

SUMMARY

In the present study, an attempt has been made to investigate the morphological characteristics of the elite Indian Track and Field athletes preparing for 2010 Commonwealth Games. The data have been collected on 246 athletes belonging to the different events of Track & Field. The data collected on 246 athletes were grouped under four major events such as running, jumping, throwing and other categories. Major events were further sub grouped as 100-m, 200-m and 400-m (Sprinters), 400-m and 800-m (middle distance runners), 3000-m, 5000-m and 10,000-m (long distance runners), long, high and triple (jumpers), Javelin, Hammer, Discus and Shot put (thrower), 20 Km walkers, Decathlons and Heptathlon (as other categories) .

A total of 30 anthropometric measurements were taken on each athlete by using standardized techniques and instruments. The morphological characteristics such as height(cm), sitting height (cm), height trochanterion(cm), weight and height – weight ratio, Ponderal index, body fat (% & Kg), lean body mass (% & Kg), muscle mass (% & Kg), bone mass (% & Kg) and somatotype were observed for each athlete.

. Somatotype ratings have been computed by the modified Carter method of somatotype (1976). The body composition has been studied from the total body fat, bone mass and muscle mass. Body fat was calculated by Brozek

(1963) equation, for which the body density was calculated by equation devised by Durnin and Womerslev (1974).

The morphological characteristics of each athlete in the first instance were compared within their own categories and later on with the Olympic counterpart. The results of the present study have been summarized under the following heads.

100-m sprinters (Men & Women)

Decimal Age (years)

Men and women 100-m sprinters of the present study are found to be approximately of the same age i.e. 23.11 and 22.98 years, respectively showing non significant differences statistically. When compared with Olympic counterpart, the present 100-m men and women sprinters are found in the same age range as shown by the different Olympic Sprinters of 100-m event.

Body Height (cm)

The comparison of mean body height of the present Indian men and women 100-m sprinters with that of their Olympic counterpart has shown that the present studied Indian 100-m men and women sprinters are shorter in their body height as compared to their Olympic counterpart. Indian women 100-m sprinters are approximately 1 to 3 cm shorter and men 100-m sprinters are 1 to 2 cm shorter than their Olympic counterpart. In the forthcoming Common Wealth Games, shorter height of the present Indian sprinters

can overcome by increasing the number of strides in a given time.

Sitting Height and Height Trochanterion (cm)

The present 100-m women sprinters have registered almost the same lengths of their upper and lower body portions. However, the present 100-m men sprinters have registered more length of legs as compared to their upper portion.

In order to have better performance in the forth coming CWG 2010, women sprinters should not gain weight or fat mass especially in the upper portion of the body so as to allow lower body portion to move fast.

Body Weight

Comparison with International data indicated that except for 1928 Olympic Games at Admestron , 100-m sprinters (both men and women) of all other Olympic Games are found to be heavier then the present studied 100-m men and women sprinters. Present studied Indian 100-m men and women sprinters are found to be lighter in their body weight and therefore it is suggested that they should gain more lean body mass so as to perform better in the forthcoming 2010 Common Wealth Games.

Height – Weight Ratio and Ponderal Index

Height – Weight ratio and Ponderal Index are the two different indicators to access the body size. Body size has the direct influence upon performance. The present Indian 100-m sprinters need to improve their height weight ratio and

Ponderal index as they are found heavier w.r.t. their body height.

Body Fat (% & Kg)

Indian 100-m men and women sprinters are found to have 1.5% and 8.4% respectively more values of fat as compared to their Olympic counterpart. Fat is the dead weight of the body and excess fat than the required level has negative relationship with performance. The values of sum of three skin folds (Triceps, Sub scapular and Suprailiac) is found to be significantly higher in the Indian 100-m sprinters (both men and women) as compared to their Olympic counterpart. It is suggested that Indian 100-m sprinters must reduce the body fat in order to perform better in the CWG- 2010.

Muscle Mass (%&KG)

In order to get the medal in the competitions like Olympic, Asian and Commonwealth Games, men and women athletes must have 55 to 60% and 50 to 55% of muscle mass, respectively. Present Indian 100-m sprinters, both men and women have been found to possess lower values of muscle mass not only as compared to the above given normative values but also as compared to their Olympic counterpart.

Lean Body Mass (%& KG)

100-m Sprinters both men and women of the present study need to improve their Lean Body Mass.

Somatotype

Somatotype characteristics of the present study 100-m **men** sprinters have revealed that they are found to be more in endomorphy, less in mesomorphy and almost same in ectomorphy component as compared to the Olympic **men** 100-m sprinters. However, Indian **women** 100-m sprinters though found almost same in endomorphy and ectomorphy components as that of their Olympic counterpart yet were less in the mesomorphy component.

Track Athlete 200-m (Men & Women)

Decimal Age (Years)

It has been observed that men and women 200-m sprinters of the present study have not differed in their Decimal Ages. When 200-m sprinters (men and women) were compared with Olympic counterpart, it has been found that they were less in their mean decimal ages as compared to their Olympic counterpart.

