ADDIS ABABA UNIVERSITY, College of health sciences, SCHOOL OF MEDICINE

DEPARTMENT OF PEDIATRICS AND CHILD HEALTH

What is normal infant body temperature during the era of digital thermometer?

An institution based cross-sectional observational study.

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Addis Ababa, Ethiopia

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Declaration

I hereby declare that the thesis titled "***What is normal infant body temperature during the era of digital thermometer?"*** has been carried out by me in partial fulfillment of the requirements for Specialty Certificate in Pediatrics and Child Health with the guidance and support of my adviser professor Amha Mekasha department of pediatrics and child health. The information derived from the literature has been duly acknowledged in the text and a list of reference provided. I also reveal that the work has not been submitted for any other degree or professional qualification.

Name of investigator Almaz Tarekegn

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Abstract

Background: Body temperature is one of the major components of vital signs in patient care. The threshold between normal body temperature and fever is unclear. Regardless of age, fever is now defined as a temperature >100.4°F (38.0°C) by the American Academy of Pediatrics and the European Centre for Pediatric and Adolescent Medicine guidelines to be the current practice Several publications and organizations have, however, questioned this fixed figure for fever regardless of age in recent times.

Objective: The aim of this study was to define the normal values of axillary body temperature in healthy infants in Addis Ababa, visiting a health institution for routine vaccination

Methods: From September 1st to September 30th, 2023, all infants visiting certain public health facilities in Addis Ababa for regular vaccinations participated in an institution-based observational cross-sectional study. A certified registered nurse took the body temperatures of all eligible newborns who were visiting the medical facility for their regular immunizations to compile the data. Data were entered using Excel Spreadsheet version 2016 and analyzed by Statistical Package for Social Sciences (SPSS) version 26, and descriptive statistics along with the Student T test were calculated for analysis.

Results: Of the 214 infants included, 120 (56.1%) were boys. The overall median (interquartile range) age was 3 (2–9) months. The mean (SD) axillary body temperature was 36.4°C (0.52°C); minimum, 35.1°C; maximum, 37.5°C). The 95th and 99th percentiles were 37.0°C and 37.2°C, respectively. There were no statistically significant differences between male and female sexes and age groups for body temperature measurements.

Conclusion: In infants, axillary body temperature should be considered as fever when they are more than 37.2°C, regardless of age and sex.

Keywords: temperature measurement, axillary temperature, thermometer, infants

Acronyms /Abbreviations

EDHS	Ethiopian Demographic Health Survey
EPI	Expanded Program of Immunization
IRB	Institution Review Board
IQR	Inter Quartile Range
OR	Odds ratio
°C	Degree Centigrade
°F	Degree Fahrenheit
SD	Standard Deviation
SPSS	Statistical Package for Social Sciences
WHO	World Health Organization

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1. Introduction

1.1 Background

A child's body temperature is one of the vital signs used to determine whether or not they are ill. When patients come to any medical facility for a medical condition, their body temperature is measured routinely. Periodically, parents take their kid's body temperature when they suspect that their child is hot to the touch or when they feel ill. However, most studies have focused on unwell babies, so there is no information to determine the typical range of average body temperature for babies. Traditionally, there is a range of body temperature set to define average body temperature, fever, and hypothermia, which states that average body temperature is between 36.5°C and 37.5°C, fever above 37.5°C and hypothermia less than 36.5°C (1,2). The different methods to measure body temperature include axillary, rectal, oral, tympanic, and others. Some investigators believe the axillary temperature is precise enough for routine clinical practice (3).Human body temperature is frequently taken at home and at regular intervals in medical settings to gauge a patient's level of "sickness." (4). Despite its long history of usage, there has been a lot of debate over its interpretation in the context of medical practice. (1,2,4). Determining what is considered a "normal" body temperature is the first step to identifying the association between temperature and sickness, and then variations are quantified. Several attempts have been made in this direction, including Wunderlich's seminal study in 1868(5), which claimed credit for being the first to relate a fever to a clinical diagnosis.Wunderlich identified that the maximum limit of normal body temperature was 38.0°C, and the average axillary temperature was 37.0°C based on a large sample size. However, this "normothermia" proposed by Wunderlich faces opposition from more recent research, such as Sund-Levander M (1,5). The most typical sign of disease in infants and children is fever. However, parents experience anxiety and stress even though it gives a clear indicator of disease in their child. Fever is the illness that worries caregivers the most. Thus, they often give antipyretics to bring their child's high temperatures down to a normal range. (6,7). Since it affects patient diagnosis and treatment, accurate temperature measurement is essential to patient care.

1.2 Statement of the problem

Fever is a crucial indicator in the evaluation of patients and causes a great deal of anxiety for parents and other caregivers. A precise limit for temperature might prevent medical professionals and caregivers from misdirecting patients (8). Therefore, it is crucial to establish a normal range for body temperature before making a fever diagnosis. (9, 10). A

child's sickness is evident from a high temperature, which worries and disturbs parents. More than any other sickness, fever terrifies caregivers and parents, who frequently use antipyretics to bring temperatures back to normal. Since it affects patient diagnosis and treatment, precise measuring of temperature is essential to patient care. (6,7,11). Different studies have conducted to define the threshold for axillary body temperature in healthy children. However, the results are different, with a wide gap in the range of average body temperature in all studies using various types of thermometers and sites of measurement such as tympanic, rectal, and axillary. This study will serve as a benchmark in our situation because the typical body temperature range still varies.

