Original Article

Comparison of Oral, Tympanic and Fresh Urine Temperature in Healthy Young Adult Males in Kingdom Suadi Arabia

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ABSTRACT

Background: Core body temperature (CBT) is commonly evaluated by measuring oral (OT) and tympanic membrane (TT) temperatures; however, there are considerable debates on which of these methods is the most appropriate.

Objective: To evaluate concordance of OT and TT with CBT.

Material and Methods: OT, TT and fresh urine temperature (FUT) were measured simultaneously in 45 apparently healthy young adult males from Buraydah, Qassim, KSA during July 2015. All readings were obtained between 7:00 and 10:00 pm according to the standard methods. FUT was used as indicator of CBT.

Results: OT (36.35±0.41° C) was significantly higher compared with TT (35.99±0.81° C, P = 0.013) as well as FUT (35.55±0.76° C, P < 0.001). TT was significantly higher compared with FUT (P = 0.003). Using one sample t-test, the difference between OT and TT (0.36±0.92° C, P = 0.011), OT and FUT (0.80±0.90° C, P < 0.001) and TT and FUT (0.44±0.80° C, P = 0.001) were significantly above zero. Disconcordance of the OT, TT and FUT measurements are further illustrated by Bland-Altman plots. There were no significant correlations between OT and TT as well as between OT and FUT. However, TT correlated positively with FUT (*r* = 0.48, P = 0.001).

Conclusions: OT and TT are inappropriate measures for CBT. CBT has influence on TT, but not OT.

Key words: Core body temperature, oral, tympanic, urine.

Assessment of body temperature is an essential part of clinical examination[1, 2]. Physiologically, core body temperature (CBT) is kept within narrow limits[3]. Significant alteration in the CBT is closely related to diseases and usually enforces patients to seek medical advice[4, 5]. Body temperature is commonly evaluated by oral, axillary, rectal, urinary bladder and tympanic membrane thermometry; however, there are considerable debates on which of these methods is the most appropriate[6-12]. Smoking, mouth breathing, recently taken food and drinks are likely to affect oral thermometry[7] and hence preclude this method as a faithful indicator of CBT[8]. Although measurements derived from rectal[9] and urinary bladder[10] thermometry correlate better with CBT than oral temperature (OT), they are inconvenient for most of the patients. Theoretically, tympanic membrane shares a common blood supply with the thermoregulatory centers in the hypothalamus and may therefore reflect CBT better than the other methods[11, 12]. However, previous studies evaluating reliability of tympanic thermometry as an indicator of CBT failed to confirm this implication[13-15]. There is

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evidence that fresh urine thermometry is useful in the determination of basal body temperature[16]. Kawanami and his colleagues measured fresh urine temperature (FUT) of 31 subjects to ascertain whether or not this measurement could act as an index for CBT. Results showed close correlation and acceptable limits of agreement between FUT and rectal temperature (RT)[14]. Kawanami *et al* concluded that FUT is a reliable surrogate for RT in biological monitoring of CBT.

Age[17], gender[18], ambient temperature (AT)[19], day-night cycle[20], body mass index (BMI)[21]and smoking[22] are known to affect CBT. Gender difference of body temperature can be attributed to the variations of surface area, subcutaneous fat thickness, evaporative efficiency of sweating and sex hormones in men compared with women[18,23]. Cigarettes smoking, which is more common among males in Arab countries, is known to affect energy expenditure[24] and thus CBT[7]. The aim of the present study is to evaluate concordance of OT, tympanic (TT) and FUT in apparently healthy young adult males. In addition, OT, TT and FUT were compared between smokers and non-smokers. The studied subjects were selected in a way that ensured less influences of age, gender and related physiological parameters on the expected variations in OT, TT and FUT[17, 18, 21, 22].

