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Range for Normal Body Temperature in the General Population of Pakistan

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Abstract

Objectives: To determine the range for normal body temperature in the general population of Pakistan and to determine if any age, sex and ambient temperature related variations exist in body temperature. Moreover, to compare how much axillary temperature differs from oral temperature measurements.

Methods: Oral as well as left and right axillary temperature recordings were made using an ordinary mercury-in-glass thermometer in 200 healthy individuals accompanying patients at various clinics at the Sindh Institute of Urology and Transplantation (SIUT) between mid-May to mid-June 2006. Data analysis was done using Epi Info version 3.3.

Results: The range for Normal Oral Temperatures fell between 97 degrees F to 99.8 degrees F (mean 98.4 degrees F). There were no significant age related (p=0.68) and ambient temperature related variations (p=0.51) in body temperature, but women had slightly higher normal temperatures than men (mean 98.5 degrees F vs. 98.3 degrees F; p=0.01). A wide variation existed in the difference between oral and axillary temperatures, with axillary temperatures ranging up to 2.6 degrees F lower or up to 1.1 degrees F higher than the oral temperatures (mean difference=0.85 degrees F). The correlation between oral and axillary temperatures increased at higher oral temperatures (p=0.009).

Conclusion: There is a range for Normal Body Temperature and any temperature above 98.6 degrees F/37 degrees C is not necessarily pathological. Women appear to have higher body temperatures. As there is no uniform oral equivalent of axillary temperature, the latter should be interpreted with caution.

Introduction

The body produces heat by muscular exercise, assimilation of food and the vital processes and this is lost from the body by radiation, conduction and vapourization, and in small amounts through urine and faeces. The balance between the heat production and heat loss determines the body temperature. Normal body function depends upon a relatively constant body temperature[1]. Despite the widespread application of thermometry in clinical medicine for over a century and a half, the definition of normal body temperature is still debated[2].

The academic study of body temperature began in 1868[3]. Normal body temperature has traditionally been considered to be 98.6ºF (37ºC). However, a recent study indicates that normal body temperature (measured orally) varies among individuals as well as throughout the day ranging from 96ºF in the morning to 99.9ºF in the evening with an overall average of 98.2ºF[4].

There are many factors causing variation in normal body temperature, for example there is a gender based variation in normal body temperature[5,6]. Also, data is available on age related variations in the normal body temperature[7,8]. Body temperature is very sensitive to hormone levels and women exhibit increases in body temperature of about 0.9°F at the time of ovulation[9]. In addition, exercise, digestion and underlying disorders such as chronic renal failure and shock, and neuro-psychiatric disorders such as chronic depression may alter the thermoregulatory response[9]. Ambient temperature and humidity have also been shown experimentally to affect body temperature[9].

Temperature checking is an integral part of patient care as it influences diagnosis and subsequent patient management. The temperature measurements vary

according to the site where the temperature is recorded; oral, rectal, tympanic and axillary body temperatures[6]. Of the three sites most commonly used for clinical thermometric measurement (rectum, mouth and tympanic membrane), the oral temperature measurements have long been standard in clinical practice, largely because of accessibility, but also because oral temperature responds promptly to changes in the core temperature[9]. The temperature of the sublingual pocket is especially relevant clinically, because its main artery is a branch of the external carotid artery and, like its parent artery, responds quickly to changes in the core temperature[9]. Axillary temperature measurements are also used as an alternative being particularly convenient in young children and in un-cooperative adults. However, studies have shown mixed results with regard to the oral equivalent of axillary temperatures[10], and the reliability of axillary temperature measurements[11].

In Pakistan, the range for normal body temperature has not been ascertained and often temperature of 99ºF is considered as fever. We therefore carried out a study to determine the range for normal body temperature and to determine if any age, sex and ambient temperature related variations exist in the body temperature. We was also compared how much the axillary temperatures differed from oral temperature measurements.

Subjects and Methods

We carried out a small scale observational cross sectional study in which 200 subjects including equal number of males and females were selected by stratified sampling method. All apparently healthy individuals accompanying patients at the different clinics at the Sindh Institute of Urology and Transplantation (SIUT) between mid May to mid June 2006 were included in the study. A questionnaire was prepared which contained details about the age, sex, ambient temperature, time of the day, pregnancy and last menstrual period (LMP) in case of females, history of any chronic illness like diabetes and hypertension and history of any recent infections and if the subject was on any medications, and the oral and right and left axillary temperature recordings.

Infants and young children were excluded due to non-compliance, while subjects with any chronic illness or those having a recent history of infections such as urinary tract infection (UTI), respiratory infections or sore throat etc were also excluded to avoid discrepancies in temperature recordings. Similarly, pregnant women and women suspected to be at or around their ovulation were also excluded to avoid discrepancies in temperature recordings due to altered hormone levels.

