UNIVERSITY OF PARMA, ITALY

CENTER OF MORPHOLOGY AND BODY COMPOSITION (CMBC)

SCIENTIFIC REPORT ON "Anthropometric and stabilometric evaluation of 5-13 years old children for the definition of the normal reference parameters"

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THE PoDATA SYSTEM

The PoDATA system measures the body weight distribution on feet. PoDATA is a postural stabilometric bilaminate footboard with a crystal top, and a system with 6 load cells that can be positioned to detect loads on the 1st and 5th metatarsal and heel. It is also used for measuring the center of pressure (COP), the center of foot (COF) and the fluctuations of body's centre of gravity.

The system in the photograph (GPS400) was used for all the analysis.

The 6 load cells should be positioned to detect loads, according to the first and fifth metatarsal heads and heels. The weight distribution can be reported as percentage of body weight for each analyzed point.
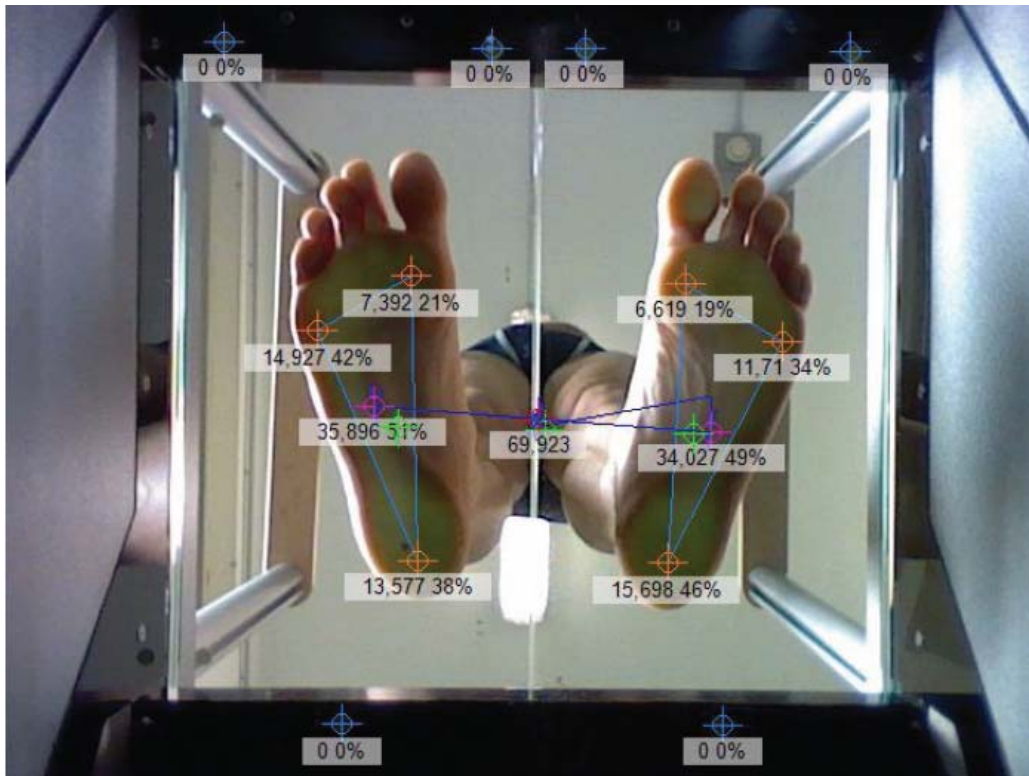
AIM OF THE STUDY

The aim of this study was to create the distribution pattern of plantar pressure during growth in a sample of children from the area of Parma. All data on the distribution of the plantar load were collected in static conditions.

The analyzed data create a database of reference values for normal body weight plantar distribution in specific age groups.

RELEVANCE

The expected results will be relevant in: 1) the early identification of abnormalities of the plantar pressure; 2) patient-tailoring of corrective therapy prescription.

ANALYZED SAMPLE

All the children were recruited from the Parma's area during the summer period.

To this purpose, a PoDATA system was installed in a dedicated room.

Four operators, selected from the master in Preventive and Adapted Sport Sciences of the University of Parma, were trained to acquire the data in the respect of the standardized protocol (see next chapter).

The operators worked constantly under the supervision of the responsibles of the project.

SUBJECTS INVOLVED (n°)	F	517
	M	573
SUBJECTS EXCLUDED (n°)	F	27
	M	24
SUBJECTS ANALYSED (n°)	F	490
	M	541

The analyzed children were sub-divided in 8 age-based groups as follows:

Groups (age)	6	7	8	9	10	11	12	13
n° of girls/group	31	85	88	83	73	63	45	22
n° of boys/group	43	90	111	95	62	56	38	46

For each subject, the percentage of body weight distribution on both feet and on each interest point per foot (1st, 5th metatarsal heads and heel) were analyzed.

All the percentage values for each subject were simultaneously analyzed .

Each operator followed the same procedure: subjects were asked to remove shoes and to climb on the platform. All the measures were performed on the platform at room temperature.

All the measures were performed by the same PoDATA and PC systems.

MEASUREMENT PROTOCOL

Subject preparation

1. The **subject** was asked to:

- remove clothes, except her/his underwear, shoes and socks[a];

- sit on a cot showing the sole of the feet.

2. The **subject** was asked to:

- climb on the PoDATA platform[b];

- perform two steps in place;

- stop feet without moving until the end of the exam;

- look forward (to the horizon);

- keep arms relaxed at her/his sides

Analysis

The **operator** acted as follows:

- check the patient posture on the PoDATA (as described above);

- take the picture of the feet soles;

- start the exam;

- constantly control patient posture[c] during the exam.

[a]**Note.** It is important to see patients' ankles and body posture, during the examination. Clothes, in particular trousers, might interfere.
[b]**Note.** In case the patients have to wait before the analysis, we suggest to ask them to stay on a foam mat.
[c]**Note.** Patients frequently do not understand the importance not to move their feet or body. For this reason it is really important to constantly observe patient's movements.

STATISTICS

The Measurement of Percentiles

Standardization is the process of testing a group of people to see the scores that are typically attained. With a standardized test (as PoDATA), the subject's values can then be compared to the standardization group's performance. With standardization, the normative group must reflect the population for which the test was designed. The group's performance is the basis for the tests norms.

To organize and summarize data for normative purposes, data must be grouped into a frequency distribution. The information provided by frequency distributions are presented graphically in the form of a bell-shaped normal distribution curve.