1.3 Significance of the study

By understanding the typical range of a baby's body temperature, medical practitioners may prevent misdiagnosing healthy infants as having a fever or hypothermia.

Misdiagnosis happens when a patient receives an inaccurate diagnosis for an illness they do not have. In addition to causing parents and other caregivers discomfort, this can waste time and money. The worst-case situation might result in disability or death as well.

The results of these studies would provide insights about the average range of infant body temperature for health professionals and would prevent unnecessary prescription of drugs and investigations. Furthermore, it will also decrease parental anxiety and fear about their child's body temperature and prevent them from giving unnecessary medications.

Parents and medical professionals may also learn from it that taking a patient's body temperature is a crucial part of medicine and that several things influence body temperature.

Even though there is a lot of literature on body temperature measurement, nothing has been done in Ethiopia. Thus, this study may serve as a baseline investigation to set a benchmark for the typical baby's body temperature.

2. Literature Review

Various studies have attempted to establish the tympanic and axillary body temperature limit for children in a healthy state.

The tympanic temperatures of 244 healthy children between the ages of one and six years were measured by Purssell et al. (12). The tympanic temperature measured was 36.65°C on average (range: 35.6°C - 37.8°C), with a 37.5°C 95th percentile.

A fever is defined as an axillary temperature of 37.4°C or above, according to El-Radhi et al.'s findings, which ranged from 34.7°C to 37.3°C (mean, 36.4°C) (13).

As stated in Ward's study (14), 37.2°C or above is the axillary temperature limit for fever.

Using a digital thermometer, Ng et al. (15) measured the axillary temperatures of 109 children and showed that the average (SD, range) body temperature was 36.91°C (0.63°C, 34.9°C–39.8°C).

Devrim et al. (16) used a mercury thermometer to assess 102 patients in emergency rooms in Turkey. They discovered that the mean (SD) axillary body temperature was 36.8°C (0.68°C, 35°C–39.7°C). Fever and infectious illness cases were included in these studies. Some children without a fever or other infection-related symptoms were the subjects of the same study. They used a digital thermometer to take the axillary temperature, and the mean (SD, range) body temperature was 36.04°C (0.46°C, 35°C–37.6°C). In their study, the maximum recorded axillary temperature was 37.6°C; the 95th percentile represented by 36.8°C, and the 99th percentile by 37°C. Children who have temperatures beyond the 99th percentile (37°C), in their opinion, may have fever. In their research of 719 children under the age of eleven, Chamberlain et al. (17) measured the mean (SD) tympanic temperature as 36.78°C (0.47°C), the 95th percentile as 37.6°C, and the 99th percentile as 37.9°C, and define fever as exceeding the 99th percentile. The tympanic temperature mean (SD, range) for all age groups was determined to be 36.91°C (0.46°C, 35.15°C–37.90°C), with the 95th percentile measuring 37.6°C and the 99th percentile measuring 37.8°C.

The Powell et al. (18) study tried to establish average tympanic temperatures for children in various age groups who are in good health. Their findings revealed the following: the mean temperature for babies aged 0 to 2 months (n = 62) was 37.2°C (95th percentile, 37.8°C); mean, 36.9°C (95th percentile, 37.9°C) for kids between the ages of three and forty-seven months (n = 346); children aged 48 to 119 months (n = 226) had a mean temperature of 36.7°C (95th percentile: 37.7°C); and 36.7°C (95th percentile, 37.7°C) on average for kids

between the ages of 120 and 227 months (n = 172). The authors suggested 37.8°C as the tympanic temperature threshold for fever.
Among healthy children aged 0 to 17 years who were visiting Istanbul Medical Faculty's ambulatory general pediatric, an observational cross-sectional study was carried out.

The mean (SD, range) age of the 1364 children was 72.5 (53.6, 1–204) months, with 651 (47.7%) of the children being girls and 713 being males. Axillary body temperature was measured with a mean (SD) of 36.04°C (highest, 37.6°C; lowest, 35.0°C). The results showed that the tympanic body temperature ranged from 35.15°C to 37.9°C, with an average (SD) of 36.91°C.

There were statistically significant differences between the sexes for only tympanic body temperature. In 0 to 2 months, axillary and tympanic body temperatures were substantially higher than those of other age groups. The tympanic temperature was 37.85°C, and the axillary temperature was 37.5°C, which was the 99th percentile for this age group (8).

The Turkish study cited above concluded that body temperatures measured in the tympanic and axillary should be regarded as fever when they exceed 37.0°C and 37.8°C, respectively. Fever during 0–2 months is 37.5°C and 37.85°C, respectively, in the tympanic and axillary measurements (8)..

Marui et al. (2017) assessed axillary temperature to determine the average body temperature of healthy young people at rest in a thermoneutral environment. The study found that the changes in core body temperature as determined by tympanic measures were less than those determined by axillary measurements.

The observed variance in axillary temperature may be attributed to variations in the measuring methodologies brought about by modern equipment and methods (the introduced modern device not mentioned in this study). On the other hand, axillary temperature values showed a strong correlation with tympanic measures, indicating that the method may accurately assess a person's health. According to this study, it's also critical for people to understand their baseline axillary temperature in order to classify future temperature readings as normal or abnormal.. Furthermore, fluctuations in axillary temperature may be somewhat indicative of changes in fat mass and the menstrual cycle (19).

