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Anthropometric, Morphometric and Posture Evaluation of The Tallest Living Person In The World: A Case Report

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Abstract

This study aims to identify the anthropometric and morphometric characteristics and reveal the postural disorder of the male case called S.K who was diagnosed with Gigantism (pituitary gigantism) caused by hypersecretion of pituitary tumor-related growth hormone and entitled as the tallest person alive in the world with a height of 2.51 cm in the Guinness World Records in 2009. Height, weight, body mass index, upper extremity lengths, lower extremity lengths, skinfold thickness, upper and lower extremity diameters, upper and lower extremity perimeters, chest depth and hand grip strength were measured for anthropometric measurement. 8 different body segments were calculated and analyzed using The Posture Screen Mobile® application for posture evaluation. Disorders in these segments were identified based on forwarding tilt of head (Anterior/Lateral -AL), position of head (A-L), tilt and position of shoulder (A-L), position of ribcage (left-right), position of pelvis (left-right), pelvic tilt (left-right) and load on the head (lb. and kg) (Figure 1.). The measurements revealed that the case surprisingly had anthropometric and morphometric values above normal human dimensions and that, there was also no other living human being with numerically the same values. (Table 2-8). As a result, since the fact investigated has an extreme length due to gigantism, he has taken his place in the Guinness Book of Records as the world's longest living person with a long length.

Key Words: The tallest human, gigantism, pituitary gland, posture, anthropometry

INTRODUCTION

Anthropometry refers to a set of systematic measurement techniques used for measuring the human body and skeleton sizes quantitatively (5). It is generally considered as the conventional, and perhaps, the main tool of biological anthropology. All people on earth are from the same species; however, none of them are exactly the same in terms of measurable characteristics. A number of differences are seen in all including genetically identical twins (monozygotic). Such differences tend to undergo changes over the period from birth to death. Since skeletal development in times of health and illness is affected by some factors based on geographical differences, there are significant differences between skeletal rates. Anthropometry is another approach that refers to direct quantitative expression of the shape of human body (20). Moreover, anthropometric characteristics are known to be directly related with to gender, shape and form. The Internal structure of body and tissue components are generated with the effect of environmental and genetical factors (1).

Posture

It is defined as the combination of each movement in the body and positions of joints that create such movements, and is also considered as an indication of the person's body structure. Height is regarded as one of the most important variables that express the size of human beings (7). Height is generally defined as distance, and expresses a standing upright position starting from the sole up to the top of head (23). Excessive increase in height

that occurs before adolescence results in Gigantism, also known as pituitary gigantism, caused by hypersecretion of growth hormone (GH). (9).

Case

Officially entitled as the tallest living person on earth in the "Guinness World Records" in 2009 with a weight of 158 kg and height of 2 m and 46 cm, thirty-seven-year-old male case, S.K., applied to the hospital at the age of six with the complaints of headache and loss of vision in left eye. The results of the examination showed that he had a tumor in his pituitary gland. He was diagnosed with Gigantism (Pituitary Gigantism) due to hypersecretion of growth hormone (GH) caused by a tumor in pituitary gland (26). Acromegaly and gigantism are considered as a quite rare condition observed throughout the human history, which typically results from chronical excessive generation and secretion of growth hormone, and pituitary tumor. Some severe gigantism cases from past years in literature are shown in Table 1. Since the increase in height continued after the establishment of diagnosis, the height was measured as 2.51 cm two years later, and thus data in the Guinness World Records was updated. The case also holds the record for having the biggest hands in the world with 28.5 cm (left and right). The length of the foot is 35.5 cm. (right), 36.5 cm. (left) and his shoe size is 60 (17). It was found that a gamma knife surgery was performed at the Virginia University, USA, in August 2010, on the tumor affecting the pituitary gland, which stopped the generation of growth hormone and prevented the further increase in the height successfully. This study aims to perform an extensive analysis on the anthropometric parameters of the case which were not measured previously, as well as his posture (18).