Standard deviation (σ)	-2σ	-1σ	0	+1σ	+2σ
Percentiles	~ 3	~ 15	50	~ 85	~ 97
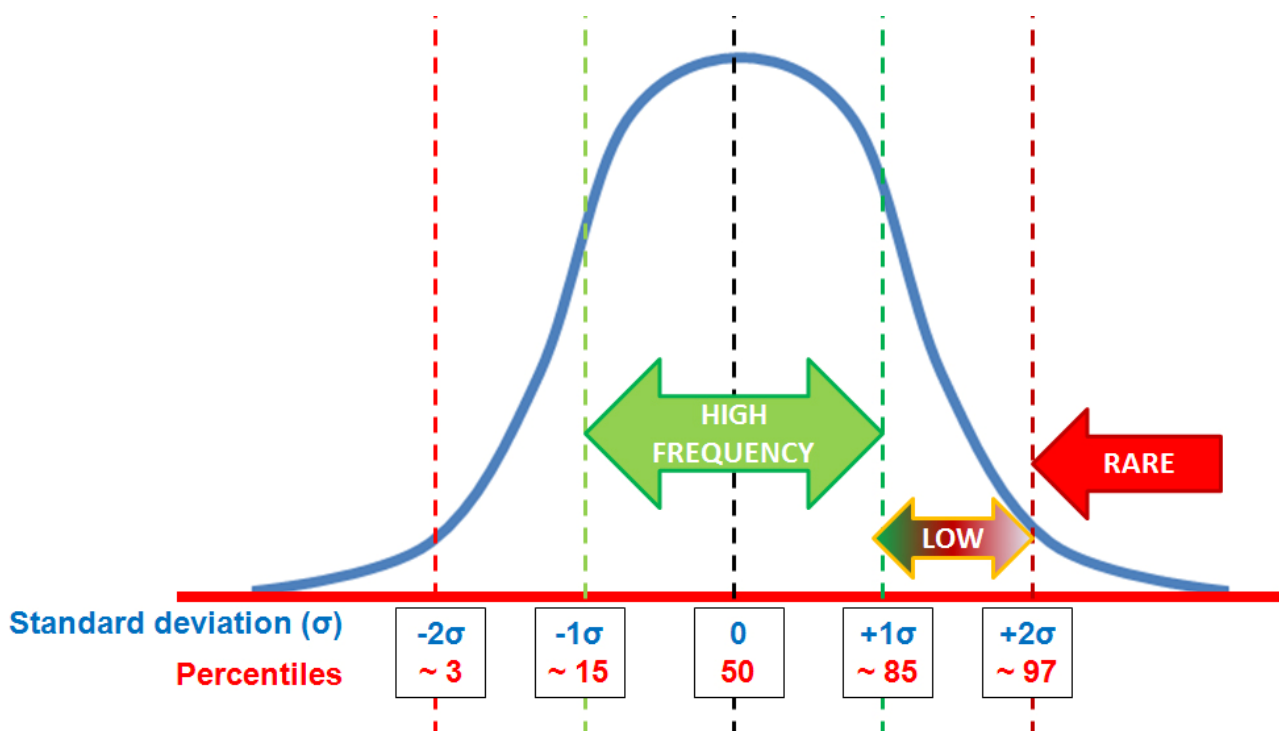
A group of scores can be summarized by a measure of central tendency. The most familiar of these measures is the arithmetic average, more technically known as the mean (M).

The score with the highest frequency occurs in the middle of the distribution and exactly half of the scores occur above the middle and half of the scores occur below. Most of the scores occur around the middle of the distribution or the mean. Very high and very low scores occur infrequently and are therefore considered rare.

A measure of variability is the standard deviation. (symbolized by SD or σ). The standard deviation (SD) is an index of the width of a frequency distribution. The smaller the standard deviation, the closer the scores cluster around the mean score. The greater the standard deviation, the greater the differences between the scores and the mean.

Scores in a normal distribution also can be described as **percentiles**. *Percentile scores express an individual's relative position within the standardization group in terms of the percentage of persons whose scores fall below that of the individual.* The score that is the mean (and also the median and mode) is the score at the 50th percentile because 50% of the scores are at that score or below. A score of one standard deviation above the mean is therefore at the 84th percentile (50% + 34.1%). Finally, a score of two standard deviations above the mean is therefore at the 97th percentile (50% + 47.5%).

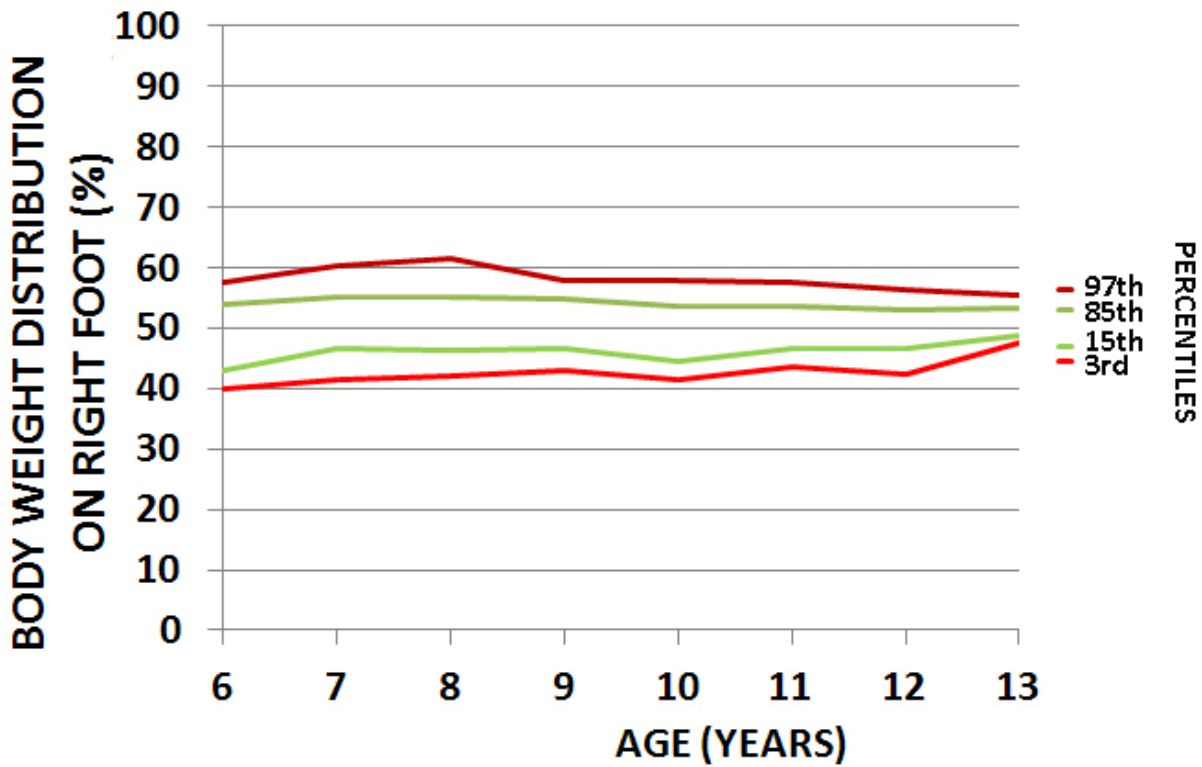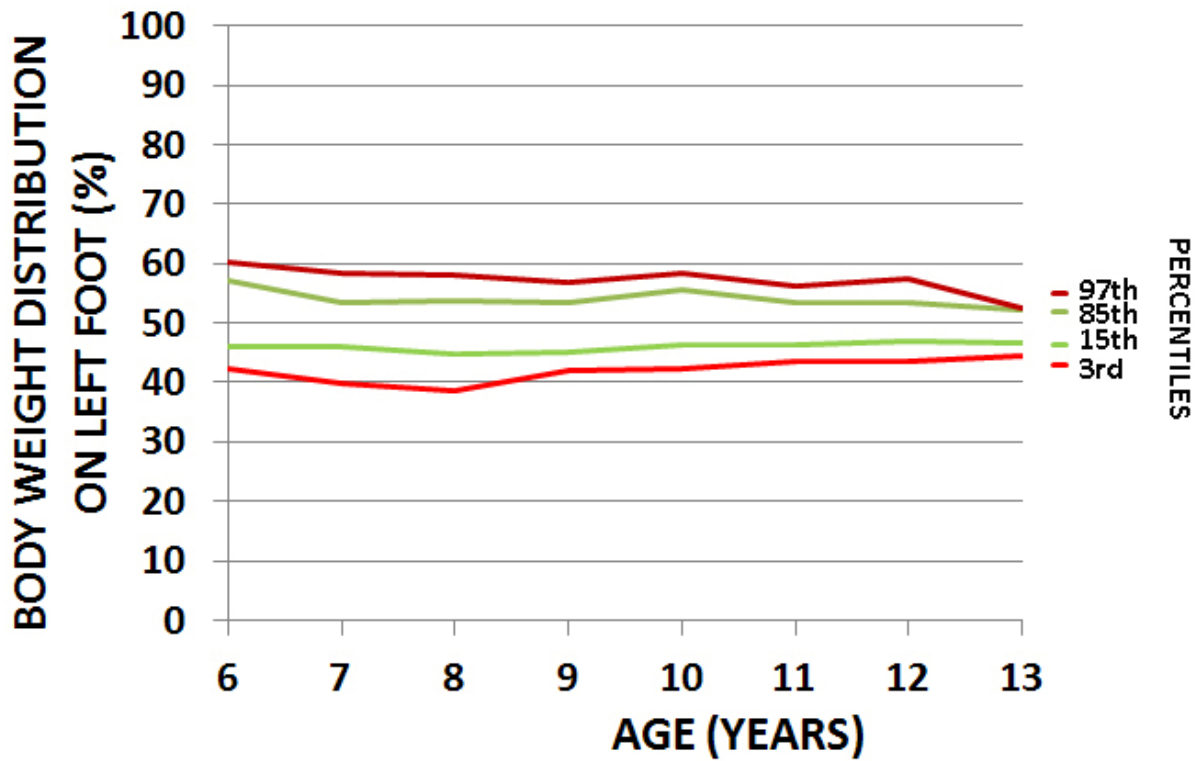# REFERENCE VALUES OF PLANTAR PRESSURE IN GIRLS