Body Height (cm)

There have been found to be non significant differences in the body height between the present studied 100-m and 200-m sprinters. However, 200-m sprinters (men & women) when compared with their Olympic counterpart showed that they were shorter in their height as compared to their Olympic counterpart.

Height plays important role in sprinting and the shorter height of the present 200-m sprinters may affect their performance.

Sitting Height & Height Trochanterion (cm)

As observed for 100-m women sprinters, 200-m women sprinters also possessed the same sizes of sitting height and height trochanterion showing that the upper and the lower portions of the body are of equal size. The mean values of height trochanterion of 100-m and 200-m **men** sprinters have shown non significant differences. However, **women** 100-m and 200-m sprinters have shown a difference of approximately 5 cm in the height trochanterion and this difference is found to be statistically significant. 200-m women sprinters have registered shorter height trochanterion as compared to 100-m women sprinters.

Body Weight (Kg)

There has been found to be approximately 20 Kgs differences in the body weight between the men and women 200-m sprinters of the present study. The present 200-m **men** sprinters when compared with their Olympic counterparts were found to be closer to their Olympic counterpart. However, present studied 200-m **women** sprinters were found to be less in their body weight as compared to their Olympic counterpart.

Body Fat (% & Kg)

It is found that **men** 200-m sprinters have 11.26% as their percent body fat and the same value for **women** 200-m sprinters is found to be 11.53%. The amount of sum of three

skin fold in the present studied 200-m **women** is significantly more than 100-m women sprinters. However, the value of sum of three skin fold in case of 100-m and 200-m **men** sprinters are found to be same and t-value has also given non significant differences statistically.

Muscle Mass (% & Kg)

The values of muscle mass in (%) have been found as 50.61 and 45.35 in case of 200-m men and women sprinters, respectively. This amount of muscle mass is found to be less as per the requirement.

Lean Body Mass (% & Kg)

Women and Men 200-m sprinters of the present study when compared with their Olympic counterparts were found to possess approximately 9 Kg & 2 Kg less amount of Lean Body Mass, respectively. In order to improve performance, the present Indian 200-m sprinters are required to develop more Lean Body Mass.

Bone Mass (% & Kg)

Amount of Bone Mass present in the **women** 200-m sprinters of the present study is towards lower side. This may be due to their significantly short height.

Somatotype

Indian 200-m Sprinters both men and women are found to be comparatively more in Endomorphy, low in Mesomorphy and less in Ectomorphy component as compared to their Olympic counterparts. It is suggested that somatotype ratings should be brought into the desirable circle so as to better performance

400-m Sprinters (Men & Women)

Decimal Age (years)

Present 400-m men sprinters are found 2.5 years younger than their men 400-m Olympic counterpart. Present 400-m **women** sprinters are found to be close to their Olympic counterpart in their mean decimal age. Among 100-m, 200-m and 400-m sprinters, 100-m **men** and 400-m **women** sprinters are found to be the oldest in age.

Body Height (cm)

Present studied 400-m men and women sprinters are found to be shorter as compared to their Olympic counterpart. India needs taller sprinters as body height plays important role in sprinting.

Sitting Height and Height Trochanterion (cm)

There are found to be significant differences in the sitting height and height trochanterion between men and women 400-m sprinters. It is important to mention here that among 100-m, 200-m and 400-m sprinters of the present study, only the 400-m sprinters (both men and women) are found to have significant differences in the upper and lower portions of the body. This is very important finding and it further substantiate the fact that why 400-m women and men sprinters have performed better in the major competition as compared to 100-m and 200-m men and women sprinters.

Body Weight (Kg)

400-m Women sprinters when compared with their Olympic counterpart were found to be closer to the values of body weight as possessed by them. However, the same has not been found in the 400-m **men** sprinters. The men 400-m sprinters of the present study are found to be lighter in their body weight as compared to their Olympic counterpart. Present findings suggest that 400-m men sprinters are required to gain more weight due to muscle mass or the lean body mass.

Height – Weight Ratio

Height – Weight Ratio of **men** 400-m sprinters have indicated that they are more lean as compared to their Olympic counterpart. However, the present 400-m **women** sprinters are found to be fatty as compared to their Olympic counterpart. It is therefore suggested that men sprinters of the present study should increase body weight due to muscle mass or lean body mass whereas women 400-m sprinters are required to decrease their body weight (fat mass) in order to have desirable level of Height – Weight ratio.

Fat (% & Kg)

The present studied 400-m **men** sprinters have observed with 11.58% as their body fat whereas the same value for women 400-m sprinters is found to be 19.51%. Available International data indicates that Indian **men** 400-m sprinters has approximately 1.5% more values of body fat as compared to their Olympic counterpart. Amount of fat

present in the **women** 400-m sprinters is much higher than Olympic counterpart.

Sum of three Skinfolts (mm)

The amount of sum of three skin folds present in the women 400-m sprinters of the present study is significantly higher than their Olympic counterpart.

