Journal of Exercise Science & Physiotherapy Vol.19 No.1 (January - June) 2023
I2OR Impact Factor = 7.505 ISSN: 0973-2020 (Print) ISSN: 2454-6089 (Online)

JOURNAL OF EXERCISE SCIENCE AND PHYSIOTHERAPY
Indexed, Peer Reviewed, Referred

A Study of Body Mass Index & Waist-to-Hip Ratio of Male & Female Athletes

Kuldeep Singh and Ashok Kumar

Abstract

Aim: The aim of the study was to observe body mass index and waist-to-hip ratio of male & female athletes.**Materials and Methods**:The present study was conducted on 10 female athletes of different events of athletics (Group 1), 14 male wrestlers of different weight categories(Group 2) and 19 male football players (Group 3) and their age ranged from 12-28 years.**Results**: It was found that there was a statistical significant difference of age ($F = 32.68$, $p < .001$), height ($F = 6.96$, $p = .003$), weight ($F = 15.89$, $p < .001$), hip circumference ($F = 6.54$, $p = .003$), waist Circumference ($F = 6.61$, $p = .003$), and BMI ($F = 13.618$, $p < .001$). **Conclusion**: It was concluded that the mean waist circumference, WHR and BMI of female athletes (group1), male wrestlers (group2) and male football players (group 3) were normal as per WHO Expert Consultation on Obesity and NHLBI Obesity Education Initiative. Further, it was found that wrestlers (group 2) having higher mean body weight, hip circumference, waist circumference and BMI than athletes and football players (group 1 and group 3).

Kuldeep Singh
M.Sc. Sports Science Student
Department of Sports Science
Punjabi University Patiala (Punjab), India.
Ashok Kumar
Professor
Department of Sports Science
Punjabi University Patiala (Punjab), India.
E-mail: ashokpup@pbi.ac.in

Key words: Athlete, BMI, WHR, Football, Wrestler
DOI: 10.18376/jesp/2023/v19/i1/221100

Introduction

The 1997 WHO Expert Consultation on Obesity recognized the importance of abdominal fat mass (referred to as abdominal, central or visceral obesity), which can vary considerably within a narrow range of total body fat and body mass index (BMI). It also highlighted the need for other indicators to complement the measurement of BMI, to identify individuals at increased risk of obesity-related morbidity due to accumulation of abdominal fat (WHO, 2000a). Waist–hip ratio (i.e. the waist circumference divided by the hip circumference) was suggested as an additional measure of body fat distribution. The ratio can be measured more precisely than skin folds, and it provides an index

of both subcutaneous and intra- abdominal adipose tissue (Bjorntorp, 1987). The suggestion for the use of proxy anthropometric indicators arose from a 12-year follow-up of middle-aged men, which showed that abdominal obesity (measured as waist–hip ratio) was associated with an increased risk of myocardial infarction, stroke and premature death, whereas these diseases were not associated with measures of generalized obesity such as BMI (Larsson et al., 1984). In women, BMI was associated with increased risk of these diseases; however, waist–hip ratio appeared to be a stronger independent risk factor than BMI (Lapidus et al., 1984). The 2002 WHO Expert Consultation on Appropriate Body Mass Index for Asian Populations and Its Implications for Policy and Intervention Strategies (WHO, 2004) reviewed the issue of ethnic differences in the meaning of BMI cut-off values. In populations with a predisposition to central (i.e. abdominal or visceral) obesity and the related increased risk of developing metabolic syndrome, the consultation recommended that, where possible, waist circumference should be used to refine action levels based on BMI. For example, levels based on BMI might be increased by one level if the waist circumference were elevated above a specified level. The choice of the action level for waist circumference should be based on population-specific data and health considerations. An expert working group was formed by the 2002 consultation, to start examining data on the relation between waist circumference and morbidity, and on any association between BMI, waist circumference and health risk. The aim was to develop recommendations for using waist measurements to further define risks (WHO, 2004). Both generalized and abdominal obesity are associated with increased risk of morbidity and mortality. The main cause of obesity-related deaths is CVD, for which abdominal obesity is a predisposing factor (WHO, 2008). BMI has traditionally been the chosen indicator by which to measure body size and composition, and to diagnose underweight and overweight. However, alternative measures that reflect abdominal adiposity, such as waist circumference, waist–hip ratio and waist– height ratio, have been suggested as being superior to BMI in predicting CVD risk. This is based largely on the rationale that increased visceral adipose tissue is associated with a range of metabolic abnormalities, including decreased glucose tolerance, reduced insulin sensitivity and adverse lipid profiles, which are risk factors for type 2 diabetes and CVD (WHO,2008).

Materials and Methods

The present study was conducted on 10 female athletes of different events of athletics, 14 male wrestlers of different weight categories and 19 male football players of Punjabi University Patiala and their age ranged from 12-28 years after obtaining their consent. The subjects were divided into following different groups.