RESULTS

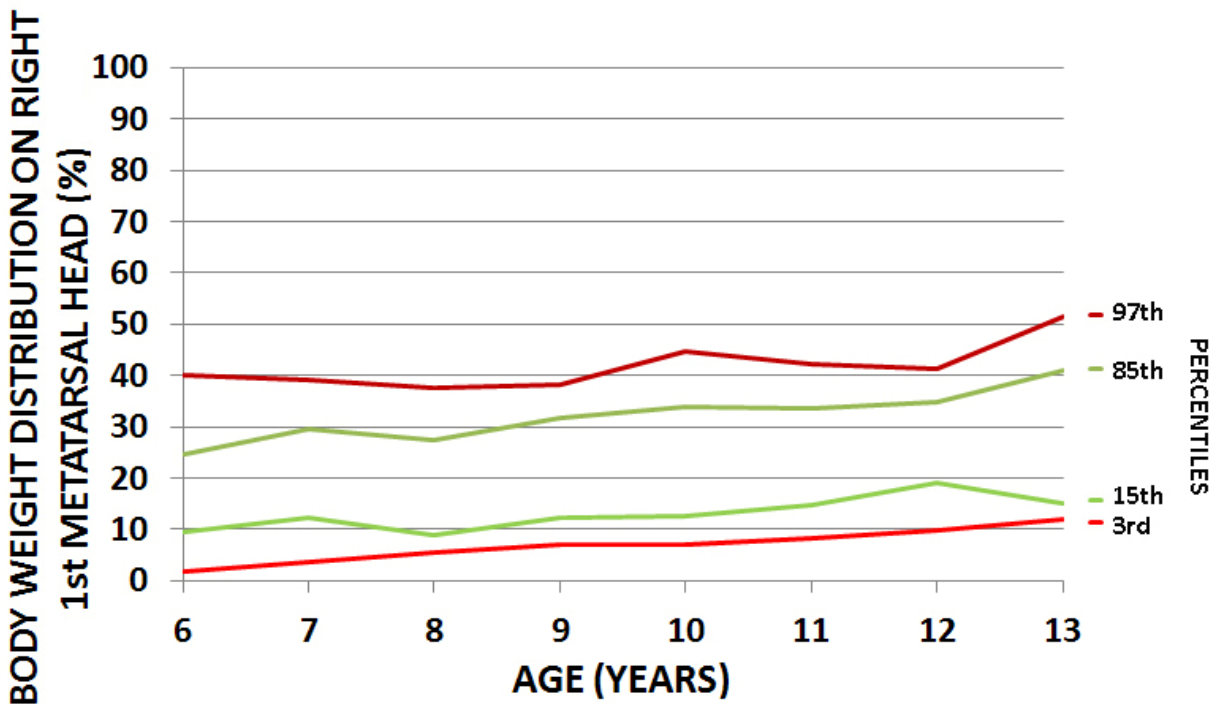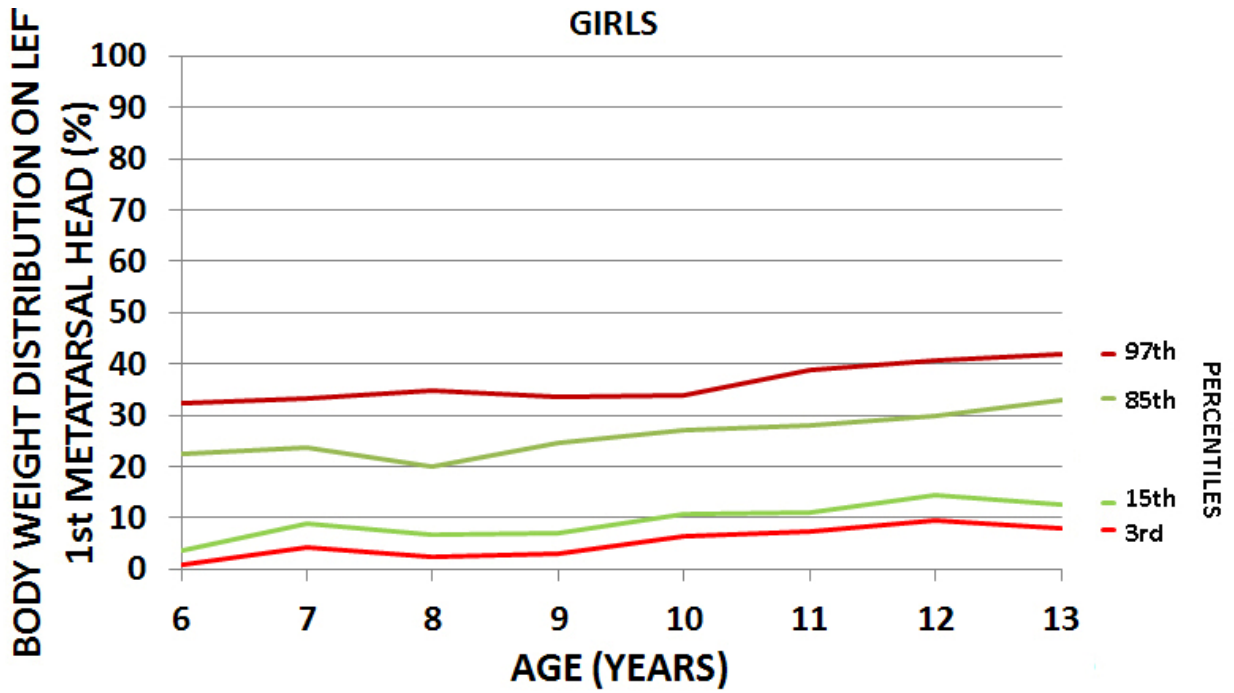| #	AGE	GENDER	BODY WEIGHT DISTRIBUTION ON LEFT FOOT (%)				BODY WEIGHT DISTRIBUTION ON RIGHT FOOT (%)			
			3rd percentile	15th percentile	85th percentile	97th percentile	3rd percentile	15th percentile	85th percentile	97th percentile
31	6	F	42	46	57	60	40	43	54	58
85	7	F	40	46	53	58	42	47	55	60
88	8	F	39	45	54	58	42	46	55	61
83	9	F	42	45	53	57	43	47	55	58
73	10	F	42	46	56	58	42	44	54	58
63	11	F	44	46	53	56	44	47	54	58
45	12	F	43	47	53	58	42	47	53	57
22	13	F	45	47	52	53	47	49	53	55