MATERIAL AND METHODS:

The study enrolled 45 apparently healthy young adult Saudi Arabian males from Buraydah, Qassim, KSA during July 2015. Participants with fever, otitis, oral, nasal, pharyngeal, upper respiratory, urinary infections and other acute or chronic diseases were excluded from the study. Medical digital thermometer (Flex temp smart, OMRON, New York, USA) was used for measuring OT and FUT. TT was measured using ear thermometer (ThermoScan 7, Braun, Germany). A team of three individuals worked simultaneously to measure OT, TT and FUT respectively so as to minimize the time laps between the readings of the three methods. All readings were obtained between 7:00 and 10:00 pm as described before[11].

A sample size of 45 males was calculated to give a significant difference in the mean of OT, TT and FUT with 80% power and a difference of 5% at $\alpha = 0.05$.

SPSS for windows version16.0 (SPSS Inc., Chicago, IL, USA) was used for statistical analysis of the data. OT, TT and FUT were expressed with mean (M) ± standard deviation (SD). Student T-test was used to assess significant differences between the three temperature measurements and to compare each temperature measurement between smoker and non-smokers. Using one sample T test, Concordance of OT, TT and FUT was evaluated by assessing if the mean of the algebraic difference of a pair of these measurements is significantly above or below zero. Concordance of OT, TT and FUT were also evaluated by Bland-Altman plots [25]. Associations between OT, TT and FUT were assessed by bivariate correlations. $P < 0.05$ was considered significant.

RESULTS:

The M±SD of OT, TT and FUT of the studied groups (N = 45, age = 23.07±3.10 years) were 36.35±0.41°C, 35.99±0.81° C, 35.55±0.76° C respectively. There were no significant correlations between OT and TT as well as OT and FUT. However, increase in TT was associated with significant increase in FUT ($r = 0.48$, $P = 0.001$).

OT was significantly higher compared with TT ($P = 0.013$) as well as FUT ($P < 0.001$) (table 1). In addition, TT was significantly higher compared with FUT ($P = 0.003$). Using one sample T-test, the difference between OT and TT (0.36±0.92° C, $P = 0.011$), OT and FUT

(0.80±0.90° C, P < 0.001) and TT and FUT (0.44±0.80° C, P = 0.001) were significantly different from zero (table 2). Disconcordance of the OT, TT and FUT measurements are further illustrated in Bland-Altman plots shown in figures 1, 2 and 3.OT, TT and FUT of smokers were not significantly different compared with non-smokers (table 3).

DISCUSSION:

The present results revealed significant differences between OT, TT and FUT. OT achieved the highest readings, followed by TT and lastly FUT in a descending manner. The average difference between OT and TT was 0.4 °C, which was equivalent to the difference between TT and FUT. These findings are comparable with some previous studies [8, 9, 13, 15], but not others [11, 12, 14, 16]. Noteworthy, previous reports measured pulmonary artery, esophageal, rectal and urinary bladder temperatures as indicators of the CBT. The present study use FUT for estimation of CBT.

Table 1: Measurements of OT, TT and FUT of the studied groups

	N = 45 M±SD	P
OT (°C)	36.35±0.41	Oral vs. Tympanic = 0.013
TT (°C)	35.99±0.81	Oral vs. Urine < 0.001
FUT (°C)	35.55±0.76	Tympanic vs. Urine = 0.003

Table 2: Concordance of OT, TT and FUT measurements

	N = 45 M±SD	P*
Difference between OT and TT (°C)	0.36±0.92	0.011
Difference between OT and FUT (°C)	0.80±0.90	< 0.001
Difference between TT and FUT (°C)	0.44±0.80	0.001

* P values are derived from comparisons between mean difference of two temperature measurements and zero using one sample t-test.

Table 3: Table 2: Distribution of OT, TT and FUT in the studied smokers and non-smokers

	Smoker N = 26 M±SD	Non-Smoker N = 19 M±SD	*P*
OT (°C)	36.30±0.41	36.42±0.42	0.339
TT (°C)	36.09±0.83	35.85±0.79	0.340
FUT (°C)	35.72±0.73	35.32±0.75	0.082