3. Objectives

3.1 General objective

This study aims to determine the normal values of axillary body temperature in healthy infants in Addis Ababa who are visiting a health institution for routine vaccination.3.2

Specific objectives.

2.2.1. To determine the distribution of body temperature among healthy infants.

2.2.2. To determine whether there is a difference in body temperature among male and female infants.

2.2.3. To find out whether there is a change in body temperature among infants less than three months of age and above.

4. Methods and Materials

4.1 Study design

An institution-based observational cross-sectional study was conducted from September 1st to 30th,2023.

4.2. Study area

The study was executed at Teklehaimanot Health Center and Tikur Anbesa Specialized Hospital EPI Center, two specifically chosen medical institutions in Addis Ababa, Ethiopia.

Ethiopia's capital city, Addis Ababa, is home to more than 3 million people and has a 2.1% annual growth rate. About 98 health centers (HC) and 48 hospitals exist in the city. The Addis Ababa Regional Health Bureau (AARHB) governs five of these hospitals out of the thirteen public hospitals. The remaining five are specialized referral hospitals, the largest of which is Tikur Anbesa Specialized Referral Hospital, which has over 800 beds in its emergency, pediatric, surgical, gynecological and obstetrics, and emergency departments in addition to an outpatient department. The hospital has one vaccination center and specialized units. Between 370,000 and 400,000 patients receive diagnosis and treatment each year at Tikur Anbesa Specialist and Referral Hospital, of which the pediatric department serves approximately 8885 in-patient cases per year with six units (pediatric surgical ward, pediatric medical ward, oncology ward, emergency ward, pediatric intensive care unit, and neonatal intensive care unit) and an average of 471 pediatric cases per month with a total of 183 beds.Teklehaimanot HC, one of the 98 health centers in Addis Ababa, Ethiopia, is located in the Lideta sub-city next to TASH and was established in 1984. Teklehaimanot Health Center provides care for 97,617 people belonging to two woredas. It offers a range of services, such as inpatient and outpatient care, pediatric outpatient departments, adult and pediatric emergency rooms, antenatal, postnatal, and delivery services, treatment for tuberculosis and HIV, minor surgery, and immunization programs. It has a pharmacy, lab spaces, and eight bedrooms.

4.3. Study period

This study was conducted from September 1st to 30th, 2023.

4.4. Source population

All infants with their parents and guardians who visited TASH and Teklehaimanot HC.

4.5. Study population

All infants who are visiting the TASH vaccination center and Teklehaimanot HC for their routine vaccination during the study period.4.6. Inclusion criteria and Exclusion criteria

4.6.1. Inclusion criteria

All healthy infants who visited the health center and the hospital for their routine vaccination.

4.6.2. Exclusion criteria

- Infants with symptom complex of febrile illness
- All infants who come to the clinic for other medical condition
- Infants whose parents did not give consent

4.7. Sample size determination

Since there was no study in Ethiopia the p value was taken 50%. with 5% marginal error, 95% confidence interval (CI) and a none response rate of 10%. Based on this assumption, the actual sample size for the study was determined using the formula for single population proportion.

$$n = \frac{(Z_{\alpha/2})^2 P(1-P)}{d^2}$$

Where n=Sample size

Z=z value corresponding to a 95% level of significance=1.96

p=expected proportion of normal infant body temperature = 50%=0.5)

q= (1-p) = (1-0.5) =0.5

d=absolute precision (5%)

None response rate=10%

Therefore, based on using the above single population proportion formula the sample size can be calculated as:

n= (1.96)2(0.5) (1-0.5)/ (0.05)2 n=384

However, since the total number of infant visiting HC for routine vaccination is <10,000. so, reduction formula was employed as follows

$$nf = \frac{n}{1+\frac{n}{N}}$$

Where nf = final sample size resulted from the reduction formula

n = calculated sample size using simple proportion formula which was 384

N = total population (total infant vaccinated per month) which was an average of 400

384/1+384/400=384/1+0.96=384//1.96=195.9

The minimum calculated sample size was 196.

Adding 10 % to the calculated number, the final sample size was 216

4.8 Sampling procedure

All infants with their guardians who were visiting the health institution during the study period were selected consecutively until the sample size achieved.

4.9 Variables of the study

4.9.1 Independent variable

Body temperature

4.9.2. Dependent variable

Age, Gender

4.10 Operational definition

Fever: in physiologic term, it is defined as "a state of elevated core temperature >37.5 °C

Hypothermia: it is a state in which the body's temperature regulation is <36,5°C)

Normothermia: is a state when core body temperature is regulated with standard limit (36.5-37.5°C)

Digital thermometer: is temperature sensing instrument that is easily portable, have permanent probe and a convenient digital display.

Axillary Temperature: is a temperature obtained by placing a thermometer for 3-5 minutes in the apex of the axilla with arm pressed closely to the side of the body.

Upper normal limit: the 99th percentile of maximum temperatures in healthy persons (20,21)

4.11 Data collection

The data collection tool utilized in this study was a questionnaire created in Amharic. Before the process of data collection, the data collector (one registered nurse with training) received training on how to do it .Bosotherm flexible tip digital axillary thermometer manufactured by Boso company made in Germany was prepared.

