

STUDIES ON BODY TEMPERATURE OF NORMAL FILIPINO CHILDREN

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This study is intended to show the average temperature of normal Filipino children and the variations with age, activity and environmental temperature. We believe that this may be of material help to medical practitioners, especially pediatricians, because of the apparent inability of our doctors to agree on what temperature among our children shall be considered a departure from health. Body temperature readings above 37° C. are often seen among children and cause apprehension on the part of the mothers. Different doctors may interpret the same temperature in various ways. One may not attach any importance to it while another may tell the mother that there is something wrong with her child. A young mother, once, in desperation, took her own temperature by rectum when doctors could not do any thing to reduce what was supposed to be an elevated rectal temperature in her child. She was pleasantly surprised to find that her rectal temperature was even higher than that of her child. This study intends to avoid such difficulties by establishing standards. It also aims to make a comparative study of different methods of temperature determination and to compare the relative reliability of these methods.

MATERIALS AND METHODS

Well children of various age groups, from the newborn age until adolescence, were used. The sources of subjects were varied and represented the areas including Manila and suburbs. Almost one-half of the subjects came from the Welfareville Institutions; the other half came from the nurseries of the Philippine General Hospital, Clinica Lopez, Correctional Institution for Women, Settlement House and from families kind enough

to consent to the study. All in all, we have a record of 3,706 determinations of body temperature representing 480 children of different ages.

Criteria used for considering these children as normal were: absence of complaints in any of them, a practically normal physical examination except for slight malnutrition in some of the Welfareville children and obvious plumpness of all.

Thermometers used were Astex centigrade clinical thermometers, tested for reliability of function and standardized by comparison with the readings of a standard thermometer when both are submerged in a heated water bath. The National Bureau of Standards of the United States accepts as tolerances for clinical thermometers readings that are accurate within 0.1° C. at 38° C. and 0.2° at 41° C. We were stricter, and we used only thermometers that gave identical readings as the standard thermometer at all temperatures of the water bath.

The initial study was undertaken during the months of January, February and early March, 1958 when the weather was relatively cool. In mid-May, corresponding to the hottest season of the year, temperatures were again taken among 104 school-age and adolescent children whose temperatures had already been taken during the cooler season. This was intended to verify whether atmospheric temperature and humidity influence the body temperature of a child.

Temperature readings were taken three times daily; to wit, (a) the waking hour, between 6 and 7 A.M.; (b) the warmest time of the day, between 1 and 2 in the afternoon; and (c) the retiring hour, between 6 and 7 at night. In around 10 per cent of the cases, daily determinations were made from 6 to 7 days consecutively; in 50 per cent, for 2 to 3 days and in the remaining 40 per cent, for one day only. For the smaller children, simultaneous temperature determinations were made with one thermometer inside the rectum and another in the axilla. For the older children, simultaneous oral and axillary determinations were utilized, while in a small group of 14 children representing 53 determinations, triple determinations of oral, anal and axillary temperature were made at the same time. The intention was to bring out possible differences in the readings of oral against axillary temperature, anal against axillary, and oral against anal temperature. Again, a group of children were ob-

served after playing or working while at the same period temperatures were also taken of another group who had just returned from mass at a nearby chapel and were thus in a virtual state of rest. This part of the work, which was carried out between 7 and 8 A.M., was intended to bring out any possible influence that the factor of muscular exertion may have on temperature of children.

Axillary temperatures were taken in all children; rectal temperatures limited to the newborn, infant proper, and half of the preschool-age children. Oral temperatures, on the other hand, were taken in the other half of the pre-school children, the school, and the adolescent children.

The procedures followed in the determination of the oral, anal and axillary temperatures of children are the standard procedures prescribed for nurses in the Philippine General Hospital (1). To summarize:

Oral:

1. Read and shake down the thermometer until the mercury registers below 35° C.
2. Place the thermometer obliquely under the child's tongue and direct him to close his lips. *Leave for 2 minutes.*
3. Remove from mouth, read, then shake the thermometer down until the mercury is below 35° C. **again.** N.B.—Oral temperature is not taken immediately after eating or drinking.

Anal:

1. Child is placed on his abdomen.
2. Wipe the thermometer dry, shake until the mercury is below 35° C., then lubricate with oil.
3. Insert gently about 1½ inches inside the rectum and hold it there *for 2 minutes.*
4. Remove, wipe, read; then wash with soap and water. Disinfect.