Group(s)	Game(s)	Sex	Number of Subjects
Group 1	Athletics	Female	10
Group 2	Wrestling	Male	14
Group 3	Football	Male	19

The waist circumference was measured at the midpoint between the lower margin of the least palpable rib and the top of the iliac crest, using a stretch-resistant tape. The hip circumference was measured around the widest portion of the buttocks, with the tape parallel to the floor. For both measurements, the subject was stood with feet close together, arms at the side and body weight evenly distributed, and was worn little clothing. The subject was relaxed, and the measurements were taken at the end of a normal expiration (Westat inc, 1998). All the measurements made after the subjects were fasted overnight or were in a fasted state in the morning (Gibson 1990). Each measurement was repeated twice; if the measurements were within 1 cm of one another, the average

was calculated. If the difference between the two measurements exceeded 1 cm, the two measurements were repeated (Westat inc, 1998).

Results and Discussion

The mean age of group 1, group 2 and group 3 was 21.40± 3.53 year, 16.07±2.36 year, and 13.84 ±1.57year. The mean height of group 1, group 2 and group 3 was 161.79±5.49cm, 168.28±10.68 cm and 154.31±12.51cm.The mean weight of group 1, group 2 and group 3 was 51.99±6.05 kg, 71.57 ±16.47 kg, and 45.05 ±13.85 kg. The mean hip circumference of group 1, group 2 and group 3 was 34.55±1.51 cm, 37.00±4.15cm and 32.36±3.97cm.The mean waist circumference of group 1, group 2 and group 3 was 28.14±1.86cm, 31.50±3.67 cm and 26.89±4.22 cm.

The mean WHR of group 1, group 2 and group 3 was 0.82 ±.03, 0.88±.12 and 0.82±.04.The mean body mass index of group 1, group 2 and group 3 was 19.65±2.05 kg/m, 25.01±3.70kg/m and 18.57±4.11 kg/m (Table 1). The maximum mean age (21.40 year) was found in group1 (athletics), and height (168.28cm), weight (71.57 kg), hip circumference (37cm), waist circumference (31.50cm), waist-to-hip ratio (WHR) (.88) and body mass index (BMI) (25.01 kg/m^2) was found in group2 (wrestling) (Table1).The minimum mean age (13.84year), height(154.31cm), weight (45.05kg), hip circumference (32.36cm),waist circumference (26.89cm), body mass index (BMI) (18.57 kg/m^2) was found in group3 (football) and waist-to-hip ratio (WHR) (.82) in group1 (athletics) & group3 (football) respectively (Table 1).

Table 1. Mean± SD of Age, height, weight, hip circumference, waist circumference, WHR & BMI of Athletes of different Games

	Group	N	Mean	Std. Deviation
Age (year)	1	10	21.40	3.53
	2	14	16.07	2.36
	3	19	13.84	1.57
Height (cm)	1	10	161.79	5.49
	2	14	168.28	10.68
	3	19	154.31	12.51
Weight (kg)	1	10	51.99	6.05
	2	14	71.57	16.47
	3	19	45.05	13.85
Hip Circumference (cm)	1	10	34.55	1.51
	2	14	37.00	4.15
	3	19	32.36	3.97
Waist Circumference (cm)	1	10	28.14	1.86
	2	14	31.50	3.67
	3	19	26.89	4.22
WHR	1	10	.82	.03
	2	14	.88	.12
	3	19	.82	.04
BMI (kg/m^2)	1	10	19.65	2.05
	2	14	25.01	3.70
	3	19	18.57	4.11

In the present study, the mean waist circumference, WHR and BMI of athletes of different groups were normal as per WHO Expert Consultation on Obesity (2000b) and NHLBI Obesity Education Initiative (2000). Changes in body weight and BMI are strongly related to changes in fat-free mass, and explain 54% of the variance in those changes (Forbes, 1999). While the associations between BMI and body fat are linear, the association with per cent body fat is curvilinear, with the slope steeper at lower BMIs than at higher BMIs (Welch & Sowers, 2000).

Table 2 shows ANOVA among age, height, weight, hip circumference, waist circumference, WHR & BMI of different groups. It was found that there was a statistical significant difference of age ($F = 32.68$, $p < .001$), height ($F = 6.96$, $p = .003$), weight ($F = 15.89$, $p < .001$), hip circumference ($F = 6.54$, $p = .003$), waist Circumference ($F = 6.61$, $p = .003$), and BMI ($F = 13.618$, $p < .001$).

