

# Study of the Normal Internal Organ Weights in Thai Population

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The normal adult internal organ weight and the relationship between it with body weight (BW) and body height (BH) have not been studied in Thailand. The 499 corpses of autopsy were performed in Maharajnakorn Chiang Mai Hospital, the center of the northern part of Thailand during 2000-2005. All of these cases were unnatural deaths including accident, homicide and suicide with no organ injuries or pathologic abnormalities and excluded decomposed bodies, diseases and previous medical treatments. These organs were collected from 269 males and 230 females and were aged between 15 and 60 years. The determination of average organ weight (AOW) was made based on the weight of brains, pituitary glands, thymuses, thyroids, hearts, lungs, livers, pancreases, adrenal glands, kidneys, spleens, ovaries, testes and uterus. The organ weight (OW) was set in relation to sex, age, body weight (BW) and body height (BH). The AOW (g) of male and female was found to be: brain 1311/1170, pituitary gland 0.6/0.6, thymus 23/24, heart 291/246, thyroid 17/17, right lung 321/271, left lung 296/251, liver 1252/1106, pancreas 97/88, right kidney 106/97, left kidney 112/98, spleen 104/77, right adrenal 5/7.9 and left adrenal gland 6/8. It was also found that weight increased in males in relation to higher age, BW and BH adrenal gland increased in females. There was no difference in pituitary, thymus and thyroid gland weight in either sex. These results can be used as standard organ weights to determine abnormal evidences in Forensic and Pathologic corpses.

**Keywords:** Organ weight (OW), Body weight (BW), Body height (BH), Thai, Brain, Pituitary, Thymus, Thyroid, Heart, Lung, Liver, Pancreas, Adrenal gland, Kidney, Spleen, Ovary, Testes, Uterus

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There have been studies of normal OW in many countries but not in Thailand. The OW might be different in each race, and environmental conditions such as economy, weather, food and health promotion, affected. Therefore, every country should have biological data including normal OW. In Asian countries, there is an agreement to study normal OW in adults (aged 20-50 years) because the population of this age group is strong and fully grown. Furthermore, people over 50 years old are prone to be affected by many diseases, such as hypertension, diabetes, cancer or a degenerative conditions. These diseases usually interfere with the OW and growth rate. In German, Japan, China, India and France, the OW is closely correlated

with age, sex, BW and BH<sup>(1-5)</sup>. In the past, human OW in Asia was lower than in Europe, Africa and America. However, there was an improvement in food, environment, health promotion and genetic factors in Asian countries leading to increasing of OW in an Asian population.

## Material and method

The 269 males and 230 females who died during 2000-2005 with known age were included in the present study. Their ages (over 15), BW, BH and OW were recorded at the Forensic Department, Medical Faculty of Chiang Mai University, Thailand. The inclusion criteria were unnatural death, no decomposition, no previous treatment, organ injury or damage, no diseases and a well-preserved body. All organs were not collected from each corpse due to the criteria

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above. The weight of the brain, pituitary gland, thymus gland, thyroid gland, heart, lungs, liver, pancreas, spleen, kidneys, adrenal glands, uterus, ovaries, and testes was carried out after exclusion of unsuitable individual data for statistical analysis. The method of organ isolation was cutting at or near the organ tissues and the organs were immediately weighed after isolation with the same weighing machine. The authors excluded abnormal pathology of the organ by gross examination during autopsy. Microscopic examination was performed if disease was suspected. Mean values and standard errors of mean of OW, age group BW and BH were calculated by using a computer program.

## Results

A total of 499 corpses, (269 males and 230 females) were investigated. The most common cause and manner of death was a traffic accident (74%). The ages of male and female corpses ranged from 15-60 years. Mean age was 38 years in males and 31 years in females. The BW of males and females ranged from 43-74 and 43-73 kg and the means were 54 and 50 kg,

respectively. The BH of males and females ranged from 145-171 and 145-167 cm and means were 158 and 155 cm respectively (Table 1). The mean of OW for males was more than that of females except for the adrenal gland. The details of data and correlation of OW with age, BW and BH are shown in Table 2.