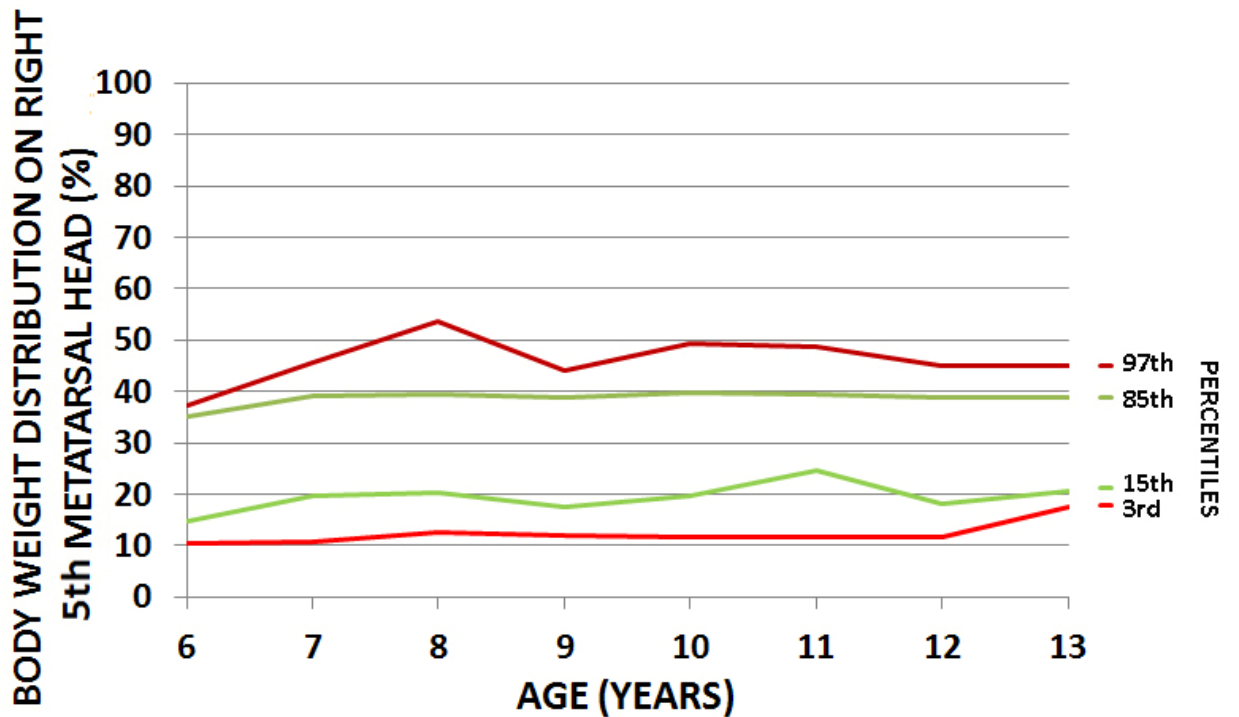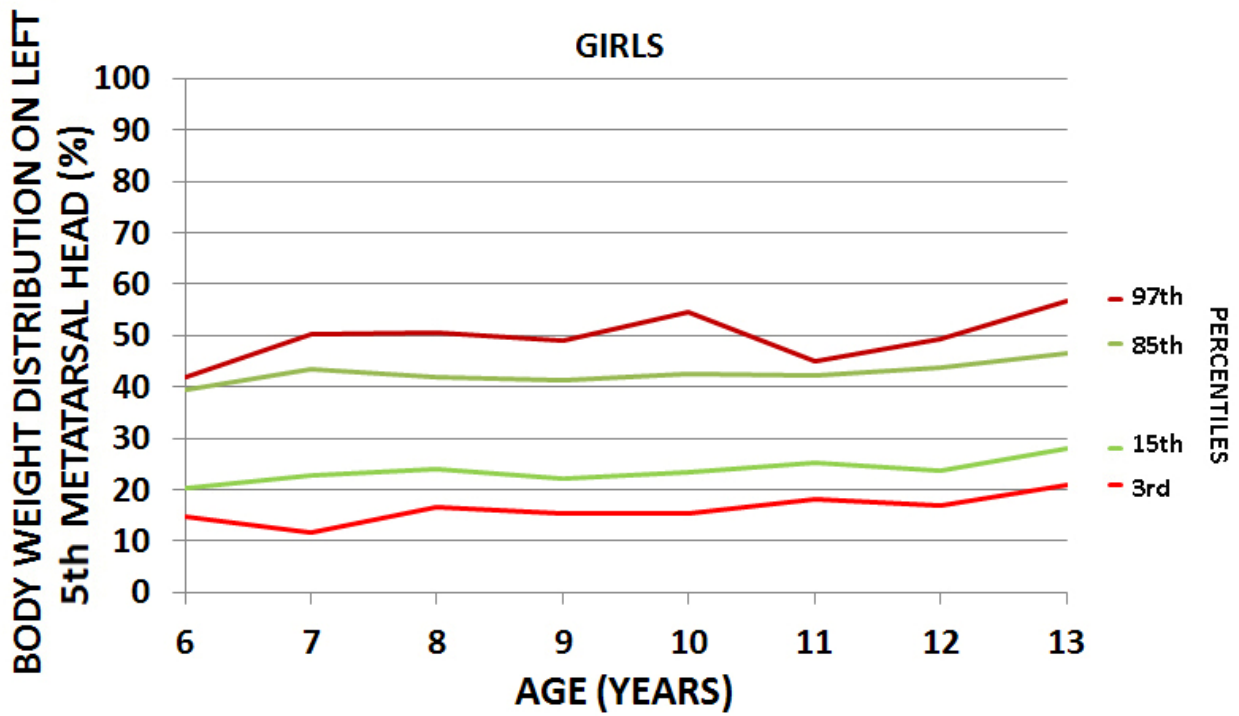| #	AGE	GENDER	BODY WEIGHT DISTRIBUTION ON LEFT 1st METATARSAL HEAD (%)				BODY WEIGHT DISTRIBUTION ON LEFT 5th METATARSAL HEAD (%)				BODY WEIGHT DISTRIBUTION ON LEFT HEEL (%)			
			3rd percentile	15th percentile	85th percentile	97th percentile	3rd percentile	15th percentile	85th percentile	97th percentile	3rd percentile	15th percentile	85th percentile	97th percentile
31	6	F	1	4	23	32	15	20	39	42	41	46	68	74
85	7	F	4	9	24	33	12	22	43	50	32	36	66	70
88	8	F	2	7	20	35	17	24	42	51	33	42	63	74
83	9	F	3	7	25	34	15	22	41	49	34	39	64	70
73	10	F	7	11	27	34	15	23	42	55	20	31	61	67
63	11	F	8	11	28	39	16	25	42	45	23	37	61	63
45	12	F	10	14	30	41	17	24	44	49	14	32	56	68
22	13	F	8	13	33	42	21	28	41	57	14	28	52	58