Each subject's body temperature was recorded by an ordinary mercury-in-glass thermometer. The temperature was first taken orally by positioning the bulb of the thermometer in the sublingual pocket in each subject. For axillary temperature measurements, the bulb of the thermometer was placed midway between the anterior and posterior axillary folds first in the right and then in the left axilla, and the temperature recordings for each axilla were recorded. The average of the temperatures on both sides was recorded as the mean axillary temperature in each subject for accuracy in axillary temperature measurement. For each temperature measurement the thermometer was kept at the body site for 2 minutes. The thermometer bulb was wiped with 70% alcohol at room temperature before checking the temperatures at different sites. All temperature recordings were made in the day time (morning/afternoon) in the waiting areas of the clinics at SIUT. The ambient temperature of the waiting areas was measured by using a wall mounted thermometer with a measuring range between -20ºF and 140ºF. This thermometer was mounted at a central point in the waiting areas each day and the ambient temperature was recorded before each subject's body temperature recording was made, so that large fluctuations in the environmental temperature do not interfere with the body temperature recordings.

Permission and approval for the study was taken from the Director of the institute prior to initiation of the study. Informed consent was taken from each subject and confidentiality and anonymity of the record was maintained. Data entry and analysis was done on Epi Info Version 3.3. The t-test was used for significance testing and a p value less than 0.05 was taken to represent a statistically significant result.

Results

A total of 200 subjects were included with equal number of males and females. Of these 16 were excluded due to history of recent infections (UTI, respiratory infections and sore throat). Of the remaining 184 subjects 52.7% (n=97) were females while 47.2% (n=87) were males. The average age of the subjects was 34 years (range=9-70 years). Using 34 years as the cutoff point, the subjects were divided into two age groups. The younger age group comprised 50% of the subjects (n=92) while the older age group also comprised 50% of the subjects (n=92). The ambient temperature of the waiting areas of the clinics ranged between 79ºF and 90ºF (mean=82.9 ± 1.9ºF). The range for Normal Oral Temperatures for all subjects fell between 97ºF to 99.8ºF with the mean falling at 98.4 ± 0.52 ºF. (Figure)

There were no significant age related variations in body temperature (p=0.68), but women had slightly higher

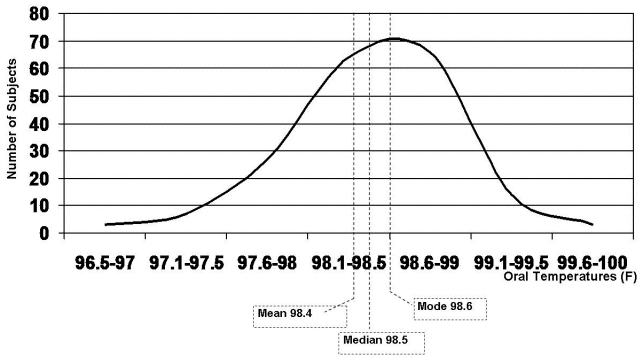

Figure: Distribution of oral temperatures in healthy individuals. Graphical representation of the distribution of oral temperatures in healthy individuals of our study population, depicting the mean oral temperature, the median and mode. The normal oral temperatures in our study population ranged from 97ºF to 99.8ºF.

normal body temperatures than men (p=0.01). The varying ambient temperature did not cause any significant variations in the body temperature (p=0.51). (Table-1)

Table-1: Age, Sex and Ambient Temperature related variations in normal body temperature.

		Mean Temperature (ºF)	p value
Age	< 34 years	98.5	0.68
	≥ 34 years	98.4	
Sex	Male	98.3	0.01
	Female	98.5	
Ambient Temperature (ºF)	< 82.5	98.5	0.51
	≥ 82.5	98.4	

The axillary temperature in the right axilla ranged from 96ºF to 99.6ºF (mean=97.5 ± 0.72ºF) and that in the left axilla ranged from 96ºF to 99.4ºF (mean=97.6 ± 0.74 ºF). There was no significant difference in the axillary temperatures in the right and the left axilla (p=1.00). The average axillary temperature was therefore calculated, the mean of which was 97.5 ± 0.68ºF ranging from 96.1ºF to 99.5ºF. This was lower than the oral temperature by an average of 0.85ºF. However, there was a wide variation in this difference, with axillary temperatures up to 2.6ºF lower or up to 1.1ºF higher than the oral temperatures. About 11.4% of the subjects (n=21) had higher axillary temperatures while 88.5% of the subjects (n=163) had higher oral temperatures.

With increasing oral temperatures, the difference between the oral and axillary temperature also increased (p=0.009). This difference ranged from a mean of 0.5ºF at oral temperatures between 97ºF to 97.7ºF increasing to a mean of 1.4ºF at oral temperatures between 99.2ºF to 99.8ºF, thus showing no constant difference between the oral and axillary temperatures. (Table-2)

Table-2: Mean difference between oral and axillary temperatures with increasing oral temperatures.