Lean Body Mass (% & Kg)

The lean body mass when calculated in percentage, showed almost the same values i.e. 88.42 and 88.49% in men and women 400-m sprinters. However, when the lean body mass was calculated in Kg, it was found that the men 400-m sprinters were found to have 60.01 Kg as their lean body mass whereas the same value in case of women sprinters was 44.58 Kg. It is therefore suggested, that any anthropometric variable calculated in percentage should also be calculated in Kg so as to have correct picture of that variable.

The amount of lean body mass (in Kg) possessed by Indian men 400-m sprinters was compared with their Olympic counterpart and it has been found that Indian men 400-m sprinters have registered almost 5 Kg less amount of lean body mass as compared to their Olympic counterpart. Performance of sprinting depends upon good amount of lean body mass. The present 400-m sprinters (men & women) need to develop more lean body mass in order to perform better in the forthcoming 2010 Common Wealth Games.

Muscle Mass (% & Kg)

The amount of muscle mass present in the 400-m men and women sprinters is 51.23% (34.88 Kg) and 46.10% (25.58 Kg) respectively. These values depict that the amount of muscle mass present in men and women 400-m sprinters of the present study is less as compared to the required level.

Bone Mass (% & Kg)

It has been found that the **women** 400-m sprinters possessed 8 Kgs of bone mass whereas the same amount for 400-m **men** sprinters is 11.14 Kg. The present study has revealed that the amount of bone mass in Kg and Percentage among 100, 200 and 400-m sprinters decreases with increases in distance.

Somatotype

It has been observed that the mean somatotype of 400-m **men** sprinters has been found as 1.92 – 4.26 – 3.03. In case of 400-m **women** sprinters, the mean somatotype value has been observed as 2.33 – 3.45 and 2.86. However, when present somatotype values of 400-m sprinters (both men and women) have been compared with their Olympic counterpart, it has been found that not like Indian women, Olympic level, 400-m women have been found to be more ectomorphy as compared to their men 400-m counterpart. Indian men 400-m sprinters are found to be more endomorphy less mesomorphy and low in ectomorphy component as compared to their Olympic counterpart.

Middle Distance Runners 800-m and 1500-m

Decimal Age (Years)

The 800-m men runners are found to be significantly younger in age as compared to 1500-m **men** runners. In case of **women** also 800-m **women** runners are found to be younger in age as compared to 1500-m **women** runners. When compared with their Olympic counterpart, it has further been found that the present 800-m **men** runners are younger in age as compared to their Olympic counterpart also. However, the 800-m **women** runners are found to be closer to the values of mean decimal age as possessed by Olympic level 800-m women runners.

In case of 1500-m runners, it has been found that 1500-m **men** runners are found to be closer to the values as possessed by the Olympic counterpart but present Indian 1500-m **women** runners are found older than their Olympic counterpart.

Body Height (cm)

800-m and 1500-m runners (both men and women) of the present study are found shorter in their mean body height as compared to their Olympic counterparts. The difference is more than 5 cm in both the cases.

Sitting Height & Height Trochanterion (cm)

Present **women** runners of 800-m and 1500-m are found to possess more values of sitting height (i.e. more length of upper part of the body). However, in case of **men**

runners of 800-m and 1500-m, they are found to have more values of height trochanterion as compared to upper portion.

Body Weight (Kg)

As evident from the findings of the present study, the Indian middle distance runners have to improve their body weight by improving muscle mass or the lean body mass as they are found lighter in their body weight.

Height Weight Ratio

It is important to mention that Height – Weight Ratio of the present studied men and women runners of 800-m and 1500-m are found to be in the desirable range. As Height Weight Ratio of the present studied middle distance runners is found in proper ratio therefore, it is suggested that without increasing weight, excess fat should be converted into the muscle mass.

Ponderal Index

In order to cross check whether the Indian middle distance runners possess the correct height weight ratio or not the Ponderal index was also calculated. Calculations of Ponderal index indicates that the Indian middle distance runners are lighter in their body weight as compared to their Olympic counterpart and have to develop more muscle mass.

Fat (% & Kg)

The amount of fat present in the 1500-m runners (men and women both) is more as compared to 800-m runners (men and women). While comparing this with International data, it has been found that the fat present in the Indian middle distance runners is quite high as compared to their

International counterpart. It is further suggested that the skin fold values in case of men and women runners of 800-m and 1500-m also need to be reduced so as to improve lean body mass.

Lean Body Mass (% & kg)

In case 800-m and 1500-m **men** runners, it has been found that they possess almost the same amount of lean body mass. However, in case of **women**, it has been found that the lean body mass (in % & Kg) has been found to be more in 800-m women runners as compared to 1500-m women runners. Practically the 1500-m women runners should have more value of lean body mass as compared to 800-m women.

Muscle Mass (% & Kg)

In muscle mass also 800-m **men** runners are found to possess more amounts of muscle mass as compared to 1500-m **men** runners. The present men and women runners of 1500-m have been found to possess less than 50% of the muscle mass in their body.

Bone Mass (% & Kg)

The amount of bone mass present in the 800-m & 1500-m **women** runners of the present is found to be on the lower side.