Erickson et al compared pulmonary artery based estimates of CBT with thermometer readings obtained from the oral cavity, tympanic membrane, urinary bladder and other sites[26]. The mean offsets from pulmonary artery temperature were 0.05±0.26° C for the oral cavity, 0.07±0.41° C for the tympanic membrane and 0.03±0.23 C for the urinary bladder. Erickson et al concluded that TT is the nearest estimate of CBT; however, had higher variability compared with OT as well as urinary bladder temperature. The lack of agreement of OT, TT and RT was demonstrated by Barnett and his colleagues when they evaluated 457 patients attended emergency department of Long Island Jewish Medical Center – USA[15]. According to Barnett et al, TT can either be higher or lower compared with

RT, but OT gave lower readings compared with RT. In a comparable study, although the average difference between RT and TT was only 0.1°C, the temperature difference increased to ≥ 1° C in as much as 10% of the studied subjects[27]. A separate report gave unacceptable standard deviations of OT, TT and RT differences ranging from 0.41° C to 0.53° C[28].

The results of the present study demonstrated two characteristics unique for OT. Firstly, OT achieved highest readings compared with TT and FUT. Secondly, OT failed to show significant

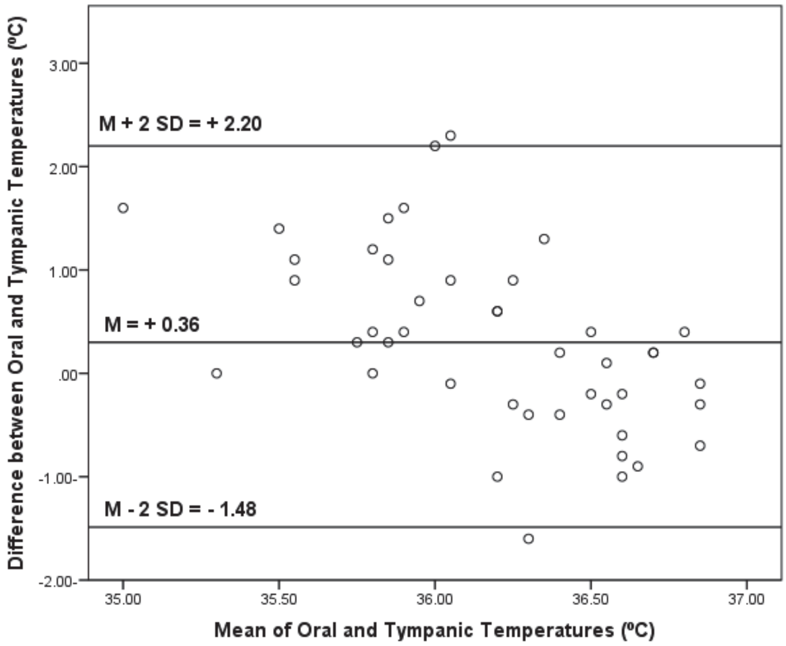

Figure 1: Bland-Altman plot of the differences between the measured OT and TT

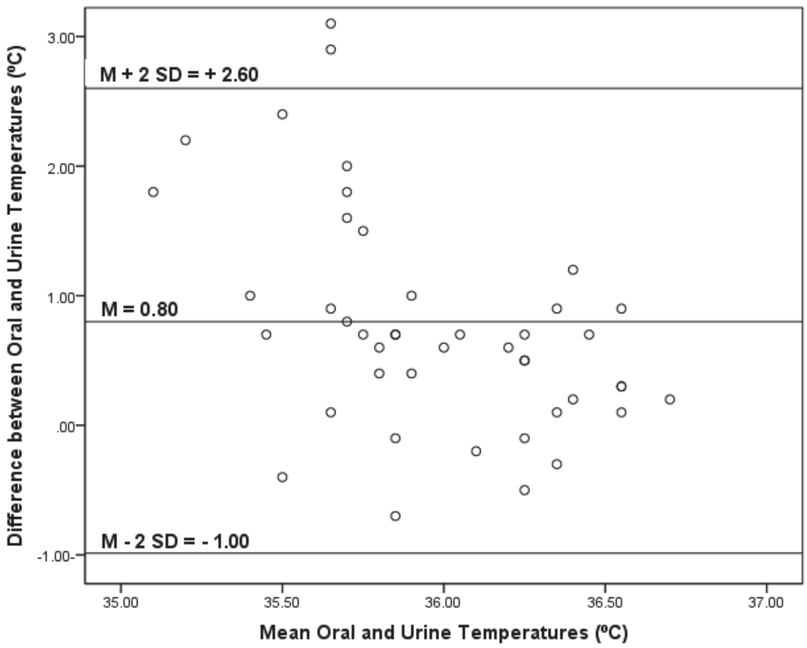

Figure 2: Bland-Altman plot of the differences between the measured OT and FUT

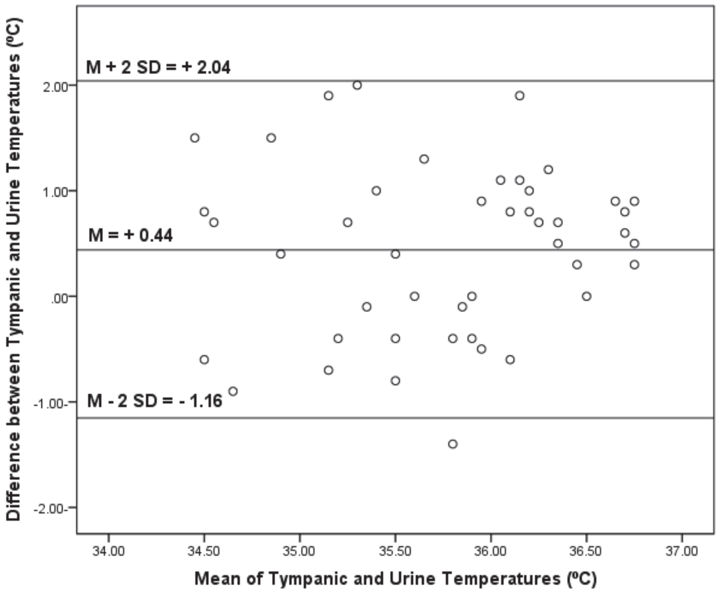

Figure 3: Bland-Altman plot of the differences between the measured TT and FUT

correlations with TT or FUT. Although several studies demonstrated lower OT compared with RT[15, 27, 29], other studies demonstrated the reverse[9, 28]. Mazerolle and his colleagues reviewed sixteen original research papers in the field to assess the reliability of using OT as an indicator of CBT[8]. Mazerolle *et al* reported that OT is not ideal to reflect CBT, probably because it is significantly affected by ambient