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Effect of obesity on body Joint angles in female Children during walking

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Abstract

Obesity is one of the leading health complications in the world, one of the most serious public health challenges of the 21st century it effect on every system of human body, locomotory system. The present study is a quantitative study, which was designed to investigate the effect of obesity on different body joints in obese & non-obese females aged between 12-14 years. The whole sample consisted of 50 subjects with equal number of obese (50) and non-obese (50) females. The subjects were instructed to run across a pre-designed walkway at their maximum speeds. During this, they were filmed using high-resolution cameras. The criterion measures of interest were different joint angles of lower extermities. Conclusion: significant difference was found in selected body joint angles between obese and non-obese females of same age category. Obese female have higher joint angel than non obeses female in all selected joints angles.

The leading World Health Organization (W.H.O) considers obesity as one of the serious public health issues of the 21st century. Obesity may be defined as the accumulation of excess body fat. This definition may vary on the basis of region in many Western countries like USA, many European countries its defined by body mass index (BMI). The BMI is calculated by dividing the weight over the square of height. If the BMI is higher than 30 kg/m2 then it indicates the obesity. Under that range it is classified as overweight, average weight and underweight. In addition to normal activity in our daily life if someone is encouraged to participate in sports activities in children and adolescents has received considerable attention for combating the obesity epidemic. Obesity is known to be associated with biomechanical alterations in the gait pattern, which may predispose children and adolescents with overweight or obesity (OW/OB) to short- and long-term musculoskeletal disorders (MSKD). From early childhood, OW/OB has been associated to the development of various MSKD (i.e., musculoskeletal pain, injuries and fractures) which may be extended to adulthood with notable consequences with regard to physical disability, quality of life and healthcare economic costs. Among other suggested explanations, increased joint loads, together with biomechanical alterations during loco-motor tasks, may be underlying the higher prevalence of MSKD in this population.

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Furthermore, previous research has revealed that OW/OB show energetic inefficiency during running which could be partially explained by a biomechanically inefficient gait pattern.

The objective of the present study was to find the difference in walking between various joint angles of Obese and non obese subjects during intial stage, mid stance phase and toe of phase of walking

Methodology

A total 100 female children (50 obese & 50 non-obese) whose age ranges from 12-14 years were selected for the present study. After studying literatures related to the study and consultation with experts, following variables were selected for the present study. The subject's walking gait was recorded using two synchronized Legaria SF10 Cannon Camcorder. The specifications were full HD 1080, 8.1 Mega Pixels, 10x Optical Zoom, a shutter speed of 1/2000, Aperture value of maximum (F 1.8) and minimum (F8.0) and frame rate of 50 Hz. It also contains video compression format (MEEG/JPEG), having hard disk and USB cable to transport videos from the hard disk by connecting it to the computer. To analyze the clipped or slashed video recording of the running gait of school children, softwares; Xilisoft Video Converter Ultimate 6.0 and Silicon Coach Pro-7 were used. These motion analysis softwares provide to identify and quantify the angles, velocity, displacement, time, and number of frames of the selected biomechanical parameters of the study.

Table 1: Descriptive Statistics of Body Joint Angles during Initial Contact Phase

		N	Mean	S. D	S. E	95% Confidence Interval for Mean	
						Lower Bound	Upper Bound
Ankle joint Angle	Non- obese	50	112.10	1.40	.19	111.70	112.49
	Obese	50	124.52	2.90	.41	123.69	125.34
	Total	100	118.31	6.64	.66	116.99	119.62
Knee Joint angle	Non- obese	50	152.14	3.05	.43	151.27	153.00
	Obese	50	172.90	2.11	.29	172.29	173.50
	Total	100	162.52	10.75	1.07	160.38	164.65
Hip joint angle	Non- obese	50	144.46	2.74	.38	143.67	145.24
	Obese	50	153.82	2.71	.38	153.04	154.59
	Total	100	149.14	5.43	.54	148.06	150.21

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Table 1 reveals the means & Standard Deviation of 12-14 years Non-obese & Obese females aged 12-14 years for the selected kinematic parameters during the initial contact phase of walking gait. The the mean and Standard Deviation of Ankle Joint Angle of Non-obese girls was 112.10 ± 1.40 deg, and of Obese girls is 124.52 ± 2.90 deg. The mean and SD of Knee Joint Angle of Non-obese girls was 152.14 ± 3.05 deg, and of Obese girls was 172.90 ± 2.11 deg. The mean and SD of Hip Joint Angle of Non-obese girls was 144.46 ± 2.74 deg, and of Obese girls was 153.82 ± 2.71 deg.