Axillary:

1. Dry the axilla.
2. Shake the thermometer until the mercury registers below 35° C.
3. Place the thermometer on the child's axilla with the bulb in the hollow and the stem pointing towards the chest.
4. Bring the arm across the chest or close to his side. Hold the arm if necessary.
5. Leave for *5 minutes*.
6. Remove thermometer; wipe; read; shake until the mercury is below 35° C. Disinfect.

RESULTS

Tables 1, 2 and 3 and Figures 1, 2 and 3 show the mean temperatures of Filipino children of different ages by time of day.

Table 1. MEAN RECTAL TEMPERATURE, BY AGE AND TIME OF DAY

Age Group	TIME OF DAY		
	6-7 A.M.	1-2 P.M.	6-7 P.M.
Newborn			
Birth — 1 week	36.8	37.1	37.2
1 week — 3 mos.	37.1	37.2	37.1
Infancy (excluding newborn)			
Below 2 years	37.3	37.5	37.3
Pre-school	37.6	37.7	37.7

Table 2. MEAN ORAL TEMPERATURE, BY AGE AND TIME OF DAY

Age Group	TIME OF DAY		
	6-7 A.M.	1-2 P.M.	6-7 P.M.
Pre-school (2-6 yrs.)	37.5	37.5	37.5
School (6-12 yrs.)	37.1	37.4	37.3
Adolescence (12-18 years)	37.0	37.2	37.0

Table 3. MEAN AXILLARY TEMPERATURE, BY AGE AND TIME

Age Group	TIME OF DAY		
	6-7 A.M.	1-2 P.M.	6-7 P.M.
Newborn			
Birth — 1 week	36.6	36.9	37.0
1 week — 3 mos.	36.5	36.7	36.7
Infancy (excluding newborn)	36.7	37.0	36.8
Pre-school (2-6 years)	36.7	36.8	36.7
School (6-12 years)	37.0	37.0	36.7
Adolescence	36.6	36.8	36.6

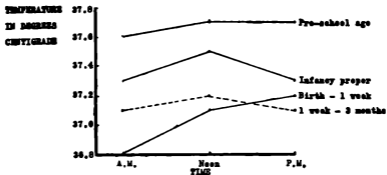


Fig. 1. MEAN RECTAL TEMPERATURE, BY TIME OF DAY

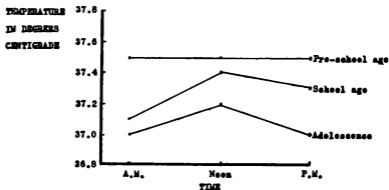


Fig. 2. MEAN ORAL TEMPERATURE, BY TIME OF DAY

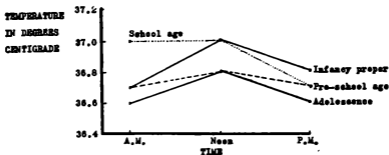


Fig. 3. MEAN AXILLARY TEMPERATURE, BY TIME OF DAY

The results show that temperatures on waking up are almost uniformly lower than the corresponding temperatures at noon and at night. Practically 98 per cent of morning values were lower by 0.1-0.3° C. than the corresponding noon values. On the other hand, noon temperatures obtained between 1 and 2 P.M. corresponding to the hottest part of the day, were higher than the evening temperatures by 0.1-0.3° C. in two-thirds of the cases, equal in one-fourth, and lower in one-sixth. In general, it can be concluded that time of the day influences the temperatures obtained in children, the lowest temperatures generally recorded in the early morning when the room temperature is at its lowest, and the highest temperatures obtained at noontime when room temperature readings are at the highest. While other factors cannot be excluded in the over-all recorded temperature of a child, it seems that time of day is an important one.

Where rectal temperature had been the method of determination, the pre-school children showed the highest recorded averages at all times of the day. The average recorded temperatures of 37.6° C. in the morning, 37.7° C. at noon, and 37.7° C. at bedtime are rather high compared to prevailing concepts. These temperatures will probably be considered indicative of fever by mothers and even by physicians. In fact, in our everyday practice we are confronted with children exhibiting such levels of temperature for which we seem unable to do anything. It is observed that the mothers of such children often say that except for the elevated temperature, these children are bright, full of pep, and otherwise without any complaint. One notes further in the case of the newborn, 1-7 days old, early morning temperatures are quite low in comparison to all other groups. On the other hand, fluctuations of temperature are much wider than in the other groups such that average daily fluctuations between morning, noon and evening temperatures reach 0.4° C. in comparison with the average 0.1-0.2° C. change in the other age-groups. These, and the observation that the temperature curve for the new borns is generally lower than that of the other groups, seem to prove the contention that newborn infants are poikilothermic and that they have lower metabolic rates because of their inactive state.