Somatotype

The present study has revealed that Indian 800-m and 1500-m **men** runners are more endomorphic, less mesomorphic than their Olympic counterpart. In case of **women**, it has been found that the present 800-m and 1500-

m women runners are found to be less ectomorphic and mesomorphic than their Olympic counterpart. It is suggested that the middle distance runners of the present study should train hard to obtain the desirable somatotype characteristics.

3,000-m, 5,000-m and 10,000-m Runners

Decimal Age (years)

Among 3000-m, 5000-m and 10000-m runners, 3000-m **men** and 5000-m **women** runners are found to be the oldest. However, when the present runners are compared with their Olympic counterpart it has been found that the Olympic level 10,000-m men runners are in the age bracket of 26 to 28 years, whereas the present studied 10000-m runners preparing for 2010 Commonwealth Games are just 22.6 years old.

Body Height (cm)

An increasing order of gradient in height has been observed as we move from 3000-m to 10000-m in case of men athletes. However, in case of women, 5000-m and 10000-m women runners have been found to possess almost the same mean height. However, when compared with their Olympic counterparts, it has been found that 3000-m and 5000-m men and women runners are found to be shorter in their height as compared to their Olympic counterpart. In case of men, 10,000-m men runners are found to be approximately 2 cm taller than their Olympic counterpart.

However, Indian 10000-m women runners are found 10 cm shorter than their Olympic counterpart.

Body Weight (Kg)

It is surprising that there is found to be an increasing order of gradient in the body weight from 3000-m to 5000-m and 5000-m to 10000-m runners in both the categories. 10000-m men runners of the present study are found to be 3 Kg heavier than their Olympic counterpart.

Height – Weight Ratio

In the present studied 3000-m (men), 5000-m (men and women) and 10000-m (men and women) none of the athlete has been found to possess the required value of Height – Weight Ratio. The value Of Height – Weight Ratio in case of 5000-m and 10000-m **women** has been found to be exactly the same.

Ponderal Index

When Ponderal Index of 3000-m, 5000-m and 10000-m runners were compared with their Olympic counterparts, it has been found that 3000-m, 5000-m and 10000-m **men** runners are found to be less in the value of Ponderal Index as compared to their Olympic Counterparts. Comparison of **women** runners could not be made with their Olympic counterpart due to the non availability of the data.

Fat Mass (% & Kg)

It is important to find that %age of body fat decrease in the **men** runners from 3000-m to 5000-m and then to 10000-m. However, when fat was calculated in Kg then it was found that the amount of fat in 5000-m **men** runners

was more than 3000-m men runners. In case of **women** long distance runners, the percentage of body fat in 10000-m runners has been found to be more than 5000-m runners. When compared with their Olympic counterparts, it has been found that present studied long distance runners are found to possess more fat as compared to their Olympic counterparts. Olympic level long distance runners are found to possess 5% to 7% as their body fat. However, in the present **men** runners amount of fat is found to be doubled and it is three times more in case of present **women** runners. The picture is same in case of sum of three skin folds, also.

Lean Body Mass (% & Kg)

In case of **men**, the Lean Body Mass has been found to increase from 3000-m to 5000-m and then to 10000-m respectively, in percentage and Kg both. However, same is not found in case of **women** runners of 5000-m and 10000-m. The 10000-m **women** runners are found to possess less Lean Body Mass as compared with 5000-m **women** runners. When present Indian runners are compared with their Olympic counterparts, it has been found that present Indian 3000-m men runners are found to have approximately 14 Kg less amount, 5000-m men runners have 9 Kg less amount and 10000-m men runners have 4 Kg less amount of Lean Body Mass as compared to their Olympic counterparts.

Muscle Mass (% & Kg)

The present 3000-m **men** runners have found to possess 45.83% of the Muscle Mass. The percentages of muscle mass in case of 5000-m and 10000-m **men** runners

have been found as 48.92 and 48.52 respectively. In case of **women**, 10000-m women runners have found to possess just 40.92% as Muscle Mass which is 4% less as possessed by the present studied 5000-m women runners.

Bone Mass (% & Kg)

It is highly surprising that 10000-m **men** runners of the present study have been found to have the highest amount of Bone Mass followed by 5000-m and 3000-m men runners respectively. Amount of Bone Mass should decrease with increasing distance and long distance runners are required to be lighter in their Bone Mass. However, the same is not found to be true in the presently studied men long distance runners.

Somatotype

The present study has revealed that the Somatotype characteristics of the present studied **men** long distance runners are in the desirable range. In them, the Endomorphic component decreases, Mesomorphic and Ectomorphic increases with increasing distance. This goes with the requirement of this event. However, only point is that 10000-m runners should develop significantly more Mesomorphic components as compared to 5000-m runners. While comparing them with Olympic counterparts, it has been noticed that Indian Long Distance Runners have to reduce their Endomorphic component.

20 Km. Walkers

Decimal Age (years)

The present studied 20 Km. Walkers are found to be younger in age as compared to their Olympic Counterparts. The difference in their mean decimal age is up to 5 years.