air[30] and temperature of ingested food and fluids[7]. The findings of Mazerolle *et al* review study may explain loss of significant correlations between OT and TT as well as OT and FUT in our study. In contrast, the significant correlations between TT and FUT may be attributed to the predictable influences of CBT on these two parameters [14].

Interestingly, the present data failed to show significant differences in OT, TT and FUT when smokers were compared with non-smokers. Smoking is expected to influence CBT through release of certain calorigenic hormones [22] or induction of vasoconstriction[31]. Cigarette smoking increases energy expenditure [24] and may increase perception of hot flushes in women independent of alterations in female sex hormone levels[32]. There is evidence that oral, but not tympanic, temperature may be affected during the first seven minutes following smoking[7]. However, studies exploring effects of smoking on the readings of the different methods used in assessing body temperature are deficient[7], a fact that should motivate researchers of concern for further investigations in this filed.

CONCLUSION:

The current study showed significant differences between OT, TT and FUT. OT achieved highest readings compared with TT and FUT, but failed to show significant correlations with each of these parameters. In contrast, the significant correlations between TT and FUT may be attributed to the predictable influences of CBT on these two parameters.

ETHICAL CONSIDERATION:

This study received ethical clearance from the Research Committee of the College of Medicine, Alneelain University, Sudan. All Participants signed a written consent before they joined the study.

COMPETING INTEREST:
None to declare

DATA AVAILABILITY:
The datasets supporting the conclusions of this article are included within the manuscript.

AUTHOR CONTRIBUTION:
Study concept and design AHA, GS; data collection WAA, FOA, OHA; data analysis, interpretation and first draft writing MFL, all authors read and approved the final draft.

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