Table 1. Cases of Excessive Jigantism that Started Growth in Early Childhood

Name	Country	Sex	Birth Year	Birth Weight (kg)	Abnormal Growth Age (Year)	Last height Measure (cm)
Martin Van Buren Batesa	U.S.A.	M	1837	Normal	< 4	222
Anna Haining Swana	Canada	F	1846	8.1	< 4	227
Ella Kate Ewing	U.S.A.	F	1872	3,4	7	225
Fedor Andreevich Machnow	Russia	M	1878	*NA	5	239
Edouard Beaupré	Canada	M	1881	4,1	3	251
Joh(a)n Aasen	U.S.A.	M	1890	*NA	< 8	218
Albert Johan Kramer	Netherland	M	1897	8,5	< 7	238
Robert Pershing Wadlow	U.S.A.	M	1918	4,1	< 3	272
Cecil Boling	U.S.A.	M	1920	Normal	< 7	235
Rigardus Rijnhout	Netherland	M	1922	Normal	> 3	238
Sandra Elaine (Sandy) Allen	U.S.A.	F	1955	2.95	3	232
Dolores Ann Pullard	U.S.A.	F	1946	Normal	4	227
Zeng Jinlian	China	F	1965	Normal	< 1	249
Yao Defen	China	F	1972	2.8	< 3	234

M=Male F=Female NA=Not Applicable (2)

Ethics: A written consent was received from the case upon provision of detailed information about the study orally.

METHOD AND MATERIAL

Anthropometric Measurements

Height

The distance from the top of head to the floor was measured in cm. at anatomic position using a body tape measure that has a reel system and is inflexible with a width of 7 mm. (19,21)

Body Weight

Weight was measured with a naked top and minimal clothing on the lowers part of the body using a Tanita (model BC545N) scales with a sensitivity of 100 gr. (19,21)

Body Mass Index

BMI (kg/m2) = weight (kg) / height2 (m2)

Measurement of Length of Upper Extremities

All length measurements were performed using a body tape measure that has a reel system and is inflexible with a width of 7 mm. (19,21)

Arm

The distance between acromion and olecranon was measured using a body tape measure at standing position with the arms parallel to the ground and shoulder muscles and arms are relaxed (19,21).

Forearm

The distance between olecranon and styloid projection of distal radius was measured using a body tape measure with the forearm parallel to the ground at a 90º angle (19,21)

Hand length

The distance between the styloid projection of radius and edge of the 3rd finger was measured over the dorsum of the hand using an inflexible tape measure (19,21).

Arm Span

The case was asked to lay on his back on the floor and spread his arms, then the distance between the edges of middle fingers of both hands was measured using a tape measure (21).

Measurement of Length of Lower Extremities

Real Lower Extremity

Distance from the spina iliaca anterior superior to inner malleolus using a tape measure (21).

Functional Lower Extremity

Distance between belly button and inner malleolus was measured using a tape measure in order to find the length difference of functional lower extremity (21).

Thigh

Distance between the upper edge of patella and center of inguinal ligament was measured using a tape measure (12).

Leg

Distance between the tibial plateau and floor was measured in standing position using a tape measure (21).

Foot

Distance between the heel and longest toe was measured laterally at standing position (21)

Skinfold Thickness

Measurement was performed using a Holtain skinfold caliper. For the reliability purposes, measurement was performed from between the thumb and index finger at a location 1 cm. away from the measurement point. Two measurements were performed on each region taking care to keep the holding pressure the same until the end of measurement. There was a waiting period between two measurements. All measurements were performed on the right side of the body while the case was at standing position. Skinfold measurement was performed on a total of 7 regions. These are listed as follows (19,21).

Chest

It was performed at the middle point of distance between nipple and front axillar line.

Subscapular

It was measured diagonally from under the scapula at an angle of 45º.

Axillary

Measurement was performed parallel to the ground at the intersection point of xiphoid projection under sternum and middle axillary line.

Triceps

A vertical measurement was performed at the middle point between acromion and olecranon with the elbows extended and arm muscles relaxed and close to the body.

Abdominal

A vertical measurement was made laterally from a point that is 2-3 cm. under the belly button.

Suprailiac

It was measured diagonally from the top of crista iliaca at an angle of 45º.

Diameter Measurements

For the diameter measurements of case, anthropometric caliper was used; pressure was applied as the arms of caliper compressed the soft tissue, and diameter was measured from between specific bone projections at a total of 7 regions. These are listed as follows (21).

Shoulder

Ends of caliper were placed on the most swollen part of the deltoid muscle, and measurement was performed at standing upright position with arms free on the sides.

Biacromial

Arms of caliper were placed on the lateral points of acromion projection and measurement was performed at standing position with arms free on the sides by determining the maximal width from posterior.

Elbow

Distance between the lateral and medial epicondyles of humerus was measured at 90º flexion and forearm supination position by applying a little pressure.