Body Height (Cm)

The men 20 Km Walkers are found up to 3 cm shorter in height as compared to their Olympic counterpart.

Sitting Height and Height Trochanterion (cm)

The present study has revealed that the Walkers of the present studied have been found to possess more values of the upper body as compared to the lower portion.

Body Weight (Kg)

Indian 20 Km men Walkers when compared with Olympic level Walkers then, it was found that they are 3 to 4 Kgs lighter in their Body Weight. Present Walkers have been found shorter in height also. Examination of Height Weight Ratio may give the exact status of body size of the present 20 Km. Walkers.

Height - Weight Ratio

Present 20 Km. men Walkers have been found to possess 11.98 ± 1.03 as their Ponderal Index value as against 13.22 ± 1.27 value of Olympic level 20 Km Walkers. This picture has revealed that Indian men walkers are found to be shorter in Height and less in body weight thereby showing lesser value of Ponderal index as compared to their Olympic counterpart.

Body Fat (% & Kg)

There has been found to exist highly significant differences in the amount of percentage of fat possessed by Indian and Olympic level 20 Km Walkers. Indian Walkers are found to have significantly higher amount of body fat as compared to their Olympic counterpart.

Sum of Three Skin fold (mm)

It is important to mention that the amount of fat in percentage was found to be significantly high in case of Indian Walkers but the value of Sum of three Skin fold has been found to be almost the same in the present and Olympic level Walkers. However, women 20 Km. Walkers need to reduce fat as it is on the higher side (18.90%).

Lean Body Mass (% & Kg)

20 Km. Walkers of the present study specially of women are observed to be less in their Lean Body Mass. In order to improve Lean Body Mass, Indian women 20 Km. Walkers should reduce body fat and convert it into Muscle Mass.

Muscle Mass (% & Kg)

The amount of Muscle Mass present in case of **men** Walkers is 50% and in case of **women** Walkers, it is just 40%. As mentioned earlier medal winning performance of the athlete requires Muscle Mass amount up to 55 to 60% for men and 45 to 50% for women.

Bone Mass (% & Kg)

Amount of Bone Mass (% & Kg) present in the men and women 20 Km. Walkers is in the desirable range.

Somatotype

On comparison with their Olympic counterpart it has been found that the men 20 Km. Walkers have been found to possess better Somatotype characteristics as compared to the women 20 Km. Walkers. In case of women 20 Km. Walkers, it has been found that they are quite less in the Mesomorphic component

Jumpers

(Long Jump, Triple Jump & High Jump)

Decimal Age (Years)

Among Indian Jumpers, High Jumpers both men and women are found to be oldest and men Long Jumpers and women Triple Jumpers are observed to be the youngest. However, when compared with their Olympic counterparts, it has been found that Indian men Long Jumpers are found to be approximately 3 years younger than their Olympic counterparts. In case of women, Indian women Long Jumpers are found to be older in age as compared to their Olympic counterpart. Triple Jumpers of India have been found closer to their Olympic counterparts in the mean decimal age. Indian men and women High Jumpers are found to be older in age as compared to their Olympic counterpart.

Body Height (cm)

Among Indian men Jumpers, the Triple Jumpers are found to be the tallest (179.83 cm) followed by High Jumpers

(176.12 cm) and the Long Jumpers (175.42cm). In case of Indian **women Jumpers**, it is found that Indian High Jumpers women is tallest followed by Triple Jumpers and Long Jumpers. Olympic data reveals that High Jumpers are tallest as compared to Triple Jumpers and the Long Jumpers. Individually when Long Jumpers both men and women were compared with their Olympic counterparts they have been found to be shorter in their Height.

Indian men Triple Jumpers are found to be little shorter in Height as compared to their Olympic counterpart but Indian women Triple Jumpers are found to be approximately 3 cm shorter in Height as compared to Olympic level athletes.

Indian men High Jumpers are found to be 10 cm shorter in Height as compared to their Olympic counterpart. In women also, Indian women High Jumpers are found to be less in their Height as compared to their Olympic counterpart.

Sitting Height and Height Trochanterion (cm)

Results have revealed that the value of Sitting Height is found to be the maximum in case of High Jumpers followed by Triple Jumpers and the Long Jumpers. The Indian **men** Long Jumpers have been found to possess almost the same values of Height Trochanterion and the Sitting Height. In case of **women** Jumpers, value of Sitting Height is found to be less than the Height Trochanterion.

Body Weight (kg)

Among Indian jumpers, **men** High Jumpers have been found to possess the lowest Body Weight followed by Triple

Jumpers and the Long Jumpers. In case of **women**, Long Jumpers women are found to be lowest in their Body Weight and High Jump women are found to be highest in their Body Weight. However, when the present Indian Jumpers (men and women) are compared with their Olympic counterpart, it has been found that **men** Long Jumpers are found to be heavier in their Body Weight and **women** Long Jumpers are lighter in their weight as compared to their Olympic counterparts. Men and women Triple Jumpers of the present study have also shown the same picture. However present men and women High Jumpers are found to be lesser in their Body Weight as compared to their Olympic counterpart.