Families were asked to remove excess clothing from their infant and put on only clothing suitable for indoor use 20-30 minutes before taking the temperature when the child felt warm to the touch. If the baby is cold, parents are asked to wrap the baby for 20-30 minutes before taking the temperature.

All infants visiting the EPI center for routine vaccination during the study period were measured.

4.12 Data quality assurance

Close supervision was maintained during data collection, and the filled questionnaire was double-checked daily for consistency and completeness by data collectors and the principal investigator before proceeding into analysis.

4.13 Data management, processing and analysis

Data entering, coding, and cleaning took place using Excel Spreadsheet version 2016, and then it was exported and analyzed using SPSS version 26. Descriptive analyses like frequency, mean, standard deviation, median, interquartile range, and range were utilized to present results. Student T-test was used to compare temperature measurements between subgroups of certain variables such as age and sex. Study findings are presented using texts and tables.

4.14 Ethical consideration

The Institutional Review Board (IRB) of Addis Ababa University, College of Health Sciences, Department of Pediatrics and Child Health Research, and publication committee granted the required ethical clearance. Permission to conduct the study was obtained from the immunization department of each study location, both verbally and in writing. Before beginning data collection, all attending caregivers for study participants were told about the purpose and significance of the research, and their informed permission was acquired. Parents were also informed about their right not to participate in the study at any time. Privacy and confidentiality of the information were assured, and data collected anonymously.

4.15 Dissemination and utilization of results

The results of this study will be presented to Addis Ababa University, College of Health Sciences, pediatrics and child health department, and efforts will be made to present the results at scientific conferences, and peer-reviewed journal publications will be considered.

5. Results

5.1 Socio-demographic characteristics

This study included data derived from two hundred and fourteen apparently healthy infants who were attending two public health institutions in Addis Ababa, after excluding two infants with incomplete data. Among the studied infants, males (120;56.1%) outnumbered females, with a corresponding male-to-female ratio of 1.3:1. Children's age ranged from 3 days to twelve months, with median (interquartile range) age of 3 (2–9) months. Half (109;50.9%) of the studied infants were younger than three months. The corresponding median (interquartile range) age of infants' caregivers was 29 (26–32) years, with the range extending from 18 to 50 years (Table 1).Almost all (208;97.2%) of the infants were attended by their mothers. The highest educational status attained by the majority of caregivers was secondary education as it was reported by 126 (58.9%) of them while one-third 71 (33.2%) stated to be have attended a tertiary-school education. In relation to occupational category, majority (153;71.5%) reported to be unemployed while twenty-nine (13.6%) were employed at a private sector (Table 1).

Most (192;89.7%) of the infants were described as healthy and active by their respective attending caregivers. More than half (119;55.6%) of the infants were on exclusive breast feeding while eighty-three (38.8%) were started on complementary diet. More than two-thirds (145;67.8%) of the infants weighing more than 5.8 kilograms, as detailed in Table 1.

Table 1. Distribution by socio-demographic of healthy infants who were attending two public health institutions of Addis Ababa, Ethiopia from September 1st to 30th, 2023

Variable	Frequency	Percent (%)
Infant's age		
<3 months	109	50.9
3-12 months	105	49.1
Median+interquartile range	3	2-9
Child's sex		
Male	120	56.1
Female	94	43.9
Caregiver's age		
≤24 years	41	19.2
25-34 years	137	64.0
≥35 years	36	16.8
Median + interquartile range	29	26-32
Attending caregiver		
Mother	208	97.2
Father	3	1.4
Other	3	1.4
Caregivers' educational status		
No formal education	17	7.9
Upto secondary education	126	58.9
College diploma and above	71	33.2
Caregivers' occupational category		
Unemployed	153	71.5
Private employed	29	13.6
Public servant	23	10.7
Other	9	4.2
Activity level		
Hyperactive	1	0.5
Active	192	89.7
Calm	16	7.5
Sleepy	5	2.3
Feeding mode		
Exclusive breast feeding	119	55.6
Complementary feeding	83	38.8
Other*	12	5.6
Weight category		
≤5.8 kilogram	69	32.2
>5.8 kilogram	145	67.8

*Six were on formula feeding and four on mixed diet.

5.2 Temperature measurements

Temperature measurements were undertaken from 10:00:00 to 10:59:59 AM in about half of the infants (92;43%) while close to one-third of the infants (63;29.4%) had their temperatures measured between 9:00:00 and 9:59:59 AM. The mean (SD) axillary temperature for the studied infants was 36.4°C (0.52), and the median (IQR) temperature was 36.4 (36.2–36.7°C). The most frequently observed measurement was 36.2°C, with the minimum being 35.1°C and the maximum 37.5°C. The 1st and 5th percentile measurements were 35.4°C and 35.9°C while 95th and 99th percentile were 37.0°C and 37.2°C respectively (Table 2).