The correlation between age groups and BW of males and females is shown as the follows:

1. There was no significant correlation between age groups and BW in both male and female. But there was an increase in BW when age increased in both sexes.

2. The increasing average age ranged from 27 to 33 and 28 to 44 years in each BW group of males and females, especially the age range of 46-65 kg. Age of females was older than that of males in each BW group.

The correlation between BW and BH of male and female is shown as follows:

1. There was no significant difference of BW in each group between males and females.

2. There was significant difference of BH in each group of BW between males and females.

**Table 1.** General data and average weight of internal organs of male and female bodies

	Number male//female	Range male//female	Average male//female
Age (years)	269//230	15-60//15-60	38 ± 0.9//31 ± 0.8
Weight (kg)	269//230	43-74//43-73	54 ± 0.8//50 ± 0.5
Height(cm)	269//230	145-171//145-167	158 ± 6//155 ± 4
Organ	Number	Range (g)	Average weight (g)
Brain	156//176	1246-1383//1092-1260	1311 ± 12//1170 ± 6
Pituitary	186//203	0.4-0.6//0.5-0.6	0.6 ± 0.02//0.6 ± 0.02
Thymus	131//122	21-33//12-28	23 ± 0.7//24 ± 0.6
Heart	260//221	209-362//213-316	291 ± 3//246 ± 3
Thyroid	250//218	11-21//16-24	17 ± 0.6//17 ± 0.4
	Number male//female	Range male//female	Average male//female
Rt. lung	160//143	277-400//238-300	321 ± 5//271 ± 4
Lt. lung	174//143	248-363//193-300	296 ± 5//251 ± 5
Liver	240//209	900-1483//836-1096	1252 ± 14//1106 ± 12
Pancreas	255//223	82-127//78-130	97 ± 2//88 ± 1
Rt. kidney	262//227	82-132//81-116	106 ± 2//97 ± 1
Lt. kidney	258//223	92-134//77-122	112 ± 2//98 ± 1
Spleen	250//215	68-113//60-99	104 ± 4//77 ± 2
Rt. testis//Rt. ovary	266//214	9.5-16.3//6.7-9.6	14 ± 0.3//9 ± 0.2
Lt. testis//Lt. ovary	265//210	9.0-15.4//5.5-9.8	13 ± 0.3//9 ± 0.2
Rt. adrenal gl.	238//220	3.2-6.2//5.5-9.5	5 ± 0.1//7.9 ± 0.2
Lt. adrenal gl.	250//219	4.4-6.5//5.9-10.5	6 ± 0.1//8 ± 0.2
Uterus	217	50-124	64 ± 2

Data are means ± SEM

**Table 2.** Average age, weight, height and internal organs in different groups of body weight in males and females

Average	Range of body weight (kg) : male/female						
	41-45	46-50	51-55	56-60	61-65	66-70	> 71
Age (year)	29±4//29±2	27±2//28±1	31±2//31±2	25±1//35±1	33±2//44±3	30±2//34±0	28±6//32±6
Weight (kg)	43±0.3//43±0.2	48±0.2//48±0.1	53±0.2//53±0.2	59±0.2//57±0.2	63±0.3//62±0.3	68±0.4//68±0.0	74±1//73±1
Height (cm)	157±2//154±0.9	160±0.8//153±0.5	163±0.6//156±0.6	166±0.8//158±0.8	168±1//156±2	167±1//155±0	171±2//167±3
Brain (g)	1246±25//1149±23	1295±18//1154±10	1328±13//1170±10	1327±18//1222±17	1358±24//1238±29	1383±23//—	1248 ±118//1260±17
Pituitary (g)	0.5±.04//0.5±.01	0.4±.02//0.6±.07	0.5±.02//0.5±.01	0.5±.02//0.5±.02	0.5±.01//0.6±.04	0.5±.03//0.5±.03	0.6±.05//0.6 ± .02
Thyroid (g)	23±0.4//23±1.6	22±2//25±1	23±1//23±1	21±1//28±1	25±0.7//14±0	26±3//12±0	33±6//24±3
Thymus (g)	16±1//16±1	16±1//16±1	16±1//17±4	18±1//17±1	20±2//21±2	21±2//24±0	20±2//20±2
Heart (g)	238±12//233±7	278±7//240±5	288±5//249±4	300±5//263±5	324±7//308±14	287±14//310±0	362±14//316±40
Rt. lung (g)	289±22//269±9	307±13//262±8	318±9//281±8	346±14//300±12	325±15//280±0	318±20//—	400±25//250±6
Lt. lung (g)	255±19//238±14	283±13//241±9	310±8//273±9	308±15//288±10	285±14//300±0	299±18//—	363±30//193±16
Liver (g)	1036±59//1117±27	1188±29//1096±20	1244±26//1120±17	1315±27//1160±18	1333±29//1292±122	1290±46//—	1483±157//1320±161
Pancreas (g)	82±9//84±3	84±3//88±2	100±3//88±2	100±3//90±2	101±4//94±6	113±6//98±0	127±15//130±10