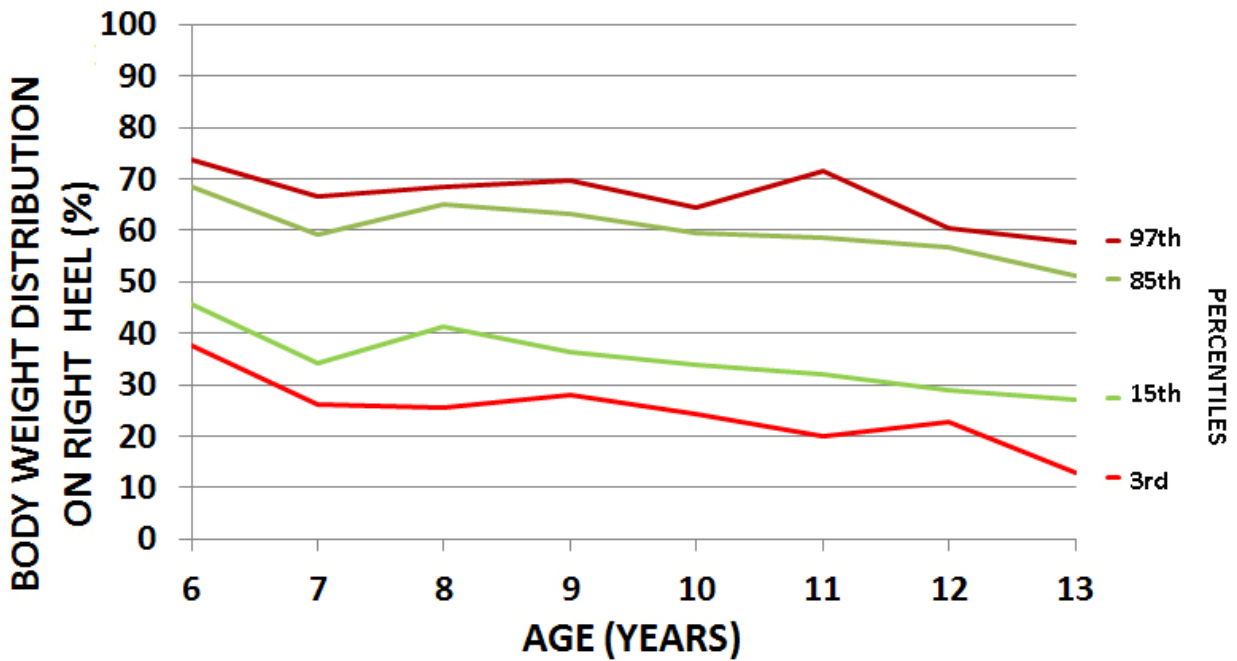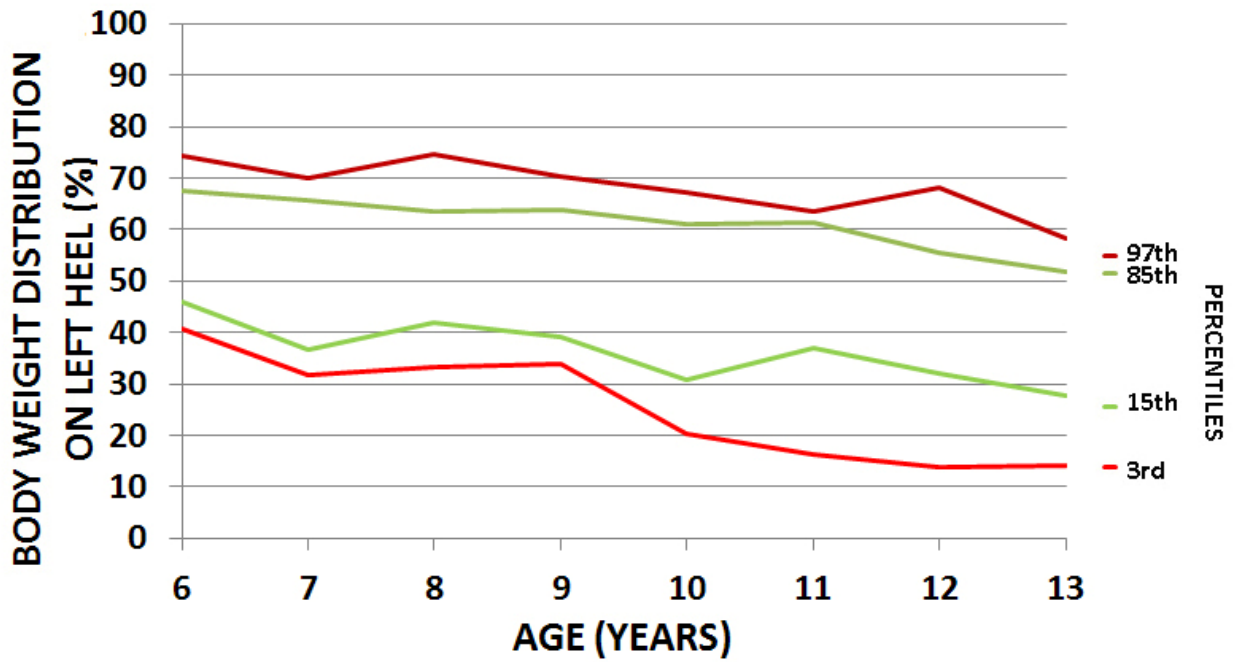| #	AGE	GENDER	BODY WEIGHT DISTRIBUTION ON RIGHT 1st METATARSAL HEAD (%)				BODY WEIGHT DISTRIBUTION ON RIGHT 5th METATARSAL HEAD (%)				BODY WEIGHT DISTRIBUTION ON RIGHT HEEL (%)			
			3rd percentile	15th percentile	85th percentile	97th percentile	3rd percentile	15th percentile	85th percentile	97th percentile	3rd percentile	15th percentile	85th percentile	97th percentile
31	6	F	2	10	25	40	10	15	35	37	38	46	68	74
85	7	F	4	12	30	39	11	20	39	45	26	35	59	67
88	8	F	5	9	27	37	13	20	39	53	26	41	65	69
83	9	F	7	12	32	38	12	18	39	44	28	36	63	70
73	10	F	7	13	34	45	12	20	40	49	24	34	60	65
63	11	F	7	15	34	42	14	25	39	49	23	32	59	72
45	12	F	10	19	35	41	12	18	39	45	23	29	57	61
22	13	F	12	15	31	52	17	21	39	45	13	27	51	58