Height – Weight Ratio

It has been found that the values of Height – Weight Ratio have been found to be the highest in High Jump (both men and women) followed by Triple Jumpers (only the men) and the Long Jumpers (only the men). Results have shown that the values of Height – Weight Ratio are more in the women Long Jumpers as compared to the Triple Jump women.

Overall picture of Height – Weight Ratio observed for Jumpers of the present study indicates that these values are on the lower side thereby indicating that the Indian jumpers have more body weight w.r.t. their body height.

Ponderal Index

The lowest value of Ponderal Index is found in case of the men and women High Jumpers. When Ponderal Index values of Indian Jumpers were compared with their Olympic

counterpart, it has been found that in none of the case, Indian Jumpers (either men or women) are found to have the values of the Ponderal index closer to their Olympic counterpart.

Fat (% & Kg)

Among **men** Jumpers highest percentage of fat is found in the High Jumpers. Among **women**, Triple Jump and Long Jump women have reported with almost the same amount of fat (%). When the comparison is made between the Indian and Olympic level Jumpers of different categories it is observed that Olympic level Long Jumpers (men and women) have been found to possess 8.2% and 14.1% of their body fat in comparison to the values as 10.15 and 17.34 respectively as possessed by Indian long Jumpers. These figures have clearly indicated that Indian Long Jumpers are found to be more fatty as compared to Olympic level Long Jumpers. When Indian High Jumpers and Triple Jumpers (men and women) were compared with their Olympic counterparts, it has been observed that Indian men and women Triple Jumpers especially the women are found to be doubled in their body fat as compared to Olympic level Triple Jumpers.

Sum of Three Skin folds (mm)

In men, the Sum of three Skin folds is found to be maximum in case of men High Jumpers i.e. (30.90 mm) followed by men Long Jumpers (20.65 mm) and men Triple Jumpers (17.0 mm). These values are found to be more as compared to Olympic level values except for the Triple Jump where Indian men Triple Jumpers have been reported to have

lesser value of Sum of three Skin folds as compared to their Olympic counterpart.

Lean Body Mass (% & Kg)

It has been found that Triple Jumper men have possessed highest amount of Lean Body Mass followed by Long Jump (men) and High Jump (men). Among **women**, all the three categories of Jumpers have found to possess almost the same amount of Lean Body Mass i.e. approximately 82%. However, when Lean Body Mass is calculated in Kg, it has been observed that High Jumper women have found to possess 51.85 Kg of Lean Body Mass followed by Triple Jump women (49.19 Kg) and Long Jump women (45.13 Kg). When comparison of Indian Jumpers has been made with their Olympic counterparts, it has been found that Indian Triple Jump and Long Jump (men) are found to have the required desirable range of Lean Body Mass, where as High Jumpers have been found to possess 17 Kg less amount of Lean Body Mass as compared to their Olympic counterpart. Further, it is good to mention that Indian Triple Jump **women** as that of Indian Triple and Long Jump men, too, are found in the desirable range of Lean Body Mass as that of their Olympic counterpart.

Muscle Mass (% & Kg)

The Indian men and women Triple Jumpers who have shown good amount of Lean Body Mass have shown 52.81 and 28.55% as their Muscle Masses respectively. This needs to be improved further so as to perform better.

Bone Mass (% & Kg)

Amount of Bone Mass present in the various categories of Jumpers, both men and women, has been found in the desirable range.

Somatotype

Triple Jump men have shown the Somatotype values even better than their Olympic counterpart. The mean Somatotype values of Indian men High Jumpers is found to be non satisfactory. In case of men and women Long Jumpers, the Somatotype rating has been found to be quite good.

Throwers

(Javelin, Hammer, Discus and Shotput)

Decimal Age (Years)

Among **men** Throwers, Hammer Throwers are the youngest (18.92 ± 4.22 years). The present studied Discus and Shot Put Throwers have been found to possess almost the same mean decimal ages i.e. 21.05 ± 2.70 and 21.81 ± 3.06 years respectively. These figures show that the present Throwers preparing for CWG 2010 are quite young in age. However, among women Throwers, it has been found that Discus Throwers are oldest followed by Javelin, Hammer and Shot Put throwers. While making comparison with their Olympic counterparts, it has been observed that the present men and women Javelin Throwers are found to be quite young in age as compared to their Olympic counterparts. The present Indian **men** Hammer Throwers are just 18.92

years old whereas men Hammer Throwers of Olympic level, ranges in age from 25 to 29 years. The present men Discus Throwers of India are found to be 21.15 years old whereas Olympic level men Throwers are 29.3 years old. The Indian Shot Put Throwers (both men and women) are also found to be quite less in their mean decimal age as compared to their Olympic counterparts.