  

Average	Range of body weight (kg) : male/female						
	41-45	46-50	51-55	56-60	61-65	66-70	> 71
Lt. testis//Lt.Ovary (g)	11.7±0.9//8.1±0.6	12.7±0.6//8.5±0.3	13.0±0.5//9.2±0.4	13.9±0.6//9.8±0.6	13.7±0.7//8.9±0.9	15.4±0.9//5.5±0.7	13.3±1//8.4±2
Rt. adrenal gland (g)	4.1±0.4//7.1±0.4	4.7±0.2//7.6±0.3	5.1±0.2//8.3±0.3	5.6±0.2//9.5±0.4	6.2±0.3//9.5±1	5.6±0.5//7.1±1	6.1±0.8//8.4±0.9
Lt. adrenal gland (g)	4.8±0.5//7.1±0.4	5.1±0.2//7.9±0.3	5.3±0.2//8.2±0.3	6.2±0.3//9.4±0.4	6.5±0.3//9.7±1	6.4±0.4//10.5±1	5.9±0.9//10.5±1
Rt. kidney (g)	82±6//94±4	100±3//96±2	108±2//98±2	105±3//106±3	111±3//110±11	123±7//116±0	132±21//116±6
Lt. kidney (g)	92±6//94±3	105±3//97±1	112±3//101±2	112±2//103±2	116±4//117±12	130±9//108±0	134±18//122±6
Spleen (g)	87±9//76±4	100±11//79±3	105±6//79±2	111±9//77±3	101±8//82±10	113±11//60±0	105±17//99±10
Uterus (g)	56±4	66±2	71±2	72±3	63±9	124±0	75±13

Data are means ± SEM

**Table 3.** Average age, body weight, height and internal organs weight categorized according to body height in males and females