Table 2: Descriptive analysis of the variance (ANOVA) of Body Joint Angles

		Sum of Squares	d.f	Mean Square	F	Sig.
Ankle joint Angle	Between the Groups	3856.41	1	3856.41	742.52	.001
	Within the Groups	508.98	98	5.19		
	Total	4365.39	99			
Knee Joint angle	Between the Groups	10774.44	1	10774.44	1560.77	.000
	Within the Groups	676.52	98	6.90		
	Total	11450.96	99			
Hip Joint Angle	Between the Groups	2190.24	1	2190.24	293.30	.003
	Within the Groups	731.80	98	7.46		
	Total	2922.04	99			

One-way analysis of the variance (ANOVA) was applied to check the difference in body joint angles (Ankle Joint, Knee Joint and Hip Joint) at Initial Contact Phase of walking gait, between Obese and Non-obese females aged (12-14) years. Table 4.8 shows that there was a significant difference in all the three joint angles i.e Ankle Joint, Knee Joint and Hip Joint Angle between Non-obese & obese females at the $p < 0.05$ level, ($F = 742.52$, $p = 0.00$) for Ankle Joint angle, for Knee joint angle ($F = 1560.77$, $p = 0.00$) and for Hip Joint angle ($F = 293.30$, $p = 0.00$). Therefore, results suggest that an Ankle Joint Angle, Knee Joint Angle, and Hip Joint Angle of Obese female is higher than Non- obese females of same age categor

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Table 3. Descriptive Statistics of Body Joint Angles during Mid Stance Phase during Mid Stance

		N	Mean	S. D	S. E	95% Confidence Interval for Mean	
						Lower Bound	Upper Bound
Ankle joint Angle (Degrees)	Non- obese	50	93.90	1.65	.23	93.42	94.37
	Obese	50	108.70	4.04	.57	107.54	109.85
	Total	100	101.30	8.04	.80	99.70	102.89
Knee Joint angle (Degrees)	Non- obese	50	135.02	3.06	.43	134.15	135.88
	Obese	50	154.28	1.88	.26	153.74	154.81
	Total	100	144.65	10.00	1.04	142.66	146.63
Hip Joint Angle (Degrees)	Non- obese	50	155.34	2.86	.40	154.52	156.15
	Obese	50	164.32	2.74	.38	163.54	165.09
	Total	100	159.83	5.30	.53	158.77	160.88

Table 3 shows the means and SD of 12-14 years Non-obese & Obese subject was aged 12-14 years for the selected kinematic variables during Mid-stance phase of walking gait in which the mean and SD of Ankle Joint Angle of Non-obese subject was 93.90 ± 1.65 deg, and of Obese subject was 108.70 ± 4.04 deg. The mean and SD of Knee Joint Angle of Non-obese subject was 135.02 ± 3.06 deg, and of Obese subject was 154.28 ± 1.88 deg. The mean and standard deviation of Hip Joint Angle of Non-obese subject was 155.34 ± 2.86 deg, and of Obese subject was 164.32 ± 2.74 deg.

Table 4: Analysis of variances (ANOVA)) of Body Joint Angles

		Sum of Squares	df	Mean Square	F	Sig.
Ankle joint angle	Between the groups	5476.00	1	5476.00	572.73	.003
	Within the groups	937.00	98	9.56		
	Total	6413.00	99			
Knee Joint angle	Between the groups	9273.69	1	9273.69	1435.60	.005

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	Within the groups	633.06	98	6.46		
	Total	9906.75	99			
Hip Joint Angle	Between the groups	2016.01	1	2016.01	255.88	.010
	Within the groups	772.10	98	7.87		
	Total	2788.11	99			

One-way analysis of the variance (ANOVA) was applied was to investigate the difference in body joint angles (Ankle Joint, Knee Joint and Hip Joint) at Mid-stance Phase of walking gait, between Obese and Non-obese females aged (12-14) years. Results of table 4.10 reveal that there was a statistically significant difference in all the three joint angles i.e Ankle Joint Angle, Knee Joint Angle & Hip Joint Angle between Non-obese & obese females at the $p < 0.05$ level, ($F = 572.73$, $p = 0.00$) for Ankle Joint angle for Knee joint angle ($F = 1435.60$, $p = 0.00$) and for Hip Joint angle ($F = 255.88$, $p = 0.00$). Therefore, results suggest that an Ankle Joint Angle, Knee Joint Angle & Hip Joint Angle of Obese female is higher than Non- obese females of same age category.