Wrist

Length between the styloid projection of radius and ulna was measured.

Bitrochanteric

With the arms free and close to body, arms of the caliper were placed on the lateral parts of acromion, and maximum width was measured and recorded with pressure on the soft tissue.

Biiliac

Measurement was performed from posterior at standing position with arms crossed on the chest and ends of the caliper on crista iliac so that they form a downward angle of 45º.

Knee

At sitting position with 90º knee flexion, ends of the caliper were placed on the medial and lateral condyles of femur, and the distance in-between was measured by pressing firmly.

Ankle

Measurement was performed at a standing upright position by placing the caliper ends on the projected points of medial and lateral malleolus.

Circumference Measurements of Upper and Lower Extremities

All circumference measurements were performed using a body tape measure that has a reel system and is inflexible with a width of 7 mm. (21)

Head

The distance between the most projected point of occipital bone and the most projected point over the eyebrows was measured (21).

Neck

Measurement was performed at anatomic position from the narrowest point under the thyroid cartilage (21).

Shoulder

Measurement was performed on the most swollen part of the deltoid muscle at standing upright position with shoulder muscles relaxed and arms free (21).

Arm

The middle point between acromion and olecranon was marked at standing position, and measurement was performed on the most swollen point of the muscle (21).

Forearm

Arms were dropped down, and measurement was performed on the most swollen point of the muscle based on the styloid projection of ulna bone (21).

Wrist

Distance between the distal styloid projection of olecranon and radius bone was measured at 90º flexion with palms facing each other (21).

Chest

Measurement was performed at the xiphoid projection right under the axillar region in normal respiration phase with the feet spread at shoulder width and arms in abduction (21).

Abdomen

Measurement was performed over the belly button with the tape parallel to the floor and not compressing the tissues (21).

Hip

Tape measure was placed on the widest part of hip parallel to the floor without compressing the tissues (21).

Thigh

With 90º knee flexion, proximal end of inguinal region and patella was marked, and measurement was performed on the most swollen point of muscle (21).

Knee

Measurement was performed on the middle line of patella after one knee was bended slightly and body weight was transferred to the other knee (21).

Leg

The case sat on a high armchair so that his legs dropped down and spread his feet for about 20 cm, then the measurement was performed 10-15 cm over the medial malleolus without compressing the tissues (21).

Ankle

At upright position with bare feet, tape measure was placed on the top of malleolus and the thinnest part of ankle, and measurement was performed without compressing the soft tissue (21).

Chest Depth

At standing position, measurement was performed at the intersection point of 3rd and 4th sternum on the left side of case by placing one end of a wide-spread caliper on the sternum and the other end on the spinous process at the back (8).

Hand Grip Strength

A Cambry (Model EH101) digital hand dynamometer was used, which was capable of measuring strength between 5.0 and 100 kg. With arms having an angle of 10º -15º from shoulders, grip strength of the dominant hand was measured in rested state. Measurements were performed on the dominant hand only, and the best value after two trials was considered as the grip strength (21).

Posture Evaluation

Posture analysis of patient was performed using the analysis application called PSM (The PostureScreen Mobile®) which was tested for validity in previous studies with positive results (10,11,13,26). PSM application performs the analysis by making angular calculations and marking the anatomical reference points on the photos of the posture variables on sagittal-coronal plane in anterior and lateral (right) directions taken using the camera of an iPad® tablet with the upper body naked and in neutral position. The male case named S.K. had a loss of balance during standing static posture position since multiple right tibia bones were fractured before. Therefore, his photos were taken while he was standing using a walking stick. Afterwards, PMS application performed an analysis of posture variables. Moreover, this application can also guide the user on how to digitalize the specified anatomical reference points. These reference points are as follows on the anterior side; right and left pupils, middle point between the nose and upper lip, top point of right and left acromioclavicular (AC) joint, right and thoracal (T8) over sternum (episternal notch), right and left anterior superior iliac spine (ASIS), and the middle point of right and left ankle joints. A total of five anatomical reference points were marked for lateral posture analysis; tragus of ear, cervicothoracic area on the middle line of shoulder, greater trochanter, tibiofemoral joint and middle line of lateral malleolus. Then the PSM application performed the calculation and analysis of 8 different body segments by using proprietary algorithms (Figure 1). These segments are forward tilt of head (Anterior/Lateral -AL), position of head (A-L), tilt and position of shoulder (A-L), position of ribcage (left-right), position of pelvis (left-right) and pelvic tilt (left-right). Application also calculated the load on the head (lb and kg).