	ORAL TEMPERATURES (ºF)			
	97-97.7	97.8-98.4	98.5-99.1	99.2-99.8
Number of Subjects (n)	16	74	77	17
Mean Oral Temperature (ºF)	97.4 ± 0.24	98.1 ± 0.21	98.7 ± 0.16	99.3 ± 0.18
Mean Axillary Temperature (ºF)	96.9 ± 0.65	97.4 ± 0.62	97.7 ± 0.62	97.9 ± 0.73
Difference between mean oral & and mean axillary temperatures	0.5	0.7	1.0	1.4

Discussion

The main aim of this study was to determine the range for normal body temperature in apparently healthy subjects and to prove that no single cut off temperature can be ascertained to separate normal temperature from fever. This was proved by a wide variation in the normal body temperatures seen in our study. A temperature of 98.6ºF is often considered as "normal" and is taken as the upper limit of normal body temperature. But one of the largest studies of oral temperature in healthy subjects demonstrated a mean temperature of 98.2ºF (36.8ºC) and concluded that 98.6oF (37ºC) should be abandoned as a concept relevant to clinical thermometry and 98.9ºF (37.2ºC) in the early morning and 99.9ºF (37.7ºC) overall should be regarded as the upper limit of the normal oral temperature range in healthy adults aged 40 years or younger[5]. No single temperature can be considered normal, because measurements in many healthy individuals have shown a range of normal temperatures measured orally from less than 97ºF (36ºC) to over 99.5ºF (37.5ºC)[12]. Our study also conflicted with the concept of 98.6ºF, as the mean oral temperature of our subjects was 98.4ºF with a wide range of normal oral temperatures from 97ºF to 99.8ºF.

Many factors can contribute to the variation of body temperature. One study pointed towards the consideration of the gender of the subject when assessing normal body temperature as it was found that the range for normal body temperature in men was 96.2ºF to 100ºF (35.7ºC to 37.8ºC) while in women it was somewhat wider, ranging from 91.7ºF to 100.5ºF (33.2ºC to 38.1ºC)[6]. Another study confirmed that women had slightly higher normal temperatures than men[5]. Wunderlich and Seguin also maintained that women have slightly higher normal temperatures than men overall and often show greater and more sudden changes in temperature[9]. This was also seen in our study as we found a statistically significant

difference between the normal temperatures of men and women, with women having slightly higher normal temperatures than men.

Some studies have been particularly conducted to determine the effect of age on the normal body temperatures. One such study used a noninvasive temporal artery thermometer to establish mean temperatures for healthy infants, children and adolescents and found a mean of 98.7ºF (37.1ºC) for infants 0 to 2 months, 98.4ºF (36.9ºC) for children 3 to 47 months, 98.2ºF (36.8ºC) for children 4 to 9 years and 98ºF (36.7ºC) for adolescents 10 to 18 years showing decreasing mean temperatures with age[8]. Another study confirmed that "older is colder" and older subjects have mean oral body temperatures lower than 98.6ºF[7]. Our study conflicted with these results as there were no statistically significant age related variations in the normal body temperature in our subjects. This may have been due to the relative homogeneity in the ages of our study population.

One study also revealed the effect of moderate ambient temperature variance and proved that spuriously elevated oral temperatures may occur in warm examination areas[13]. However, as most of our subjects were in a cool and covered area of the hospital, variations in the ambient temperature were minimal and this had no significant effect on the body temperatures.

Axillary temperature is commonly used because of convenience and safety and because measurement of the oral temperature may be unhygienic. The accuracy of axillary temperature has been debated. Some studies have supported axillary temperature measurement as an acceptable alternative to rectal/oral temperature measurements[14-16], while another study obtained a correction factor of 1ºF for the correct oral equivalent of axillary temperature[10]. The same study also showed a wide range of difference between the right and the left axillary temperature measurements and concluded that for accurate axillary temperature, the mean of the right and left axillary temperatures should be considered[10]. Other studies have refuted the reliability of axillary site for temperature measurement[17,18]. Yet another study concluded that axillary temperatures may be misleading and should be abandoned in the outpatient setting[19].

Loudon showed that axillary temperature measurements with mercury thermometers vary from 2.6°F lower to 1°F higher than simultaneous oral measurements[9]. Nichols and colleagues reported that axillary temperatures exhibit differences of 0°F to 4.2°F compared with oral temperature readings in adults[9]. Falzon A, et al revealed a wide variability in the difference between oral and axillary temperature and proved that the variation between oral and axillary temperatures increases further with increasing body temperature[11]. Our study also showed a wide range of difference between oral and axillary temperatures and an increase in the difference with increasing oral temperatures. This may be due to the known time lag in temperature elevation between the central and the core[11]. Thus, we were unable to find a uniform correction factor between the axillary and oral temperatures making the standard practice of adding 1ºF to the axillary temperature questionable.

Unfortunately, we were unable to calibrate the thermometer between each temperature measurement which may have impacted the accuracy of our results. Another limitation of our study may have been the relatively short time the thermometer was kept at the body site.

Conclusion

There is a range for normal body temperature and any temperature above 98.6ºF (37ºC) is not necessarily pathological. Women appear to have higher body temperatures than men but there is no effect of age and ambient temperature level on the body temperature. As the correlation between oral and axillary temperature differs at higher and lower oral temperatures and the difference between the two increases with increasing oral temperatures, it is therefore impossible to obtain an accurate correction factor. Nevertheless, axillary temperatures are indeed a convenient mode of temperature recording in children and un-cooperative adults, but as they do not reliably reflect oral temperatures, they should therefore be interpreted with caution.

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