Table 5: Descriptive Statistics of Body joint angles Toe Off Phase

		N	Mean	S D	S. E	95% Confidence Interval for Mean	
						Lower Bound	Upper Bound
Ankle joint Angle (Degrees	Non-obese	50	142.86	2.39	.33	142.18	143.53
	Obese	50	152.36	2.67	.37	151.59	153.12
	Total	100	147.61	5.40	.54	146.53	148.68
Knee Joint angle (Degrees	Non-obese	50	154.16	3.22	.45	153.24	155.07
	Obese	50	172.04	1.42	.20	171.63	172.44
	Total	100	163.10	9.32196	.93	161.25	164.94
Hip Joint Angle (Degree	Non-obese	50	165.04	2.41560	.34	164.35	165.72
	Obese	50	173.76	2.60737	.36	173.01	174.50
	Total	100	169.40	5.04525	.50	168.39	170.40

Table 5 presents the means and SD of 12-14 years Non-obese & Obese females aged 12-14 years for the selected kinematic parameters during Toe-Off phase of walking gait in which

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the mean and SD of Ankle Joint Angle of Non-obese girls is 142.86 ± 2.39 deg, and of Obese girls is152.36 ± 2.67 deg. The mean and standard deviation of Knee Joint Angle of Non-obese girls is 154.16 ± 3.22 deg, and of Obese girls was 172.04 ± 1.44 degree. The mean and Standard deviation of Hip Joint Angle of Non-obese girls was 165.04 ± 2.42 deg, and of Obese girls is 173.76 ± 2.60 deg.

Table 6: Analysis of the variance (ANOVA) Summary of Body Joint Angles

		Sum of Squares	df	Mean Square	F	Sig.
Ankle joint Angle (Degrees)	Between the groups	2256.25	1	2256.25	350.11	.050
	Within the groups	631.54	98	6.44		
	Total	2887.79	99			
Knee Joint angle (Degrees)	Between the groups	7992.36	1	7992.36	1282.6	.040
	Within the groups	610.64	98	6.23		
	Total	8603.00	99			
Hip Joint Angle (Degrees)	Between the groups	1900.96	1	1900.96	300.94	.003
	Within the groups	619.040	98	6.31		
	Total	2520.00	99			

One-way analysis of the variance (ANOVA) was applied to check the difference in body joint angles (Ankle Joint, Knee Joint, and Hip Joint) at Toe-Off Phase of walking gait, between Obese and Non-obese females aged (12-14) years. Results of table 4.11 shows that there was a statistically significant difference in all the three joint angles i.e Ankle Joint Angle, Knee Joint Angle, and Hip Joint angle between Non-obese & obese females at the $p < 0.05$ level, ($F = 350.16$, $p = 0.00$) for ankle joint angle, for knee joint angle ($F = 1282.67$, $p = 0.00$) and for hip Joint angle ($F = 300.94$, $p = 0.00$). Therefore, results suggest that an ankle Joint angle, knee Joint angle & Hip Joint Angl

Results

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Initial Contact Phase of Gait Cycle

S. No	Variables	Result	Description of results
1	**Ankle Joint Angle (Deg^{o})**	Significant difference was seen in Ankle Joint Angle between non-obese & obese females	the Ankle Joint Angle of obese females is higher than non- obese females of same age category.
2	**Knee Joint angle measured in Degre^{e}**	statistically significant difference in Knee Joint Angle between non-obese & obese females	Obese females has higher knee joint angle than non- obese females of same age category.
3	**Hip Joint angle measured in Degre^{e}**	statistically significant difference in Hip Joint Angle between non-obese & obese females	Obese females has higher hip joint angle than non- obese females of same age category.

At Mid-Stance Phase of gait cycle

S. No	Variables	Result	Description of results
1	**Ankle Joint Angle (Deg^{o})**	Statistically significant difference was seen in Ankle Joint Angle between non-obese & obese females	The ankle Joint Angle of obese females is higher than non- obese females of same age category.
2	**Knee Joint Angle measured in Degre^{e}**	statistically significant difference in Knee Joint Angle between non-obese & obese females	the Knee Joint Angle of obese females is higher than non- obese females of same age category.
3	**Hip Joint Angle measured in Degre^{e}**	statistically significant difference in Hip Joint Angle between non-obese & obese females	Obese females has higher hip joint angle than non- obese females of same age category.

At Toe Off Phase

S. No	Variables	Result	Description of results
1	**Ankle Joint Angle measured in Degre^{e}**	statistically significant difference in Ankle Joint Angle between non-obese & obese females	The ankle Joint Angle of obese females is higher than non- obese females of same age category.
2	**Knee Joint Angle (Deg^{0})**	statistically significant difference in Knee Joint	Obese females has higher Knee joint angle than non- obese females

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		Angle between non-obese & obese females	of same age category.
3	**Hip Joint Angle (Deg^{o})**	statistically significant difference in Hip Joint Angle between non-obese & obese females	At Hip Joint the Angle of obese females is higher than non- obese females of same age category.

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