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Early Detection of Body Temperature with Infrared Technology for Prevention of Endemic Outbreaks of Primary School Age Infectious Diseases

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ABSTRACT
Initial detection of body temperature with infrared technology is currently only used for diagnosis of an infectious disease, but has not been used as a parameter to prevent disease transmission, resulting in an increase in the rate of disease transmission. The use of a device to measure the increase in body temperature of school pupils, namely the mercury thermometer, requires physical contact or contact with the body between the gauge, the measured school student and the measuring instrument, and requires a long time, so that it will interfere with learning activities at school. Physical contact when using a mercury thermometer can potentially be a medium for disease transmission. This study aims to analyze the effect of students whose body temperature is above normal who do not attend school on preventing the transmission of infectious disease and the effectiveness and accuracy of an infrared thermometer in comparison with a digital thermometer. The research design was a cross sectional or crosssectional study, where measurements were only carried out once at a time for a population in the school. The sample to be given treatment came from grade V students with a total of 40 students from 4 classes totaling 146 students. From data testing using SPSS, it was found that the use of an infrared thermometer was effective almost 100% in preventing outbreaks of transmission of infectious diseases in elementary school-aged students. The infrared thermometer is easy to operate and gives students a sense of security and comfort. So that early detection of body temperature with infrared technology for the prevention of endemic outbreaks of infectious diseases in elementary school children is highly recommended.

Keywords: *infrared thermometer, infectious disease, elementary school age students*

1. INTRODUCTION

Infectious disease is a collection of types of diseases that are easy to attack children caused by viral infections, bacterial infections, and parasitic infections. Infectious disease is one of the most important health problems in developing countries, including Indonesia [1].

Furthermore, it was stated that based on the 2007 Household Health Survey, the main causes of death were 28.1% due to infectious and parasitic diseases, 18.9% due to vascular disease, and 15.7% due to respiratory diseases.

The data for the top 20 diseases in the Puskesmas in the city of Bandung show that non-specific acute upper respiratory infections are in the first rank, with a total of 149,889 cases with a percentage of 13.79%. Similar cases were served at the Bandung City Hospital polyclinic in 2019, in the children's polyclinic the percentage was 27% in infants, 47% at under-five and at 26% at the age of children [2].

The process of disease occurrence is an interaction between the disease agent, humans (host) and the surrounding environment. The uncontrolled spread of disease transmission will increase mortality (mortality) and morbidity (morbidity) due to disease, which will reduce the economic and social value of the community, and can reduce the productivity of society [3].

The degree of public health is a reflection of the quality of a nation's resources in creating common prosperity. One of the indicators used to measure the degree of public health is the percentage of the population who have health complaints. One of the Strategic Issues and the 2019-2024 Health Development Policy Draft as a follow-up to the

achievement of the SDGs target in 2017, namely ensuring a healthy life and promoting welfare for all people of all ages by 2030 [4].

The event of an increase in sufferings or deaths caused by an infectious disease in a certain area, can sometimes be a shocking event and can cause an epidemic that attacks the wider community in a short time due to infectious diseases.

Seeing the course of the disease in the host (host), the form of germ carriers (carrier) can be divided into several types [5]:

1. Healthy carriers (inapparent), namely those who in their history have never shown that they have the disease clinically but contain elements that can be transmitted to others.
2. Incubatory carrier (shoot period), namely those who are still in the budding period but already have the potential to transmit disease.
3. Convalescent carrier (clinically cured), namely those who have just recovered from certain infectious diseases but are still the source of transmission of the disease for a certain period.
4. Chronic carrier (chronic), is a source of transmission that is quite long.

In the course of the disease, sensitive hosts will naturally interact with pathogenic microbes and cause symptoms as a response to the body's response to infection in the form of increased body temperature, redness of the skin or pain in organs or in part or all of the body. Of these symptoms the most easily recognized is an increase in body temperature through measurement with a thermometer**.**

The use of medical devices in assisting diagnosis and treatment is concerned about nosocomial infections (infections that develop in the hospital environment). Approximately 5 - 15% of patients hospitalized have nosocomial infections with Staphylococcus and Vancomycin-Resistant enterococci (VR) [6]. Furthermore, the response of children such as crying, tantrums and fussing towards hospitalization creates opportunities for transmission in the implementation of the treatment to be provided and hinders the healing process [7]. By looking at this fact, the formulation of the problem in this study can be arranged, namely:

1. Is there an effect of students whose body temperature is above normal who do not attend school on the transmission of infectious diseases?
2. How is the effectiveness and accuracy of infrared thermometers compared to digital thermometers in terms of time duration and body temperature measurements?

The research aims are analyzing the effect of students whose body temperature is above normal who do not attend school on the prevention of transmission of infectious diseases and analyzing the effectiveness and accuracy of infrared thermometers in comparison with digital thermometers.

2. MATERIALS AND METHOD

In this study, two types of data were used, namely primary data and secondary data, where the primary data was obtained from direct temperature measurement data, as well as a sick certificate from parents or doctors. Meanwhile, secondary data obtained from several literature studies, literature, books and journals.

The equipment used, among others: Camera to document a series of research activities; stationery and paper to record observations and data collection; infrared thermometer and digital thermometer for measuring body temperature; 70% alcohol and wipes; earloop mask; face shield; plastic gloves.

