and 30% greater than self-selected cadences. [3 (p. 248)]	Hip joint power:[3 (p. 249,250)] Power Generation of Hip Extensor (H1-S) Moment: NW and OW had significantly greater joint power during FP than SSP, with **OW generating more power** during FP. Power Absorption of Hip Flexor (H2-S) Moment: OW displayed **greater power absorption** during FP. Power Generation of Hip Flexor (H3-S) Moment: Significant differences; **OB increased power generatio**n during FP. Power Absorption of Hip Abductor (H1-F) Moment: Significantly **greater power absorption** during FP and SSP in OW. Power Generation of Hip Abduction (H2-F) Moment: OW greater, but not significant during FP and SSP.	Limitations: No direct measures of physical activity (physical activity and fitness may play a role in locomotor strategies of obese children) Skin motion artifact Impact of trunk size on trunk and pelvis motion (authors accounted for body weight in attempt to diminish the impact of trunk size)[3 (App. A)] Conclusions: Body mass and walking cadence affect hip, knee, and ankle joint powers in all planes and could place increased demands on locomotion with negative implications on children's gait.[3 (p. 250)] Obese children require larger sagittal plane joint powers to control the trunk and prevent the collapse of the lower limb, while promoting locomotion through greater propulsion. The result may include greater difficulty performing locomotor tasks and decreased motivation to exercise.

			Knee Joint Power:[3(p. 250)] Power Absorption of Knee Extensor (K1-S) Moment: OW displayed **greater power absorption** at FP until body weight was a covariate. Power Generation of Knee Extensor (K2-S) Moment: OW **generated greater energy** at knee extensor (K2-S) moment phase for both SSP and FP, but not after adjusting for body weight. Power Absorption of Knee Extensor (K3-S) Moment: **greater joint powers at FP than SSP in the OW**. After accounting for body weight, no group differences remained. Power Absorption of Knee Abductor (K1-F) Moment: Significant group power and walking cadence differences were seen at the power absorption of knee abductor (K1-F)	Obese children also required greater frontal plane joint powers at the hip and knee to control external adductor moments during weight acceptance and to raise the pelvis quickly for adequate toe clearance. Greater mass and walking cadence create a gait cycle that requires more mechanical power.[3(p. 251)]

			phase and remained after accounting for body weight. Power Absorption of Knee Adductor (K2-F) Moment: No difference in group power or walking cadence Power Absorption of Knee Internal Rotator (K1-T) Moment: Significant differences did not remain after accounting for body weight. There were no significant differences in walking cadence at the K1-T phase. Ankle Joint Power:[3 (p. 250)] Power Absorption of Ankle Plantarflexor (A1-S) Moment: Significant differences for group, but not walking cadence, did not remain after accounting for body weight. Power Generation of Ankle Plantarflexor (A2-S) Moment: **OW had significantly greater**	

			joint powers during SSP and FP, however not after accounting for body weight. Power Generation of Ankle Plantarflexor (A2-S) Moment: There were no significant differences in walking cadence at the A2-S phase Power Absorption of Ankle External Rotator (A1-T) Moment: No differences in group or walking cadence	
Shultz (2009)	Purpose: To determine the influence of excess mass and walking cadence on the sagittal, frontal, and transverse plane biomechanics of the lower-extremity joints in overweight and normal weight children.[4 (p. 2150)] Subjects: 20 participants, ages 8-12 yo[4 (p. 2147)] • Normal weight (NW) group (n=10): BMI = 16.85±1.31 • Overweight (OW) group (n=10): BMI = 30.47±5.54	Sagittal, frontal, and transverse plane angular displacements (degrees) and peak moments (newton meters) at the hip, knee, and ankle joints.[4 (p. 2146)] 5-camera Vicon 460 motion analysis system[4 (p. 2147)]	Sagittal, frontal, and transverse plane joint kinematics were similar between groups; however, significant differences existed between walking cadences in the sagittal and frontal planes.[4(p. 2148)] The OW group had significantly greater hip flexor, extensor, abductor, and external rotator moments compared with the NW group. [4(p. 2148)]	Limitations: Because of the cross-sectional research design, this study was unable to establish the causal relationship between excess mass and gait biomechanics in children.[4(p. 2153)] Small sample size Skin motion artifact can induce measurement errors [4(p. 2153)] Conclusions: Increased absolute joint moments in the sagittal, frontal, and transverse planes for all lower-extremity joints in overweight

			The OW group had significantly greater knee flexor, extensor, abductor, adductor, and internal rotator moments compared with the NW group. [4(p. 2149)] The OW group had significantly greater ankle plantarflexor, inverter, external rotator, and internal rotator moments compared with the NW group. [4(p. 2149.2150)] There were significantly larger peak hip extensor and ankle inverter moments during FW compared with SW. The percent of increase in joint moments from SW to FW was not significantly different between OW and NW groups. [4(p. 2150)]	participants, regardless of walking cadence[4(p. 2153)] Increased joint forces can have long-term orthopedic implications and suggest a need for more nonweight-bearing activities within exercise prescription. [4(p. 2153)] Both OW and NW participants walked had larger peak joint moments in the hip and ankle during FW. However, the percentage of increase in joint moments between OW and NW participants was not significantly different during fast walking. [4(p. 2153)]

References:

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