Table 2. Summary of temperature measurements of healthy infants who were attending two public health institutions of Addis Ababa, Ethiopia from September 1st to 30th, 2023

Variable	Frequency	Percent (%)
Time of measurement		
9:00:00‑9:59:59	63	29.4
10:00:00‑10:59:59	92	43.0
11:00:00‑11:59:59	59	27.6
Statistical parameter		
Mean (SD)	36.4	0.52
Median (IQR)	36.4	36.2‑36.7
Mode	36.2	
1st percentile	35.4	
5th percentile	35.9	
95th percentile	37.0	
99th percentile	37.2	
Minimum	35.1	
Maximum	37.5	

SD: Standard deviation; IQR: Interquartile range

Body temperatures were evaluated for both sexes; the mean (standard deviation) axillary body temperatures were 36.46°C (0.38°C) for males and 36.39°C (0.38°C) for females (T value = 1.44; P = 0.152), with no statistically significant different results between both sexes. Additionally, age-wise, this study found no statistically significant difference between infants three months or younger and those older than three months in terms of axillary body temperatures, with mean (standard deviation) of 36.40 (0.39) and 36.47 (0.36), respectively (Table 3).

Table 3. Comparison of axillary body temperature among healthy infants who were attending two public health institutions of Addis Ababa, Ethiopia from September 1st to 30th, 2023

Variable	Temperature (Mean ± SD)		T value	P value	95%CI
Sex	Male	Female			
	36.46±0.38	36.39±0.38	1.44	0.152	-0.03,0.18
Age	≤3 months	>3 months			
	36.40±0.39	36.47±0.36	-1.38	0.168	-0.17,0.03

6. Discussions

The pursuit of understanding human body temperature and defining normothermia is continuing, as is demonstrated by the accumulating number of published studies (4). This study aimed to define the average values of axillary body temperature, which is considered ideal for infants and small children, in well-appearing infants in Addis Ababa by using the recently available noninvasive digital (electronic) thermometer. Thus, this study generated a mean axillary temperature for the infants of 36.4°C and 99th percentile of 37.2°C, with no statistically significant variation between male and female sexes and age groups.

Specifically, this study found that the mean axillary temperature for the apparently healthy infants is 36.4°C, a value slightly lower than Wunderlich's original estimate of 37°C, which in turn had been established using foot-long axillary thermometers that may have been calibrated higher than the thermometers used nowadays (5). Moreover, the present value is in line with the report of Purssell et al, who obtained an overall mean temperature of 36.65°C among English children (12). The current finding corroborates with the report of El-Radhi et al., who documented a mean axillary temperature of 36.4°C and defined an axillary temperature of 37.4°C or more as fever (10). The present finding was consistent with the observation of Oguz and colleagues who found a mean (SD, range) body temperature of 36.04°C (0.46°C, 35°C–37.6°C) with a digital thermometer (8). This finding is comparable to the finding obtained by a comprehensive systematic review of Geneva et al., who documented an axillary temperature of 35.97°C among apparently healthy children (4). On the contrary, the current finding was slightly different from that of Ng et al., who found a mean axillary temperature of 36.91°C using a digital thermometer (15). The mean value obtained in this study was quite lower than the finding obtained by Abdulkadir et al. in Nigeria, where the mean (SD) axillary temperature was 38.1 (0.7) °C (22). The current

finding corroborates with the report of El-Radhi et al., who documented a mean axillary temperature of 36.4°C and defined an axillary temperature of 37.4°C or more as fever (10). The present finding was consistent with the observation of Oguz and colleagues who found a mean (SD, range) body temperature of 36.04°C (0.46°C, 35°C–37.6°C) with a digital thermometer (8). The present findings were different from what Wunderlich and Mackowiak et al. independently observed in that 37.2°C rather than 37.7°C or 38.0°C was the upper limit (99th) of the normal temperature range for this study cohort (5,21).

The variations between this study and previous reports can be attributed to the type of thermometer used, the specific time of the day the temperature measured (diurnal fluctuations throughout the day), the calibration of the apparatus used, and measurement error or environmental factors. More specifically, while this study is performed on infants without fever or infectious signs, other studies included cases with fever or febrile illnesses (15,16,22). In terms of procedures, axillary skin must be dry during measurement. The precision of axillary temperature measurement can be affected by peripheral vasoconstriction, sweating, and evaporation resulting in different skin temperatures compared to the actual body temperature (23).

The level of measurement did not differ between age groups in this study, which is in agreement with the report of Purssell et al. who observed similar findings among English children (12). In contrast, the current finding was different from the report of Oguz et al., who observed that axillary body temperatures were higher in all infants aged 0 to 2 months compared with older children (8). However, this discrepancy can be justified by the fact that while this study included only infants as its study population, the Turkish study included children as old as 227 months (8). .

The current study also demonstrated that there is no statistical difference between the male and female sexes. This was similar to the report of Oguz et al. in which the 99th percentile of tympanic temperature for both sexes was equal, standing at 37.8°C (8). It supports the lack of clinical significance of gender-based body temperature difference, and it confirms the physiological basis of body temperature regulation, although it is recognized that menstrual cycles and hormonal variability may affect this as they get older (4).

7. Strength and Limitation

7.1 Strengths

- The study tried to provide information on what we can call normal body temperature and define normal temperature ranges concerning age and sex in the era of digital clinical thermometers.
- The study used a noninvasive electronic thermometer, which does not create anxiety and pain in infants during measurement.

7.2 Limitations

- The main limitation of the present study was that we did not have a true measure of core body temperature to use as a criterion standard.
- Another limitation is that this study did not aim to compare different forms of clinical thermometers.

8. Conclusion and Recommendation

8.1 Conclusion

The mean (SD) axillary temperature for the studied infants was 36.4°C (0.52), and the 99th percentile was 37.2°C, which should be regarded as the upper limit of the normal axillary temperature range in apparently healthy infants in our setting. There was no significant difference between both sexes and age groups.