Body Height (cm)

Present **men** Discus Throwers are found to be the tallest followed by Shot Put, Javelin and Hammer Throwers. Among women Throwers too, Discus Throwers have been found to be the tallest followed by Shot Put, Hammer and the Javelin Throwers. When compared with their Olympic counterparts, the Indian men and women Javelin Throwers are found to be quite short in their Height as compared to their Olympic counterparts. The differences in the mean body height between Indian and Olympic level women Javelin Throwers are found to be more than 10 cm. Indian men Hammer Throwers are also found to be approximately 7 cm shorter than their Olympic counterpart. Indian men Discus Throwers are found to 5 cm shorter than their Olympic counterpart. Only, the Indian women Discus Throwers have been found to be some how near to the Olympic value in their body height. In Shot Put also 8 to 10 cm differences in the body height is found between Indian and Olympic level Shot Put Throwers (in case of men and women both). As known that the proper body height has its own advantage in the throwing events. Therefore, shorter height of the present

Indian throwers may have disadvantageous effects on performance.

Sitting Height and Height Trochanterion (cm)

Among men Throwers, Shot Put Throwers have been observed with the maximum value of Sitting Height followed by men Discus, Javelin and Hammer Throwers, respectively. The value of Height Trochanterion is found to be the maximum in case of Discus men Throwers followed by Shot Put, Javelin and Hammer men Throwers. The lengths of upper and lower body parts in case of **men** Discus Throwers are found to be the same. However, other men Throwers such as Shot Put, Javelin and Hammer have been found to possess more length of upper portion as compared to the lower one. In case of **women** Throwers, it has been found that the maximum value of Sitting Height (i.e. the upper portion) is observed in Hammer Throwers followed by Discus, Shot Put and the Javelin Throwers. In throwers well developed upper portion with massive Thorax and wider biacromiale diameter act as a power house. In the present study except Discus men and women throwers, all other throwers have observed with bigger upper portions as compared to the lower ones.

Body Weight (kg)

Among men Throwers, Shot Put Throwers have been found to possess maximum Body Weight followed by Discus Throwers, Hammer Throwers and the Javelin Throwers, respectively, . When these weight values were compared with Olympic data, it has been found that the Indian men Javelin

Throwers have been found to be approximately 10 Kg less than their Olympic counterpart. In case of men Hammer Throwers, the difference is of 15 to 20 Kg. In case of Indian men Discus and Shot put Throwers, it has been found that Olympic level men Discus and Shot Put Throwers are heavier than the Indians. In case of present studied **women** Throwers, it has been found that the Shot Put Throwers have been found to possess maximum body weight (74.5 Kg) followed by Discus Throwers, (72.55 Kg) Hammer Throwers (71.2 Kg) and the Javelin Throwers (61.65 Kg). When compared with their Olympic counterparts, it has been observed that the present Indian **women** Throwers of all categories are found to be less in their Body Weight as compared to their Olympic counterparts.

Height – Weight Ratio

The Height – Weight Ratio in case of women Javelin Throwers is found as 40.36. When compared with their Olympic counterpart, it was found that they are less Lean as the value of Height Weight Ratio for Olympic level women Javelin Throwers is found to be 43.0. Indian Discus Throwers are found to be closer to the Olympic values of Height – Weight Ratio. The present Indian women Shot Put Throwers are also found to be less in their Height – Weight Ratio as compared to their Olympic counterpart. On the whole, it has been found that except Discus Throwers, other categories of the Throwers are not found in the desirable range as possessed by Olympic counterpart.

Ponderal Index

In Ponderal Index value, the Indian Javelin Throwers are found to be more bulky as compared to their Olympic counterparts. Men Hammer Throwers are found to possess more body weight with respect to their height. The Discus Throwers (both men and women) have also been found to possess more body weight with respect to their body height when compared with their Olympic counterpart, Ponderal Index values have also shown the same picture for Indian Shot Put Throwers (both men and women). On the whole, the present Indian Throwers both men and women of all Throwing categories are found to be more in the Ponderal Index values as compared to their Olympic Counterparts. This shows Indian Throwers possess more weight with regard to their body height. Further, more weight is also perhaps due to more fat.

Fat Mass (% & Kg)

Among men Throwers, the Javelin men have been found to possess the lowest amount of fat whereas Shot Put men have reported with highest amount of fat. Among women Throwers surprisingly, the Javelin, Hammer and Shot Put Throwers have been found to possess almost the same amount of body fat i.e. more 29%. However, when the fat is calculated in Kg, it was found that the highest amount of fat in Kg. i.e. 22.45 Kg. is present in Shot Put women followed by 21.25 Kg in Hammer Throwers and 18.50 Kg in Javelin Throwers. These values are found to be on the higher side.

Sum of Three Skin folds (mm)

Among men Throwers, it has been found that Shot Putters have been observed with maximum value of Sum of three Skin folds followed by Discus Throwers and Javelin Throwers. Among women Throwers, it has been found that the highest value of sum of three Skin folds has been found in the Javelin Throwers followed by Hammer Throwers, Shot Putters and the Discus Throwers. It is important to mention that sum of three Skin folds values are found to be higher in the Indian Throwers as compared to their Olympic Counterpart. It is suggested that Indian Throwers must reduce their skin folds values and convert it into lean body mass.