Figure 2 again shows that pre-school children show higher oral temperature readings than any other group. However, the

actual values are lower by mouth than by rectum. Figure 3 which represents axillary temperatures of all age groups, does not show any significant pattern and the trends for the various ages do not have a definite relationship with the rectal or oral determinations. This is proof that axillary temperatures are not reliable as an index of body temperature.

Tables 4, 5 and 6 show mean temperatures and temperature ranges (95 percent zone) of all age groups, classified by time of day. Comparing the results of different methods of determining body temperature, especially in pre-school children where all methods had been used, one can conclude that rectal and oral temperatures are higher than axillary temperatures; however, rectal temperatures are higher than oral temperatures. Table 7 shows the average of all rectal temperatures combined, all oral temperatures combined, and all axillary temperatures combined. Total rectal average is higher than total axillary average by 0.55° C. Total oral average is higher than total axillary average by 0.50° C. In the small group where he had simultaneous determinations of oral and rectal temperatures, the total rectal average was higher than the total oral average by 0.30° C. All these differences should thus be borne in mind when one takes temperatures by any of these routes so that he can make the necessary allowances for any value obtained by a specific method. In this connection, it might also be mentioned that when one studies individual cases, he gets the immediate idea that the range of variation between axillary readings and rectal readings on the one hand and axillary readings and oral readings on the other hand is so wide that it is obvious that the axillary temperatures are not at all reliable. Differences of 1 to 2° C. are not unusual and there are instances when axillary temperatures are exceptionally higher than either oral or rectal temperatures. It can be concluded, then, that for the detection of fevers in children, axillary temperatures are only significant when they reach febrile limits; low readings may not mean an absence of fever in the child.

Table 4. MEAN MORNING BODY TEMPERATURES, BY AGE AND METHOD OF DETERMINATION

Age Group	Rectal		Oral		Axillary		No. of Determinations
	Mean	Range*	Mean	Range*	Mean	Range*	
Newborn:							
Birth — 1 week	36.8	36.0-37.7			36.6	35.8-37.3	166
1 week — 3 mos.	37.1	36.6-37.5			36.5	36.1-37.0	70
Infancy proper:					37.0		
(3 mos. — 2 yrs.)	37.3	36.8-37.7			36.7	36.2-37.2	58
Pre-school: (2-6 yrs.)	37.6	37.0-38.1	37.5	37.0-37.9	36.7	36.1-37.4	165
School: (6-12 yrs.)			37.1	36.7-37.8	37.0	36.3-37.3	225
Adolescence: (12-18 yrs.)			37.0	36.3-37.6	36.6	36.0-37.3	51

* Range encloses 95 per cent of observations in each category.

Table 5. MEAN NOON BODY TEMPERATURE, BY AGE AND METHOD OF DETERMINATION

Age Group	Rectal		Oral		Axillary		No. of Determinations
	Mean	Range*	Mean	Range*	Mean	Range*	
Newborn:							
Birth — 1 week	37.1	36.4-37.2			36.9	36.2-37.6	166
1 week — 3 mos.	37.2	36.9-37.5			36.7	36.3-37.2	70
Infancy proper:							
(3 mos. — 2 yrs.)	37.5	37.0-38.0			37.0	36.5-37.7	58
Pre-school: (2-6 yrs.)	37.7	37.2-38.0	37.5	37.2-38.0	36.8	36.2-37.4	165
School: (6-12 yrs.)			37.4	37.0-37.9	37.0	36.2-37.4	225
Adolescence: (12-18 yrs.)			37.2	36.6-37.5	36.8	36.3-37.1	51

* Range encloses 95 per cent of observations in each category.

Table 6. MEAN EVENING BODY TEMPERATURE, BY AGE AND METHOD OF DETERMINATION

Age Group	Rectal		Oral		Axillary		No. of Determinations
	Mean	Range*	Mean	Range*	Mean	Range*	
Newborn:							
Birth — 1 week	37.2	36.5-37.9			37.0	36.3-37.0	166
1 week — 3 mos.	37.1	36.8-37.4			36.7	36.4-37.1	70
Infancy proper:							
(3 mos. — 2 yrs.)	37.3	36.7-38.0			36.8	36.1-37.6	58
Pre-school: (2-6 yrs.)	37.7	37.4-38.0	37.5	37.0-38.0	36.7	36.0-37.2	165
School: (6-12 yrs.)			37.3	36.8-37.8	36.7	36.2-37.2	225
Adolescence: (12-18 yrs.)			37.0	36.4-37.5	36.6	35.9-37.3	51

* Range encloses 95 per cent of observations in each category.