GIRLS

GIRLS

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GIRLS

REFERENCE VALUES OF PLANTAR PRESSURE IN BOYS
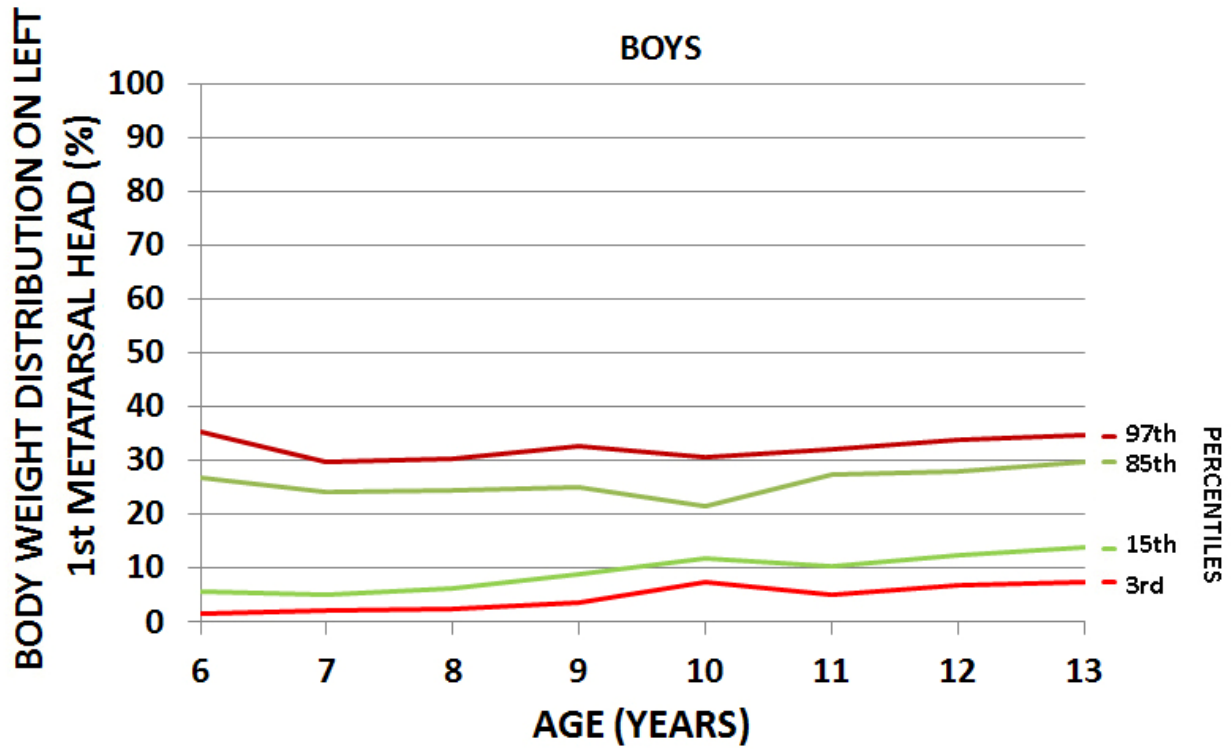
RESULTS

#	AGE	GENDER	BODY WEIGHT DISTRIBUTION ON LEFT FOOT (%)				BODY WEIGHT DISTRIBUTION ON RIGHT FOOT (%)			
			3rd percentile	15th percentile	85th percentile	97th percentile	3rd percentile	15th percentile	85th percentile	97th percentile
43	6	M	39	45	55	57	43	45	55	61
90	7	M	41	45	56	61	39	44	55	59
111	8	M	42	46	56	59	41	44	54	58
95	9	M	43	45	54	59	41	46	55	57
62	10	M	41	46	55	61	39	45	54	59
56	11	M	45	47	55	58	42	45	53	55
38	12	M	45	47	53	59	41	47	53	55
46	13	M	45	47	53	59	41	47	53	55