Table 2. ANOVA of Age, height, weight, hip circumference, waist circumference, WHR & BMI among different groups

		Sum of Squares	Mean Square	F	Sig.
Age	Between Groups	375.58	187.79	32.68	<.001
	Within Groups	229.85	5.74		
Height	Between Groups	1591.66	795.83	6.96	.003
	Within Groups	4572.57	114.31		
Weight	Between Groups	5811.35	2905.67	15.89	<.001
	Within Groups	7314.38	182.86		
Hip Circumference	Between Groups	173.27	86.63	6.54	.003
	Within Groups	529.14	13.22		
Waist Circumference	Between Groups	174.86	87.43	6.61	.003
	Within Groups	528.54	13.21		
WHR	Between Groups	.03	.01	2.39	.104
	Within Groups	.25	.006		
BMI	Between Groups	355.08	177.54	13.61	<.001
	Within Groups	521.47	13.03		

Table 3 shows scheffe post-hoc multiple comparisons for age, weight, height, hip circumference, waist circumference, BMI, and WHR among different groups. It was found that there was a statistical significant difference of age between group 1 vs. group 2, group 1 vs. group 3 and group 2 vs. group 3. In other words, we can say that group 1 (athletics) having a higher mean age than the other two groups (wrestlers and football).For height, there was a statistical significant difference between group 2 vs. group 3. In other word, we can say that group 2 (wrestlers) having a higher mean height than the group 3(football). For weight, there was a statistical significant difference

between group 1 vs. group 2 and group 2 vs. group 3. In other word, we can say that group 2 (wrestlers) having a higher mean weight than the other two groups. For hip circumference and waist circumference, there was a statistical significant difference between groups 2 vs. group 3 that is group 2 having a higher mean hip and waist circumference than the group3 (football). For BMI, there was a statistical significant difference between group 1 vs. group 2 and group 2 vs. group 3, with group2 (wrestlers) having a higher mean BMI than the other two groups (athletics and football). For WHR, there was no statistical significant difference among different groups.

Table 3. Scheffe post-hoc multiple comparison of Age, weight, height, hip circumference, waist circumference, WHR & BMI

Dependent Variable	(I) Group	(J) Group	Mean Difference (I-J)	Sig.
Age	1	2	5.32*	<.001
		3	7.55*	<.001
	2	3	2.22*	.040
Height	1	2	6.48	.351
		3	7.48	.214
	2	3	13.96*	.003
Weight	1	2	19.58*	.005
		3	6.93	.430
	2	3	26.51*	<.001
Hip Circumference	1	2	2.45	.278
		3	2.18	.318
	2	3	4.63*	.003
Waist Circumference	1	2	3.36	.095
		3	1.24	.683
	2	3	4.60*	.004
WHR	1	2	.062	.180
		3	.009	.955
	2	3	.053	.181
BMI	1	2	5.36*	.004
		3	1.07	.750
	2	3	6.43*	<.001

*significant at the 0.05 level.

Conclusion

It was concluded that the mean waist circumference, WHR and BMI of female athletes (group1), male wrestlers (group2) and male football players (group 3) were normal as per WHO Expert Consultation on Obesity and NHLBI Obesity Education Initiative. Further, it was found that wrestlers (group 2) having higher mean body weight, hip circumference, waist circumference and BMI than athletes and football players (group 1 and group 3).

Acknowledgement
The author(s) thanks all the female athletes, male wrestlers and male football players who participated in the study.

References

Bjorntorp P. 1987. Fat cell distribution and metabolism. *Annals of the New York Academy of Sciences*, 1987, 499:66-72.

Forbes GB.1999. Longitudinal changes in adult fat-free mass: influence of body weight. American Journal of Clinical Nutrition, 1999, 70(6):1025-1031.

Ford ES, Mokdad AH, Giles WH.2003.Trends in waist circumference among U.S. adults. Obesity Research, 2003, 11(10):1223-1231.

Lapidus L, Bengtsson C, Larsson B et al.1984.Distribution of adipose tissue and risk of cardiovascular disease and death: a 12 year follow up of participants in the population study of women in Gothenburg, Sweden. *British Medical Journal*, 1984, 289(6454):1257-1261.

Larsson B, Svardsudd K, Welin L et al.1984.Abdominal adipose tissue distribution, obesity, and risk of cardiovascular disease and death: 13 year follow up of participants in the study of men born in 1913. *British Medical Journal*, 1984, 288(6428):1401-1404.

NHLBI Obesity Education Initiative.2000.*The practical guide: Identification, evaluation and treatment of overweight and obesity in adults*. National Institutes of Health (NIH Publication Number 00-4084),2000.

Welch GW, Sowers MR. 2000.The interrelationship between body topology and body composition varies with age among women. Journal of Nutrition, 2000, 130(9):2371-2377.

Westat Inc.1998. *National Health and Nutrition Examination Survey (NHANES) III.* National Center for Health Statistics (NCHS), Centers for Disease Control and Prevention (CDC), 1998.

WHO, 2000a.*Obesity: Preventing and managing the global epidemic. Report of a WHO Consultation (TRS 894)*. Geneva, World Health Organization (WHO), 2000a.

WHO, 2004.Appropriate body-mass index for Asian populations and its implications for policy and intervention strategies. *Lancet*, 2004, 363(9403):157-163.

WHO, 2008. *Report of a WHO Consultation - Waist Circumference and Waist-Hip Ratio*. Geneva, World Health Organization (WHO), 2008.

Conflict of Interest: None declared