Table 7. MEAN BODY TEMPERATURE, BY METHOD OF DETERMINATION

No. of Determinations	Mean Rectal	Mean Oral	Mean Axillary	Average Difference
1071	37.3		36.75	0.55
1137		37.3	36.8	0.50
53	37.3	37.0		0.30

Another aspect of the problem is to determine whether activity can have an influence on temperature. We had the fortune to answer this question when during one of our morning visits to Welfareville, we had the opportunity to determine simultaneously the temperature of 48 school-age and adolescent children just arrived from mass held at the Chapel a stone's throw from the place, and another group of 48 children of the same age groups who had just come in from some active playing or work. Table 8 shows that the 48 children in a virtual state of rest showed definitely lower temperatures, both oral and axillary, than the 48 children who had spent some time in activity. It can thus be deduced that activity has an effect of raising body temperature and that it is on account of such an active state that pre-school children have generally higher body temperatures than other groups. It would probably have been ideal if the same subjects had been utilized for temperature determinations at rest and after activity, but this was rather hard for us to do because Welfareville children have routines that we could not just interrupt.

Table 8. EFFECT OF ACTIVITY ON BODY TEMPERATURE

	No. of Cases	TEMPERATURE	
		Oral	Axillary
1. Children at rest	48	36.8	36.5
2. Children after exertion	48	37.3	36.8

Lastly, we wanted to see whether atmospheric temperature and humidity have an influence on recorded temperatures in children. One hundred and four school-age children were utilized in our study of this particular aspect. Temperatures were taken in February when the weather was relatively cool. In mid-May, when the daily papers were carrying notices of the heat of the weather, temperatures were again recorded in the same children. Table 9 shows the results.

Table 9. INFLUENCE OF SEASON ON BODY TEMPERATURE
Mean Body Temperature (Centigrade)

Season	A. M.		NOON		P. M.	
	Oral	Axilla	Oral	Axilla	Oral	Axilla
February (cooler month)	37.1	36.6	37.3	36.9	37.2	36.7
Mid-May (warm month)	37.1	36.6	37.2	36.5	37.2	36.6

Air Temperature (Fahrenheit) and Humidity

Season	A. M.		NOON		P. M.	
	Temp.	Hum.	Temp.	Hum.	Temp.	Hum.
February	80	62%	87	45%	82	40%
Mid-May	84	56%	93	40%	88	48%

Table 9 shows that the mean oral and axillary readings taken during the early mornings of February and May were identical. The noon readings were slightly different. Mean oral and axillary readings during the cooler day of February were even slightly higher than the corresponding temperatures of mid-May. The evening oral and axillary temperatures were, again almost identical. On the whole, then, we were not able to demonstrate a relationship between body temperature and environmental temperature and humidity. However, our work in this respect has been very limited and not enough to draw conclu-

sions from. An accurate study along this line may be done in a laboratory with facilities for controlling temperature and humidity.

DISCUSSION

In man where the mechanisms for temperature regulation are fairly well developed, different parts of the body even in perfect health have different temperatures. Experiments by Hardy and DuBois (2) have shown that the temperature of the feet is lowest, followed by that of the hands, the trunk, the head and finally the rectum. The chief concern of the clinician, however, is in regard to the internal temperature of the body. For clinical purposes, the temperatures most often recorded are those of the rectum, mouth, and axilla. Rectal temperature is best for infants and young children. However, even rectal temperature has its limitations. Variations up to 1.50° F. may occur depending on the position of the thermometer, as the lowest temperatures are found in the parts of the rectal wall closest to the veins from the legs and buttocks. Depth of insertion is important and a depth of 14 cm. will give temperatures 0.2-1.3° C. higher than a depth of 2 to 6 cm., as is done in clinical practice. Recently administered enemas are also important as a factor. Finally, any thermometer withdrawn with plenty of fecal matter should be re-inserted for another reading.