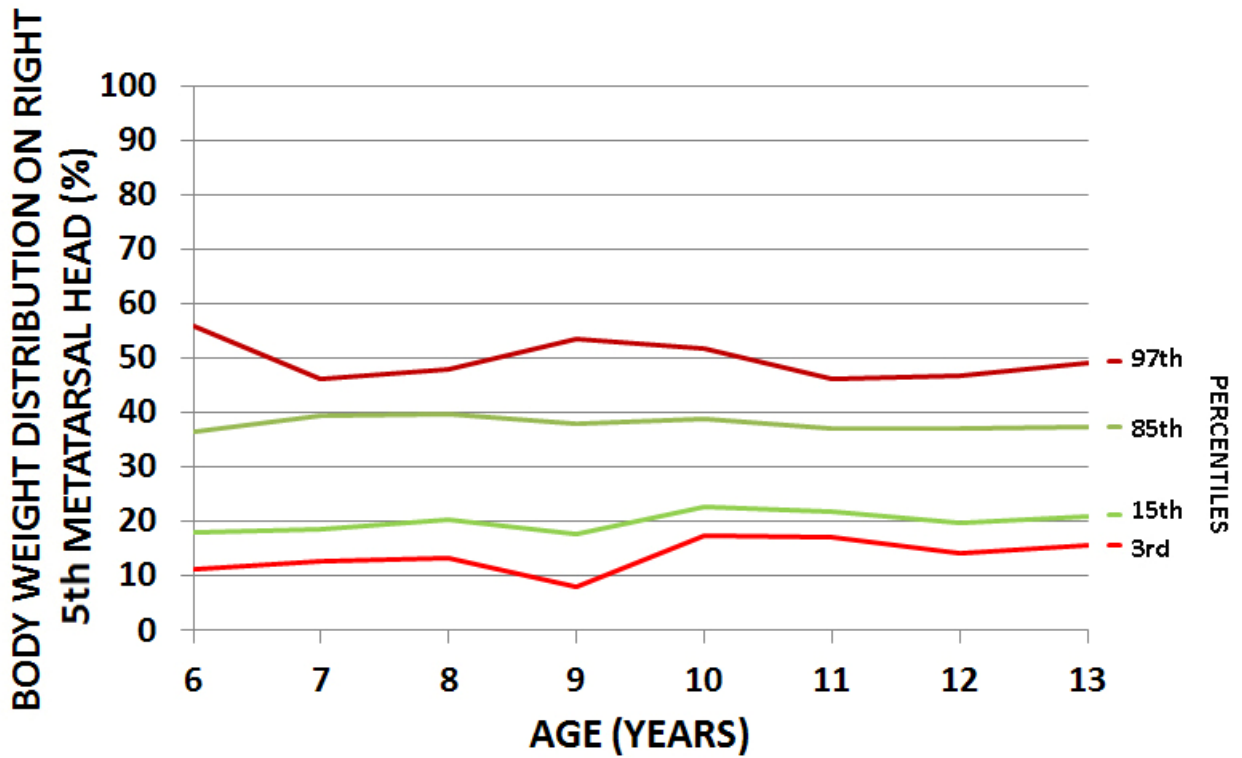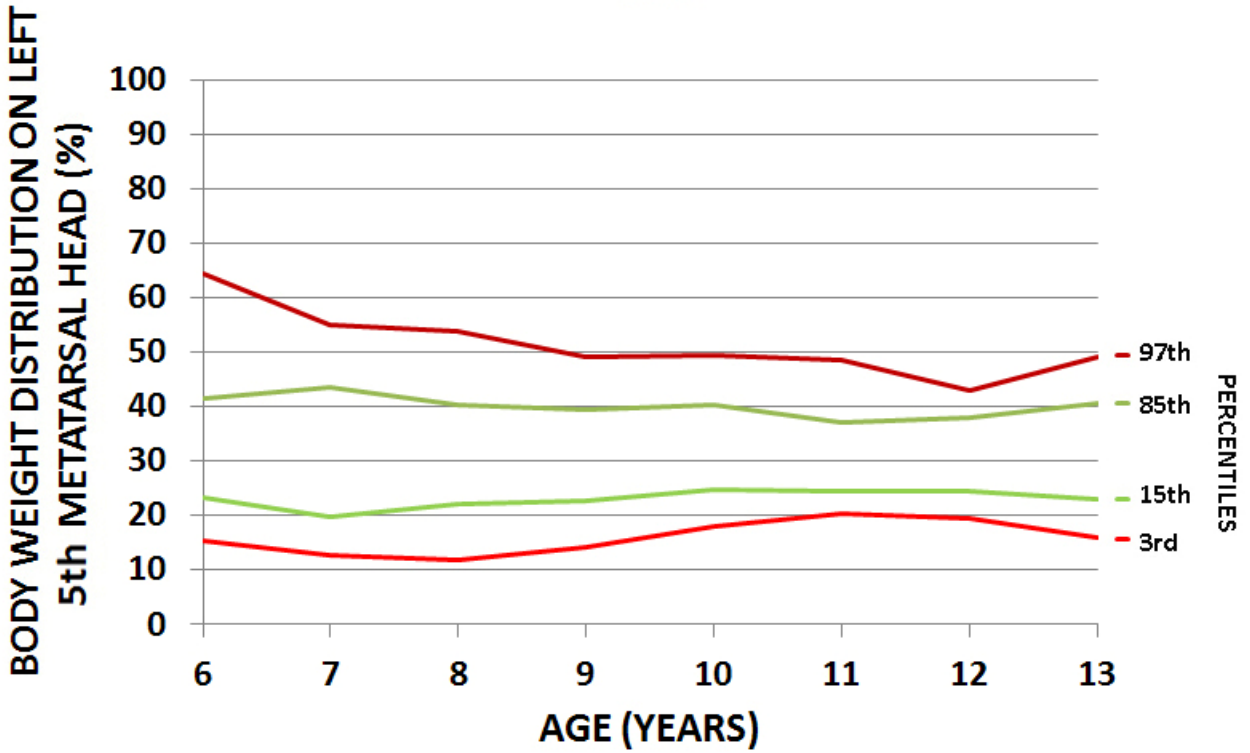| #	AGE	GENDER	BODY WEIGHT DISTRIBUTION ON LEFT 1st METATARSAL HEAD (%)				BODY WEIGHT DISTRIBUTION ON LEFT 5th METATARSAL HEAD (%)				BODY WEIGHT DISTRIBUTION ON LEFT HEEL (%)			
			3rd percentile	15th percentile	85th percentile	97th percentile	3rd percentile	15th percentile	85th percentile	97th percentile	3rd percentile	15th percentile	85th percentile	97th percentile
43	6	M	1	6	27	35	15	23	41	64	25	42	66	72
90	7	M	2	5	24	30	13	20	43	55	33	43	64	69
111	8	M	2	6	24	30	12	22	40	54	29	40	66	70
95	9	M	4	9	25	33	14	23	39	49	29	43	64	69
62	10	M	7	12	21	31	18	25	40	49	31	41	58	67
56	11	M	5	10	27	32	20	24	37	48	30	38	62	68
38	12	M	7	12	28	34	19	24	38	43	28	40	59	65
46	13	M	7	14	30	35	16	23	40	49	20	34	57	61
50	14	M	6	15	27	35	12	16	40	46	27	43	64	72
46	15	M	8	13	26	44	20	27	41	45	26	35	60	63