8.2 Recommendation

Based on the study findings, the following recommendations can be suggested.
For parents,
Parents with a home axillary temperature measurement of 37.2°C or more (of their infants) should seek medical care for a proper evaluation.
For clinicians,
For clinicians working at well-baby clinics and triage, healthy infants should have their axillary temperature measured, and those with 37.2°C or more should be redirected to a pediatric department for a thorough clinical evaluation regardless of their sex and age.
For researchers,
There is a need for further studies to validate the present finding, with the inclusion of sensitivity and specificity analysis.

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Annex I: Information sheet

Addis Ababa University

College of Health Sciences

Information sheet to medical director of the hospital

This sheet was read by the medical director of the hospital before collecting any information from the registries.

Greetings. My name is Dr. Almaz Tarekegn, and I am a postgraduate student in the Department of Pediatrics and Child Health, College of Health Sciences, Addis Ababa University.

This governmental hospital was selected to conduct the proposed study, “Normal infant body temperature in the era of digital thermometer,” In Tikur Anbessa Specialized Hospital, Addis Ababa, Ethiopia" and Teklehaymanot Health Center Department of Vaccination.

I humbly request your esteemed office to permit me to conduct the stated study in this hospital and Health center. Please read the following information for further understanding:

What the study is about: The purpose of this is to define the normal values of axillary body temperature in healthy infants in Addis Ababa, Ethiopia, who are visiting a health institution for their routine vaccination.
An observational cross-sectional study utilizing a questionnaire prepared for this study was used in infants visiting TASH and Teklehaimanot HC (Health Center) for their routine vaccination.

What I will ask for: I would respectfully ask that you let me and my trained data collector, measure the body temperature of infants and speak to the parents, and caregivers who bring their infants for routine vaccination at TASH and Teklehaimanot HC Vaccination department

Risks and benefits: The result of the study would help to know the normal infant body temperature range of healthy infants, and to avoid unnecessary costs and stress for the family and health professionals.

Confidentiality: All information gathered will be kept confidential. Any personal information will not be registered. The records of this study will be kept private. In any sort of public report, the author will not include any information that will make it possible to identify the infants. Research records will be kept in a locked file; only the researcher will have access to the records.

Contact Address of the Principal Investigator

Name**:** Almaz Tarekegn

Mobile Phone**:** 0911108355

Email: almazteferi@yahoo.com.

Annex II: Assurance of Principal Investigator

The undersigned agrees to accept responsibility for the scientific ethical, and technical conduct of the research project and for the provision of required progress reports as per terms and conditions of the faculty of medicine-pediatrics department in effect at the time of grant is forwarded as the result of this application.

Name of the student: Almaz Tarekegn

Date. _____ Signature _____

APPROVAL OF THE ADVISOR

Name of the advisor: _____

Date. _____ Signature _____

Annex III: English Version questionnaire

Normal body temperature of healthy infants

Addis Ababa University

College of Health Sciences School of Allied Health Sciences

Department of Pediatrics and Child Health

Participant Information Sheet

1. Name of the study area (TASH and Teklehaimanot HC department of vaccination)
2. Name of the vaccination center_____
3. Questionnaire identification no. _____

INTRODUCTION:

Good morning/afternoon? My name is _____.

In this study which is undertaken by Addis Ababa University, you and I would have a short discussion for about 5 minutes only and we are going to measure your infant temperature (Axillary) and I am asking you to help us. Before we go to our discussion, and measuring the body temperature of your infant, I will request you to listen carefully to what I am going to read to you about the purpose and you will tell me whether you agree or disagree to participate in this study at the end. The purpose of this study is to know the normal infant body temperature of a healthy infant who is visiting TASH and Teklehaimanot HC for their routine vaccination and conditions that affect body temperature. The study will be conducted through interviews, questionnaires, and measurements of the body temperature of your infant. The results of the study will enable to improve the quality of health service delivered to the pediatric population. I would like to assure you that confidentiality will be maintained strictly throughout. A code number will identify every infant, and no name will be used. Your responses to any of the questions will not be given to anyone else, and no reports of the study will ever identify you. If a report of results is published, only information about the total group will appear. Your participation in the study is strictly voluntarily, and your decision to complete the study will not affect the care of your child. You will not be paid for your willingness to complete the survey.

Are you willing to participate in this study?

1. [ ] Yes.
2. [ ] No Thank you!!!

NB: 1. if the study subjects agree to participate in the study, go to consent form

2. No need of enforcing the clients to be included in the study

Informed consent/Assent

I the undersigned, have been informed about the purpose of this particular research project. I have been informed that I am going to respond to this question by answering what I feel and experienced concerning the issue. I have informed you that the information I give will be used only for this study, and my identity as well as the information I give will be kept confidential. I have also been informed that I can refuse to participate in the study or not respond to questions if I am not interested. Furthermore, I have been informed that I can stop responding to the questions at any time in the process.

Based on the above information, I agree to participate in this research voluntarily. Signature: _____ Date: _____

NB: 1. If the study subject is voluntary to participate in the study, start the interview.

2. Interviewer signature certifying that informed consent has been given verbally by the respondent.

3. If there are things that require clarification, please don't hesitate to ask the Interviewer or the principal investigator for clarification.