For older children and adults, temperatures are more conveniently determined by mouth. Oral temperature may, however, be influenced by recent eating or drinking and it is well to remember this when taking temperatures by mouth. Axillary temperatures have greater sources of error. Granting that the procedure of determination is correct, axillary temperature can be low in the presence of fever if the child has a tendency to perspire which keeps the surface temperature low. Accurate determination of axillary temperature cannot be obtained in a thin or bony child because of defective approximation of parts. Our studies have shown that axillary temperatures are unreliable and do not parallel oral or rectal temperatures. They are only significant to the clinician when elevated. In clinical practice axillary determination finds its indication in infants with proctoclysis or its variations.

Normal values of temperature for children are hard to find. While different sources state that temperatures of children are generally higher than those of adults, actual figures are lacking except in the newborn age. Among adults, average temperatures are given by Loewenberg (4) as follows:

Mean Oral -----	98.6° F. (37.0° C.)
Range -----	97-99.2° F. (36.0-37.3° C.)
Mean Rectal -----	99.2° F. (37.3° C.)
Range -----	97.5-100° F. (36.3-37.7° C.)
Mean Axillary -----	98° F. (36.5° C.)
Range -----	96.5-97.5° F. (35.5-36.3° C.)

In newborn infants, all workers are agreed that in the course of the first few hours, the temperature may go down by 1-3° F. Shortly thereafter, it again rises to 98.5-99° F. (36.9-37.2° C.). While this has been attributed to the immaturity of the temperature-regulating mechanism, Brock, Thomas, and Peiper (5) have suggested that lack of practice of the mechanism in temperature regulation may be more important. Smith (6) supports this view because attainment of relatively good temperature control occurs so quickly in normal newborns that it is difficult to conceive of actual anatomic maturation as playing the major role.

As an infant normally grows, he acquires an increasingly more stable basal metabolism with the acquisition of regular meal habits, increased and stabilized activity, a characteristic thick panniculus, and increased neural control of his peripheral vascular system. Among bigger children, Talbot (7) mentions a study where oral temperatures had been taken in a group of children aged 2 to 12 years, under all sorts of conditions without regard for surrounding temperature, season, time of day, degree of muscular activity, or amount of clothing worn. It is interesting to note that the average of the observations closely approximates 37° C. (98.6° F.), which is the accepted standard for normal healthy adults. On the other hand, Holt and McIntosh (8) state that rectal temperature under normal conditions varies from 98-99.5° F. (36.7-37.5° C.); occasionally the range may be as wide as 97.5-100.5° F. (36.4-38.1° C.) in apparent perfect health. These figures are nearer our results.

Temperature fluctuations have been thoroughly studied by Jundell (9) who has found that in 2 to 5 year olds, the daily fluctuations in temperature are considerably greater than in adults. Bosma and Kelley (10) call attention to this physiological fact as the cause of many healthy children being confined in bed for prolonged periods because of the occurrence of a daily "fever" which is in reality only a reflection of a normal temperature variation.

SUMMARY

1. Temperatures of children are variable, depending on the time of the day. The lowest temperatures are recorded during the early morning and the highest during the hottest part of the day between 1 and 2 P.M.
2. The newborns show the lowest rectal temperatures during the mornings; they also show the greatest fluctuations of temperature during the day.
3. Pre-school children have the highest body temperatures, whether rectal or oral, probably because of their inherent over-activity. Average recorded temperatures of 37.6-37.7° C. during the day are often misinterpreted as fevers by parents and doctors.
4. Axillary temperatures are lower than oral and rectal temperatures by 0.5° C. and 0.55° C. respectively. Oral temperatures are lower than rectal temperatures by an average of 0.3° C. Axillary temperatures are unreliable and should not be used as a routine in temperature determination.
5. Muscular exercise influences body temperature, the rise it causes being non-pathologic in character. Muscular exertion influences body temperature by elevating local temperature of the muscles concerned, elevating rectal temperature and to a certain degree oral temperature of the subject.
6. We failed to show correlation between environmental temperature and humidity on the one hand and body temperature on the other hand. Our work was quite limited and we lacked the necessary room and equipment to control the factors of room temperature and humidity.

ACKNOWLEDGMENTS

We wish to acknowledge our gratitude to the officials and personnel of the following institutions — The Philippine General Hospital, the Clinica Lopez, the Correctional Institution for Women, the Settlement House and the Welfareville Institutions.

We also thank the Associated Drugs, Inc. for supplying us a number of Astex clinical thermometers used in the study and Dr. Victor C. Valenzuela of the Institute of Hygiene for his suggestions in the preparation of the tables. Last but not least, we are indebted to Prof. Irineo Lawas of the U.P. College of Medicine for having given us invaluable aid during our study.

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