Average	Range of body height (cm) : male/female				
	< 145	146 -155	156-165	166-175	> 176
age	19±0//36±0.6	32±2.5//33±1.3	29±0.9//29±1.1	31±0.9//26±4.1	26±2.8//-
weight	46±0//43±2.3	49±1.1//48±0.6	55±0.6//52±0.6	63±0.6//62±3.6	64±1.9//-
Height (cm)	145±1//145±1	150±0.2//150±0.9	160±0.8//160±0.5	170±0.6//170±0.6	176±0.8//176±0.8
Brain (g)	1200±47//1,164±47	1223±92//1158±10	1302±12//1179±11	1304±17//1275±25	1385±70//-
Pituitary (g)	0.5±0.4//0.9±0.4	1.2±0.7//0.5±0.3	0.5±0.1//0.5±0.1	0.5±0.1//0.6±0.1	0.5±0.1//-
Thymus (g)	-//21.1±2.9	19±1.9//23±1.2	22±1//24±1	25.6±1.3//25±5	29.7±5//-
Thyroid (g)	18±2//19±2	16±1.4//16±6	17±.7//18±.7	18.4±.7//18.8±3.6	24±6//-
Heart (g)	232±9.6//198±9.6	276±11//247±4	281±4//250±4	288±4//222±6	333±17//-
Rt. lung (g)	270±19//231±19	307±15//257±8	315±9//289±7	331±8//296±21	372±34//-
Lt. lung (g)	236±24//195±24	260±15//233±8	301±9//278±10	327±11//270±60	323±44//-
Liver (g)	1400±82//967±82	1203±44//1079±17	1217±20//1138±16	1304±16//1255±105	1477±83//-
Average	Range of body height (cm) : male/female				
	< 145	146 -155	156-165	166-175	> 176
Pancreas (g)	82±7//87±7	92±4//88±1.5	94±2//87±1	101±2//114±15	109±15//-
Rt. testis/Rt. ovary (g)	12 ±0.5//7.8±1	12.2±0.6//8.8±0.3	13.5±0.3//9.3±0.3	14.1±0.4//7.0±1.4	13.7±1.3//-
Lt. testis/Lt. ovary (g)	10±0.6//7.7±1.2	11.8±0.6//8.6±0.3	13.3±0.3//9.1±0.3	13.4±0.4//7.3±1.2	12.7±0.9//-
Rt. adrenal gland (g)	4±0.6//7.1±0.6	4.6±0.3//7.5±0.3	5.6±0.2//8.5±0.3	6.7±0.2//8.5±1.2	7.4±1//-
Lt. adrenal gland (g)	4±0.8//7.1±0.9	5.4±0.4//7.8±0.3	6.0±0.2//8.4±0.3	7.0±0.2//9.6±1.4	7.8±1//-
Rt. kidney (g)	103±4.7//89±5	97±4//96±1.4	106±2//98±2	108±2//117±8	119±8//-
Lt. kidney (g)	102±4//91±4	107±4//97±2	110±2//99±2	112±2//118±7	119±7//
Spleen (g)	136±3//59.6±3.5	83±13//74±2	100±5//82±3	96±4//81±7	147±22//-
Uterus (g)	70±8	66±2	66±2	66±7	-
Data are means ± SEM					



3. The increase of BH correlated with the increase of BW.

4. The BH of males in each group of BW was higher than females.

The correlation between OW and BW in each group is shown as follows:

1. The AOW of brain, heart, lungs, liver, pancreas, spleen and kidneys in both sexes significantly tended to increase as the range of BW. The weight of these organs in male was higher than that in females in every group of BW.

2. The average weight of pituitary gland was approximately 0.6 g (Table 1) and the values were not different among BW groups or genders.

3. The average thymus gland weight in males and females was 23 and 24 g. There was no significant difference between males and females in each group of BW.

4. The thyroid weight increased when the body weight increased in both males and females and no significant difference between males and females in each group of BW.

5. The testes weight of left and right sides increased when the BW increased from 40 to 70 kg. And the ovarian weight increased when the body weight increased from 40 to 60 kg in both right and left side.

6. The adrenal gland weight of males and females increased when the BW increased from 40 to 65 kg in both right and left side. But the average adrenal glands weight in females was higher than in males in every group of BW.

7. The uterine weight tended to increase as the range of BW increased.

The correlation between OW and BH in each group is shown as follows, (Table 3):

1. The AOW of brain, thymus, thyroid, heart, lungs, liver, spleen, pancreas, adrenal glands and kidneys in both sex significantly increased as the range of BH. The weight of these organs in males was higher than that in females except the adrenal glands, in every group of BH. Testes and ovaries tended to increase as the range of BH in both sexes.

2. Uterine weight was not increased as the range of BH.

The correlation between OW and age in each group is shown in as follows, (Table 4):

1. The AOW of lungs in both sexes significantly increased as the range of age and in male was higher than that in females in every age group.

2. The AOW of heart and liver, pancreas, kidneys in both sexes significantly increased as the

range of 15 to 55 years and 15 to 45 years respectively.

3. The AOW of adrenal glands in females and males significantly increased as the range of 15 to 60 years and 15 to 35 years. These organs in females were higher than in males

4. The AOW of brain, pituitary, thymus, thyroid, ovaries, spleen and uterus did not significantly increase with the range of age.