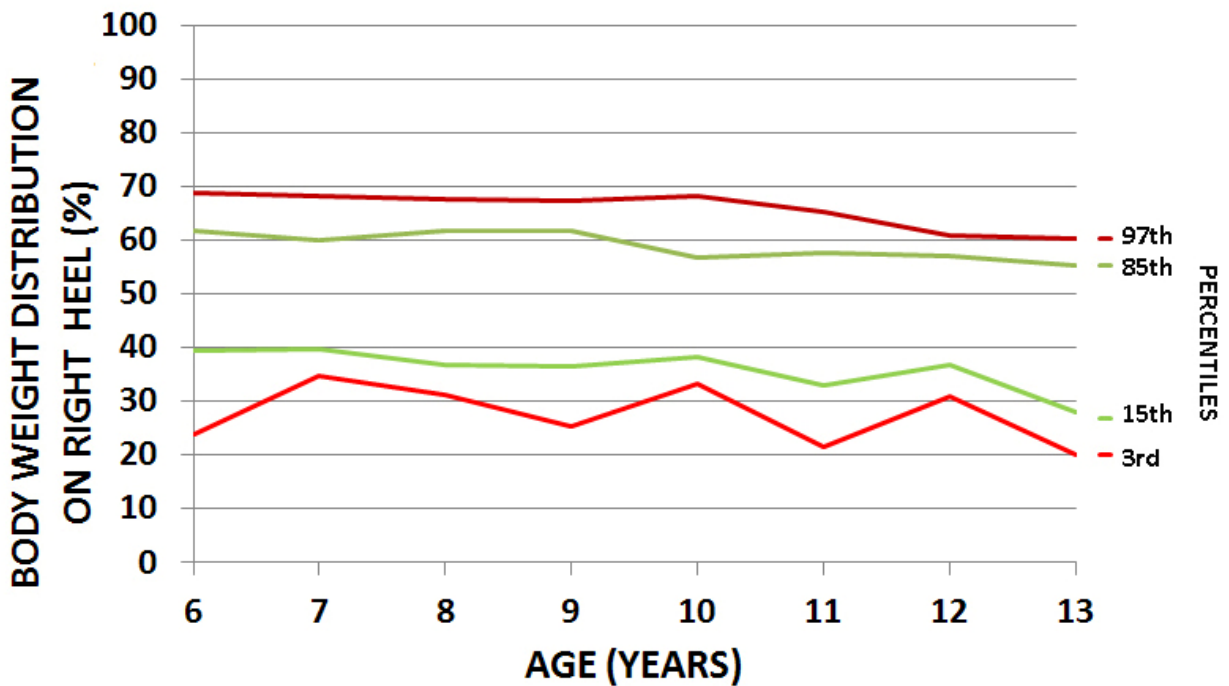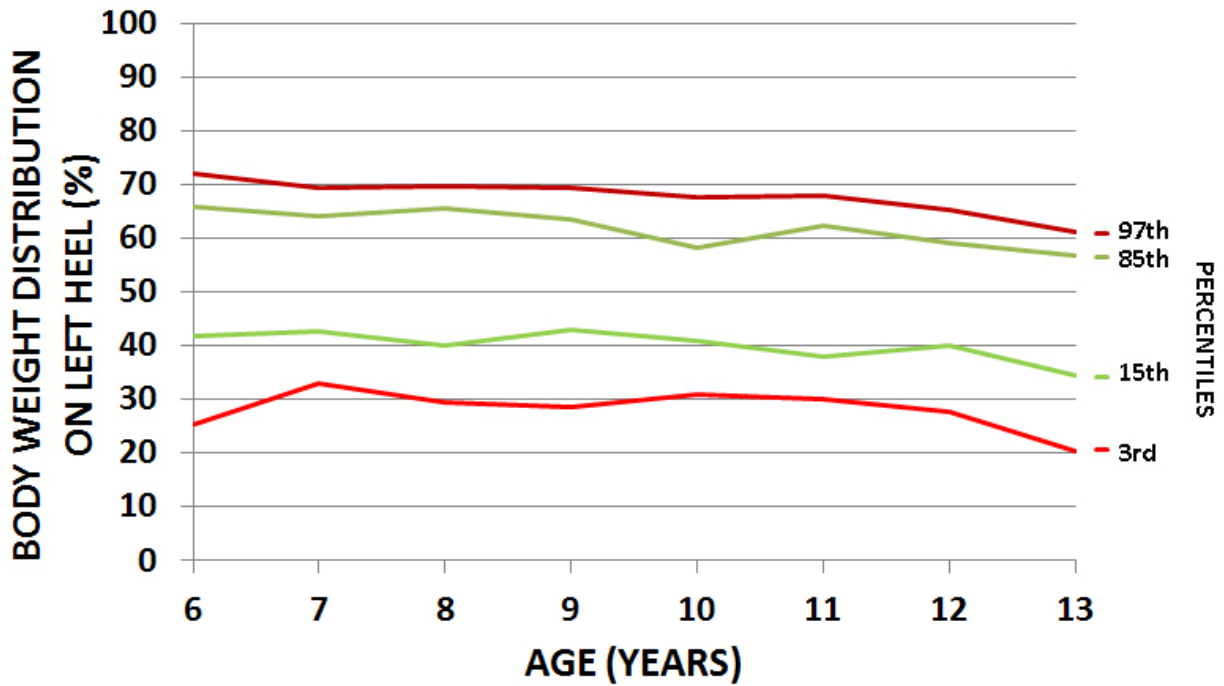| #	AGE	GENDER	BODY WEIGHT DISTRIBUTION ON RIGHT 1st METATARSAL HEAD (%)				BODY WEIGHT DISTRIBUTION ON RIGHT 5th METATARSAL HEAD (%)				BODY WEIGHT DISTRIBUTION ON RIGHT HEEL (%)			
			3rd percentile	15th percentile	85th percentile	97th percentile	3rd percentile	15th percentile	85th percentile	97th percentile	3rd percentile	15th percentile	85th percentile	97th percentile
43	6	M	5	10	33	39	11	18	37	56	24	39	62	69
90	7	M	3	8	31	39	13	18	39	46	35	40	60	68
111	8	M	4	12	30	42	13	20	40	48	31	37	62	68
95	9	M	7	13	32	38	8	18	38	54	25	36	62	67
62	10	M	7	15	28	35	17	23	39	52	33	38	57	68
56	11	M	10	14	33	38	17	22	37	46	22	33	58	65
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46	13	M	12	15	38	46	16	21	37	49	20	28	55	60
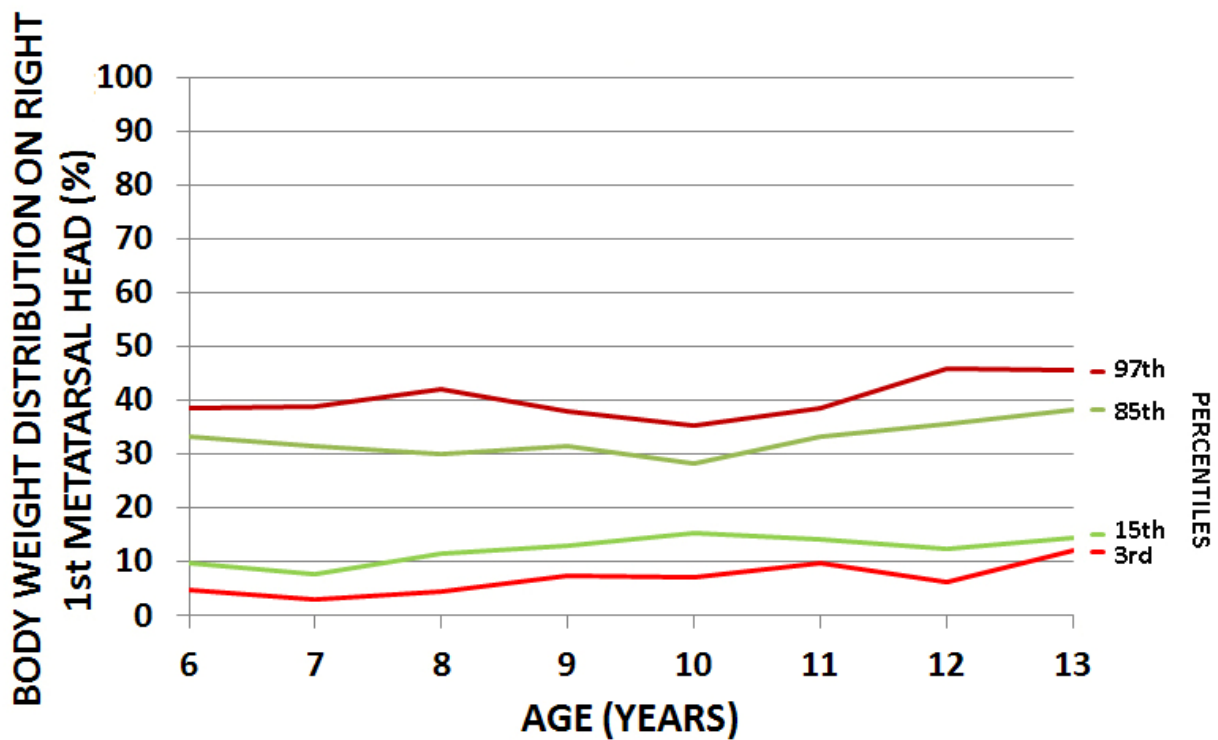
BOYS

CONCLUSIONS

As previously demonstrated, PoDATA measures are both reproducible and reliable provided they are taken following a strictly controlled protocol, that has been used throughout this study.

The results reported define the reference values (expressed as percentiles) of the distribution of foot plantar pressure on the 3 relevant anatomical locations (1st and 5th metatarsal heads and heel) in children of specific age classes and gender.

The normal values included the intervals between the 15th and 85th percentiles (one SD around the median value).

Borderline values included the intervals between the 3rd and 15th percentiles (-2SD values) and 85th and 97th percentiles (+2SD values).