Address of the principal investigator

Almaz Tarekegn MD

Addis Ababa University, college of Health Sciences, School of Medicine

Department of Pediatrics and Child Health.

Mobile: 09-11-10-83-55

Email: almazteferi@yahoo.com

Determining Normal infant body temperature and factors affecting body temperature

Health facility -------

Time Temperature taken ----------

Please answer the questions on the following pages as accurately and honestly as you can,

1. **Is your infant a…** ☐ Boy ☐ Girl
2. **Age of infant?** _____Month/yr.
3. **Are you the child's**
   ☐ Mother ☐ Father ☐ Other__
4. **How old are you?**_____years
5. **What is you Occupation**
   ☐ Farmer ☐ government employee ☐ Private sector
   ☐ Merchant ☐ House wife ☐ Other specific
6. **Area of residence** ☐ **Urban** ☐ **Rural**
7. **What is the highest level of education you completed?**
   ☐ No formal education
   ☐ Below high school
   ☐ College
8. **Do you feel your infant is healthy today?**
   ☐ Yes ☐ No
9. **In general, what do you think about the activity level of your infant**
   ☐ Hyperactive? ☐ Active? ☐ Calm? ☐ Sleepy?
10. **Did you give any medication for your infant today or yesterday?**
    ☐ Yes ☐ No
11. **If Your answer is yes for question No 10,**

    please specify the type of medicine and why?
12. **How is the feeding of your infant currently?**

    ☐ EBF? ☐ Complementary feeding started? ☐ Other Specify----------

Case report form

Sr. No	Age of infant	Sex	Body weight	Address	Body temperature	Time temperature taken	Remark
1							
2							
3							
4							
5							
6							
7							
8							
9							
10							
11							
,							

የተሳታፊዎች መረጃ መስጫ ቅጽ-በአማርኛ
1. ጥናቱ የሚካሄድበት ቦታ ስም (ጥቁር አንበሳ ስፔሻላይዝድ ሆስፒታል / ተክለሃይማኖት ጤና ጣቢያ)
2. የህክምና ክፍሉ ልዩ ስም_ክትባት ክፍል
3. የመጠይቅ መለያ ቁጥር_____
መግቢያ ፡ እንደምን አደሩ/ዋሉ? ስሜ_ ዶ/ር _አልማዝ ታረቀኝ ይባላል ::

በአዲስ አበባ ዩንቨርስቲ ህጻናት ስፔሻሊቲ ክፍል አስተባባሪነት በሚከናወነው ጥናት እኔ እና እርስዎ አጠር ያለ እና ከ 5_10 ደቂቃ የሚወስድ ውይይት ይኖረናል:: ለዚህም ውይይት እንዲተባበሩኝ በትህትና እጠይቃለሁ:: ወደ ውይይቱ ከመግባታችን በፊት ስለጥናቱ አላማ እና ጠቅላላ ሁኔታ ስለማነብለዎት በጥሞና እንዲያዳምጡኝ በትህትና እጠይቃለሁ:: በመጨረሻም በጥናቱ ለመሳተፍ መስማማትዎን ወይም አለመስማማተዎን ይነግሩኛል::
የዚህ ጥናት በዚህ በጥቁር አንበሳ ስፔሻላይዝድ ሆስፒታል/ በተክለሃይማኖት ጤና ጣቢያ ክትባት ክፍል ክትባታቸውን የሚከታተሉ እስከ 1 አመት ያሉ ህፃናት ትክክለኛ የሙቀት መጠን ስንት እንደሆነ ለማወቅ ሲሆን ጥናቱ የሚካሄድበት ሁኔታ እርሰዎን ስለ ልጅዎ አንድ አንድ ጥያቄዎችን በመጠየቅ እና የልጅዎን ሙቀት በመለካት ይሆናል።

የዚህ ጥናት አላማ ጤነኛ ልጆች ያላቸውን የሙቀት መጠን ለማወቅና ልጆቹ ሙቀታቸው ጨመረ በሚል ምክንያት አላስፈላጊ የሙቀት ማውረጃ መድሃኒት ከመስጠትና ከአላሰፈላጊ ጭንቀት ይከላከልልናል: ደረጃውን የጠበቀ ህክምናንም ለመስጠት ይረዳናል።

በቆይታዎ ሁሉ ስለሚሰጡን መረጃ ሚስጥር እንደሚጠበቅ እያረጋገጥኩኝ ለእያንዳንዱ ተሳታፊ የተለየ መለያ ቁጥር የሚኖረው ሲሆን ስምም አይጻፍም :: ለማንኛውም ጥያቄ የሚሰጡት ምላሽ ለሌላ ሰው ተላልፎ የማይሠጥ ሲሆን የጥናቱም ሪፖርት ስለእርስዎ አይገልጽም:: በተጨማሪም የጥናቱ ሪፖርትም ቢታተም የሚወጣው ስለ አጠቃላይ ተሳታፊ ሰዎች መረጃ ብቻ ይሆናል:: ተሳትፎዎ በፍጹም ፈቃደኝነት ላይ የተመሰረተ ነው:: በጥናቱ ላይ ለመሳተፍ መወሰነዎ አሁን ለልጅዎ እየተሰጠ ባለው የህክምና አገልግሎት ላይ ምንም አይነት ለውጥ ወይም ጉዳት አያመጣም ፤ ጥናቱ ላይ በመሳተፈዎ የሚያገኙት ክፍያም የለም::
ጥናቱ እንደተጠናቀቀ ውጤቱ ለጥቁር አንበሳ ስፔሻላይዝድ ሆስፒታል ተሰጥቶ ሆስፒታሉም ለታካሚዎቹ የተሻለ የህክምና አገልግሎት ለመስጠት እንደመረጃ ይቀጠምበታል::
በጥናቱ ለመሳተፍ ፍቃደኛ ነዎት?
1. ( ) አዎ 2.( ) አይደለሁም
አመሰግናለሁ!!!