## Discussion

The OW of Thai population correlated with sex, age, BW and BH because it is the natural growth. The data was the same in the Japanese<sup>(2)</sup>, Chinese<sup>(3)</sup>, Indian<sup>(4)</sup>, Caucasoid population<sup>(5)</sup>. Pituitary and thyroid gland weight were not significantly different; however, they tended to increase. The OW in males was higher than in females, except for the adrenal gland, it might be the difference of sexual hormonal regulation. The OW in both sexes increased when BW, age and BH increased and were different in each race. The OW of the Thai population was lower than Caucasians but had no significant difference when BW of both populations was the same. That means the OW is different in each race at the same age. However, internal OW in Caucasian, Negroid, and other countries could not be used as reference data in Thai populations because of different ages, BW and BH. So, the normal internal OW is the standard value only in Thai populations and evaluates early on the organs of corpses during autopsy. The increasing OW tends to have the appearance of pathological conditions or organ injuries in Forensic cases the histology of which is not always provided.

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## การศึกษาน้ำหนักปกติของอวัยวะภายในร่างกายของคนไทย

ไพฑูรย์ ณรงค์ชัย, สิริพันธ์ ณรงค์ชัย

น้ำหนักปกติของอวัยวะภายในและความสัมพันธ์กับน้ำหนักตัว ความสูง และอายุ ในคนไทยที่เป็นผู้ใหญ่ นั้นยังไม่มีการศึกษาอย่างกว้างขวางในประเทศไทยมาก่อน จึงได้ทำการศึกษาในศพที่เสียชีวิตโดยผิดธรรมชาติจำนวน 499 ศพที่นำมาชันสูตร ณ โรงพยาบาลมหาสารนครเชียงใหม่ ซึ่งเป็นศูนย์กลางของภาคเหนือ ของประเทศไทย ในช่วงระหว่างปี พ.ศ. 2543-2548 ศพทุกศพที่นำมาศึกษาเป็นศพที่เสียชีวิตโดยอุบัติเหตุ ถูกฆาตกรรม และ ฆ่าตัวตาย ที่มีอวัยวะภายในอยู่ในสภาพดี ไม่ได้รับอันตราย ไม่มีความผิดปกติทางพยาธิสภาพ ศพไม่มีการเนา ไม่มีโรคทางธรรมชาติใด ๆ และไม่ได้รับการรักษามาก่อน มีศพที่เป็นเพศชาย จำนวน 269 ศพและเพศหญิง จำนวน 230 ศพ มีอายุระหว่าง 15 ถึง 60 ปี โดยศึกษาน้ำหนักเฉลี่ยของสมอง ต่อมใต้สมอง ต่อมไทมัส ต่อมไทรอยด์ หัวใจ ปอด ตับ ตับอ่อน ต่อมหมวกไต ไต ม้าม รังไข่ มดลูก และลูกอัณฑะ และศึกษาความสัมพันธ์กับ เพศ อายุ น้ำหนักตัว และความสูง จากการศึกษาน้ำหนักเฉลี่ย (กรัม) ของอวัยวะในเพศชายและหญิง พบว่า สมองหนัก 1311/1170 ต่อมใต้สมอง 0.6/0.6 ต่อมไทมัส 23/24 หัวใจ 291/246 ต่อมไทรอยด์ 17/17 ปอดขวา 321/271 ปอดซ้าย 296/251 ตับ 1252/1106 ตับอ่อน 97/88 ไตขวา 106/97 ไตซ้าย 112/98 ม้าม 104/77 ต่อมหมวกไตขวา 5/7.9 และต่อมหมวกไตซ้าย 6/8 อวัยวะส่วนใหญ่ในเพศชายมีน้ำหนักเฉลี่ยมากกว่าเพศหญิงและมีความสัมพันธ์กับน้ำหนักตัว ความสูง และอายุที่เพิ่มมากขึ้น ส่วนต่อมใต้สมอง ไทมัส และไทรอยด์ ไม่มีความสัมพันธ์กัน ในขณะที่น้ำหนักของต่อมหมวกไตของเพศหญิงมีน้ำหนักมากกว่าเพศชาย ผลของการศึกษาน้ำหนักปกติของอวัยวะภายในของคนไทยครั้งนี้สามารถนำไปใช้เป็นน้ำหนักมาตรฐานเพื่อพิจารณาถึงพยาธิสภาพที่ผิดปกติของอวัยวะต่าง ๆ ของศพในงานนิติเวช

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