RESULTS

Table 2. Height, Weight, Age, BMI

Height (cm)	Weight (kg)	Age (years)	*BMI (kg/m²)
2.51	158	37	25.1

*Body Masss Index

Table 3. Measurement of Length of Upper Extremities (cm)

Arm (Right)	Arm (Left)	Forearm (Right)	Forearm (Left)	Hand (Right)	Hand (Left)	Arm Span
121	121	47	47	28,5	28,5	2,72

Table 4. Measurement of Length of Lower Extremities (cm)

Real Lower Extremity (Right)	Real Lower Extremity (Left)	Functional lower extremity (Right)	Functional lower extremity (Left)	Thigh (Right)	Thigh (Left)	Leg (Right)	Leg (Left)	Foot (Right)	Foot (Left)
13.4	13.8	14.2	14.9	59	62	59	63	35.5	36.5

Table 5. Skinfold Thickness (mm)

Chest	Subscapular	Axilla	Triceps	Abdominal	Suprailiac	Thigh
15	14	17	13	24	9	18

Table 6. Diameter Measurements (cm)

Shoulder	Biacromial	Elbow	Wrist	Biiliac	Bitrochanteric	Knee	Ankle
50.8	31.7	40	34	36.6	40.3	48	60

Table 7. Upper and Lower Extremity Perimeter Measurements (cm)

Head	Neck	Shoulder	Arm	Forearm	Wrist	Chest	Abd.	Hip	Thigh	Knee	Leg	Ankle
68	46	141	37	36	27	126	127	133	55	48	30	29

Abd: Abdominal

Table 8. Chest Depth (cm) and Hand Grip Strength Measurements (kg)