ማስታወሻ:
1. የጥናቱ ተሳታፊ በጥናቱ ለመሳተፍ ፈቃደኛ ከሆኑ ወደ ፈቃደኛነት ማረጋገጫ ቅጽ ይለፉ
2. የአገልግሎቱ ተጠቃሚዎች በጥናቱ እንዲሳተፉ ማስገደድ አያስፈልግም

የስምምነት መግለጫ ፎርም

ከታች ፊርማዬን ያኖርኩት እኔ የጥናቱ አላማ የተነገረኝ ሲሆን ለምጠይው ጥያቄ የማውቀውን መመለስ እንደምችል ፤ እኔ የምሰጠው መረጃ ለዚህ ጥናት አገልግሎት ብቻ የሚውል ሲሆን የምሰጠው መረጃ በሚስጥር እንደሚጠበቅ ተነግሮኛል:: ፍላጎት ከሌለኝ በጥናቱ ያለመሳተፍ ፤ጥያቄ ያለመመለስ እና በጥያቄው ወቅት ምላሽ መስጠት ማቋረጥ እንደምችል ተነግሮኛል::

በዚህ መሰረት በጥናቱ ለመሳተፍ ፈቃደኛ መሆኔን በፊርማዬ አረጋግጣለሁ::

ፊርማ_____ ቀን_____

ማስታወሻ: 1. የጥናቱ ተሳታፊ በጥናቱ ለመሳተፍ ፍቃደኛ ከሆኑ መጠይቁን ይጀምሩ

2. የፍቃደኝነት መግለጫ በመልስ ሰጪው በቃል መሰጠቱን የሚያረጋግጥ የመረጃ ሰብሳቢው ስም እና ፊርማ ስም_____ ፊርማ_____ ቀን_____

ማንኛውም ገለጻ የሚያስፈልጋቸው ነገሮች ካሉ መረጃ ሰብሳቢውን ሆነ ዋና ተመራማሪውን በአካልም

ሆነ በአድራሻቸው ይጠይቁ፡፡
የዋናው ተመራማሪ አድራሻ
አልማዝ ታረቀኝ
አዲስ አበባ ዩንቨርሲቲ

ህጻናት ስፔሻሊቲ ክፍል

ስልክ ቁጥር፡ 0911108355
አ.አ
ስለ ትብብርዎት አሁንም በድጋሜ እናመሰግናለን፡፡

እስከ 1 አመት ያሉ ህፃናት ትክክለኛ የሙቀት መጠን

ከታች የተዘረዘሩትን ጥያቄዎች በጥንቃቄ በደንብ በማንበብ ትክክለኛ እና እውነተኛውን በመመላት ይተባበሩን።

1. የልጁ/የልጅቲ ፆታ?... ☐ ወንድ ☐ ሴት
2. የልጁ/የልጅቲ እድሜ ?_____አመት
3. ለልጁ/ለልጅቲ አርስሦ ምኑ /ኗ ነዎት?
   ☐ እናት ☐አባት ☐ሌላ_____
4. እድሜዎት ስንት ነው?_____**አመት**
5. ስራዎት መደም መሥዳደሪያዎት ምንድነው?
   ☐ ገበረ ☐ የመንግስት ሰራተኛ ☐ የግል ድርጅት
   ☐ነጋዴ ☐ የቤት እመቤት ☐ ሌላ
6. የመኖርያ አድራሻ?
   ☐ ዜሮማ ☐ ገጠር
7. የትምህርት ደረጃዎ?
   ☐ አልተማርኩም
   ☐ የአንደኛ ደረጃ ትምህርት አጠናቅቄአለሁ
   ☐ የኮሌጅ ትምህርት አጠናቅቄአለሁ
8. ዛሬ ልጅዎ ሙሉ ጤነኛ ነው ብለው ያስባሉ?
   ☐ አዎ ☐ አይደለም
9. ስለ አጠቃላይ የልጅዎ ሁኔታ ምን ያስባሉ
   ☐ እጅግ በጣም ንቁ ነው ☐ ንቁ ነው
   ☐ የተረጋጋ ነው ☐ በጣም ይተኛል
10. ትናንት ማታ ወይም ዛሬ ጠዋት ለልጅዎ መድሃኒት ሰጥተውት ነበር
    ☐ አዎ ☐ አልሰጠሁም

11 የ10ኛው ጥያቄ መልስም አዎ ከሆነ ምን መድሃኒት እንደሆነና ለምን እንደሰጡት ያብራሩልን
12 በአሁኑ ሰዓት የልጅዎ የአመጋገብ ሁኔታው እንደት ነዉ
   ☐ ጡት ብቻ
   ☐ ተጨማሪ ምግብ ጀምሯል/ጀምራለቾ
   ☐ ሌላ ካለ ያብራሩ