Lean Body Mass (% & Kg)

Among elite men Throwers, the highest amount of Lean Body Mass when calculated in percentage, has been found to be present in the Javelin Throwers followed by Hammer Throwers, Discus Throwers and Shot Put Throwers. However, when the amount of Lean Body Mass was calculated in Kg completely a different picture has been obtained. The highest amount of Lean Body Mass was found in the Shot Put Throwers followed by Discus Throwers, Javelin Throwers and the Hammer Throwers. In case of **women**, highest amount of Lean Body Mass in Kg was found in the Discus Throwers followed by Shot Put, Hammer and Javelin Throwers.

Muscle Mass (% & Kg)

Amount of Muscle Mass in throwers of the present study is found to be around 50%. It needs to be improved to 60% in order get medal winning performance. The present Indian women Throwers are found to possess just 40% of the Muscle Mass. This needs to be improved to 50%.

Bone Mass (% & Kg)

The Javelin Throwers of the present study have been found to possess the highest percentage of Bone Mass followed by Discus Throwers, Hammer Throwers and Shot Put Throwers. Bone Mass in Kg has been found to be the maximum in case of men Discus Throwers followed by Shot Putter, Javelin & Hammer Throwers. In **women**, it has been observed that all Throwers of different throwing events are found to possess approximately 13% of the Bone Mass.

Somatotype

It is important to mention that Somatotype characteristics of present studied men and women throwers are found to be quite good. Both sexes have found to possess good amount of Mesomorphic component.

Decathlon

Decimal Age (Years)

The present studied Decathlon athletes are quite young in their mean age as compared to their Olympic counterpart.

Body Height (cm)

It has been found that the present studied Indian Decathlon players preparing for CWG 2010 are quite short in

their height as compared to their Olympic counterpart. The difference of mean height is up to 10 cm.

Sitting Height and Height Trochanterion (cm)

In the present Decathlon players, upper body portion has been found to be more than the lower portion. In Decathlon event, players are required to run, jump and throw. Out of 10 events in Decathlon, six are field events and four are track events. Bigger portion of upper body than the lower one will not have any adverse impact on the performance.

Body Weight (kg)

The present Decathlon players are found to be quite light in their body weight as compared to their Olympic counterpart.

Height – Weight Ratio

The present studied Decathlon players are found to be slightly more bulky i.e. they are having more weight with respect to their height.

Ponderal Index

In Ponderal index values also Indian Decathlon players are found to be more bulky as compared to their Olympic counter

Body Fat (% & Kg)

The amount of fat present in the Decathlon players is approximately 6% less as compared to their Olympic counterpart. However, as there are different methods to find out body fat percentages, so, it is necessary to examine the

sum of three skin fold thicknesses also in order to have the correct status of fat.

Sum of Three Skin folds (mm)

Results have revealed that present Decathlon players have significantly more values of Sum of three Skin folds as compared to their Olympic counterpart

Muscle Mass (% & Kg)

The amount of Muscle Mass present in the Decathlon players is just 50%. In order to have medal winning performance Decathlon players should have 55 to 60% of the Muscle Mass.

Bone Mass (% & Kg)

Decathlon players of the present study have been found to possess 16.67% (12.36 Kg) as their Bone Mass. This is found to be in the desirable range.

Somatotype

It is important to mention that the present Decathlon players are found to possess the required Somatotype characteristics. These characteristics are found to be closer to the values of Somatotype as possessed by the Olympic counterpart.

Heptathlon

Decimal Age (Years)

Heptathlon players of the present study are found near to the value of Decimal Age as that possessed by the Olympic level players.

Body Height (cm)

In mean body height also, the Heptathlon players are found to be in the desirable circle of Olympic counterpart.

Body Weight (kg)

In mean Body Weight, the present women players have been found to be lighter in their Body weight as compared to their Olympic counterpart.

Ponderal Index

The present Heptathlon players are found to be lesser in the Ponderal Index value mainly because of the reason that they are lighter in their body weight.

Body Fat (% & Kg)

It has been observed that the present Heptathlon women have been found in the desirable ranges of percent and Kg fat values when compared with their Olympic counterpart.

Sum of three Skin folds (mm)

In the Sum of three Skin fold values too, the present Heptathlon women have been found to be at par with Olympic level Heptathlon women.

Lean Body Mass (% & Kg)

The amount of Lean Body Mass present in the Heptathlon women is found to be in the desirable range but however, still it is suggested that they need to improve further so as to obtain medal winning performance.

Bone Mass (% & Kg)

The present Heptathlon women are found to possess good amount of Bone Mass.

Muscle Mass (% & Kg)

For the first time in the study, Heptathlon women have been found to possess 50% of the muscle mass in their body. The muscle mass amount found in the present women is in the desirable range.

Somatotype

Heptathlon women of the present study have shown almost all desirable morphological characteristics but however, in Somatotype features they are found less in Mesomorphic component as compared to their Olympic counterpart. Mesomorphic component is the most important parameter which has direct relationship with performance. Therefore, it is suggested that this parameter may also be brought in the desirable range so that performance may be improved significantly.