Chest Depth	Handgrip Strength
22.1	65.3

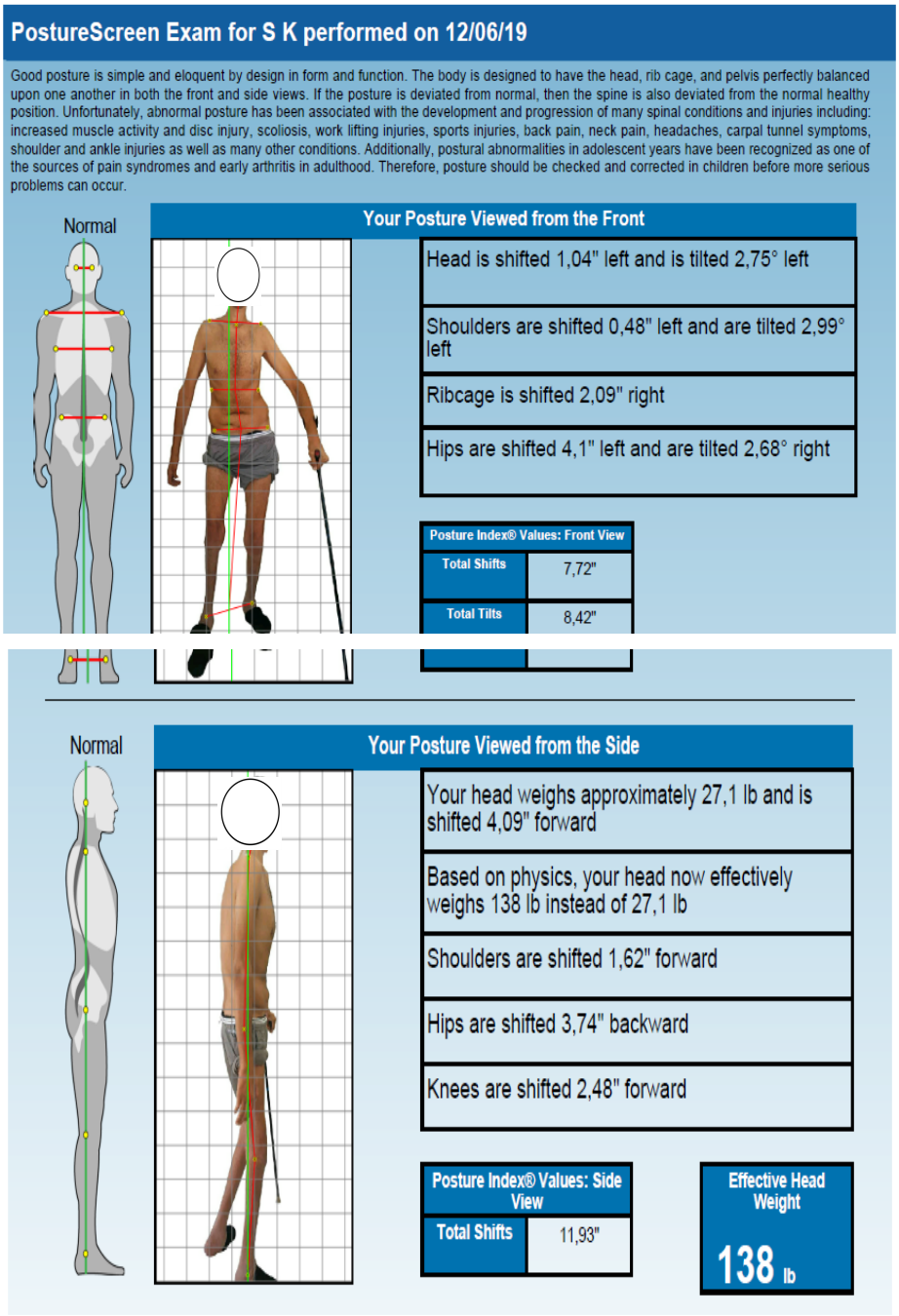

Figure 1. Posture Evaluation

DISCUSSION

Starting from the ancient ages, acromegalic and gigantic individuals with extraordinary anthropometric sizes have been the subject of many mythological stories (4). The male case in this study named S.K, has an anthropometric and morphologic structure that is over the normal human sizes (Table 2-8). It is also seen that he suffers from tibial shortness due to two right tibia fractures (right 59 cm and left 63 cm. Table 4). Gigantism occurs when open epiphyseal growth plates allow for linear growth due to secretion of excessive GH in childhood whereas acromegaly is a condition that occurs in adulthood (6). Growth and development are affected primarily by gens, hormones, nutritional sources, environmental and cultural interaction as well as combination of other factors (6). As an important element of growth and development, development of skeletal system is mainly controlled by the growth hormone that is produced in pituitary gland (24). Anomalies such as tumor malformation, hyperplasia or traumatic destruction affect the pituitary gland, and therefore

growth hormone may cause hyperpituitarism (22). According to the literature review, some of the people that were entitled as the tallest person in the world, whether gigantic or not, are as follows: Robert Wadlow (The Alton Giant) took a part in the book of "Guinness" records as the tallest person of all times after his death with a height of 8 feet 11 inches (2.72 cm) and weight of 272 kg. (6). Joseph Edouard Beaupre was born in 1881 in Saskatchewan, Canada, and died in 1904 at the age of 23 as a pituitary tumor related gigantic person with a height of 252.9 cm and a weight of 170 kg. (14). Leonid Stepanovych Stadnyk (1969-2004) put his stamp in history with a height of 2.57 cm resulting from a tumor in his pituitary gland (15). Väinö Myllyrinne (1909–1963) is known to have had a height of 2.24 cm and a weight of 141 kg. (16). It is also known that there are people recorded as the tallest in the book of "Guinness" records who are still alive today. They may be listed as follows: Brahim Takioullah, born in 1982 in Morocco, is 2.46 cm tall and has the diagnosis of acromegaly (16). Born in 1987 in Iran, Morteza Mehrzad Selakjani is known as the second tallest living person in the world with a height of 2.47 cm resulting from acromegaly (16). Born in 1983, Dharmendra Pratap Singh has officially been recorded as the tallest living person in India (16). Zhang Juncai was born in 1966 in the People's Republic of China, and is among the tallest living people in the world with a height of 2.42 cm. (16). Born in 1988, Asadulla Khan has also attracted attention in India with a height of 2.41 cm. (16). Born in 1975 in Pakistan, Naseer Soomro is 2.38 cm tall. (16) Chinese athlete Sun Mingming was born in 1983 and is entitled as the tallest basketball player in the world (16).

As a result, the fact that anthropometric, morphometric and posture structures of the male case called S.K were not evaluated extensively before led to the need to perform the required researches and reveal data. The studied case was diagnosed with gigantism due to secretion of growth hormone above normal levels caused by a tumor in pituitary gland. The increase in his length continued with the increased age, and could not be stopped until a certain age. Therefore, it was seen that he had quite higher sizes as compared to the anthropometric and morphometric structure of a healthy individual resulting with a posture disorder.

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