2.1. Research design

The independent variable to be examined in this study was an infrared thermometer and a digital thermometer, while the dependent variable to be studied was body temperature measurement. Confounding variables such as physical activity were variables that can be controlled statistically, then these variables were analyzed statistically.

The type of the research was an analytical research. The research design was a cross sectional or cross-sectional study, where measurements are only carried out once at a time in a population at the school by collecting primary data in the form of direct observations or observations in the field, to elementary school aged children using random sampling techniques. The sample to be given treatment came from grade V students with a total of 40 students from 4 classes totaling 146 students.

The combination of these methods was used to describe the conditions and facts that occur in order to obtain information related to the initial detection of body temperature with infrared technology and the effectiveness of tools for the prevention of endemic outbreaks of infectious diseases in elementary school children.

2.2. Population and Sample

2.2.1. Population

The total population in this study were 752 students of SDN 089 Babakan Ciparay Bandung. This is related to the research objective of early detection of increased body temperature with infrared technology, which is to detect early possible disease infections.

2.2.2. Sample

The sample is part of the total population and has the characteristics of a population. In this study, the research sample for measuring body temperature was 40 students, which is taken from 4 class V elementary school SDN 089 Babakan Ciparay.

2.3. Research procedure

The research procedures in this study are:

2.3.1. Observation

Observations were made to obtain primary data in the form of a profile sample, observe the implementation of activity programs, provision of infrastructure, school facilities as applied in *Permendiknas* 24 of 2007.

2.3.2. Documentation

Documents were recorded the events, in the writing or images forms. This documentation was a complement to the use of observation and interview methods in qualitative research.

2.3.3. Data processing

Data processing conducted to detect total amount of heat of students, the measurement results of the infrared thermometer were analyzed using the One Sample Proportion Test which was used to determine the criteria for achievement or completeness by using hypothesis testing about an average of a population, for parametric statistics can use the Z test.

The Z test can be applied to test the hypothesis in one treatment using percentages. The test steps were:

1. Data Normality Test
2. Determine the hypothesis to be tested
3. Find Z Count and Z Table

$$\text{Z count} = \frac{\left(\frac{x}{n} - P\right)}{\frac{\sqrt{P(1-P)}}{\sqrt{n}}} \quad (1)$$

Where : X = Lots of categorical data hypothesis

n = Number of data

P = Proposition on hypothesis

$$\text{Z table} = Z\,(1/2 - \alpha) \quad (2)$$

2.4. Determine test criteria and conclusions

The proportion of the hypothesis was in accordance with the disease transmission cycle where the host factor plays an important role, so when 1 student was detected by an infrared thermometer, it can prevent transmission of outbreaks of infectious diseases to elementary school children.

$$Po = 1 / n \,\% \quad (3)$$

Because the number of research samples is n = 40 students then the hypothesis was carried out as follows:

H_0: Measuring temperature with an Infrared Thermometer was effective in preventing the transmission of disease outbreaks if the detected student temperature above normal body temperature was more than 2.5 %; H_0: P > P0

H_a: Measurement of temperature with an infrared thermometer was not effective in preventing the transmission of disease outbreaks if the detected student temperature above normal body temperature was less than 2.5; H_a: P < P0

Because H_0: P > P0 and Ha: P < P0 then carried out the left hand one test, where the rejection area H_0 was Zscore < -Ztable.

The hypothesis test for the proportion of two populations was a test of two proportions, each of which comes from two different and independent populations. The two-proportion test was used to compare the effectiveness of using infrared thermometers and digital thermometers in measuring student body temperature. The sample requirement to test the proportion of two populations was that the sample taken must be random (random) and come from an independent population. Here are some steps in testing the hypothesis of two populations.

2.4.1. Hipotesis

The hypothesis of the two-population proportion test was the two-tailed test hypothesis. Two-way test is used to find out whether two populations have the same proportion or not, compared to the proportion in the second population.

The hypothesis for the two-sample test is H0 : P1 = P2

Ha: P1 ≠ P2
H0: effectiveness measurement of temperature of infrared thermometer and digital thermometer is the same
Ha: effectiveness measurement of temperature of infrared thermometer and digital thermometer is different

P1 is the proportion in population 1
P2 is the proportion in population 2

2.4.2. Level of Trust or Level of Significance

The level of confidence that is often used in statistical testing is 95% or (1 - α) = 0.95.

2.4.3. Test Statistics

The test statistics used in the test of the proportion of two populations are

$$z = \frac{\hat{p}_1 - \hat{p}_2}{\sqrt{\bar{p}(1-\bar{p})\left(\frac{1}{n_1}+\frac{1}{n_2}\right)}} \quad (4)$$

where:

$$\hat{p}_1 = \frac{x_1}{n_1}$$

$$\hat{p}_2 = \frac{x_2}{n_2}$$

$$\bar{p} = \frac{x_1 + x_2}{n_1 + n_2} \quad (5)$$

Information:
$\hat{p}_1$ is the proportion in sample 1
$\hat{p}_2$ is the proportion in sample 2
$\bar{p}$ is the combined proportion
x_1 is the number of successes in sample 1
x_2 is the number of successes in sample 2
n_1 is the number of samples 1
n_2 is the number of samples 2

2.4.4. Critical Areas

The critical area is the area used to reject or not reject Ho. The tipping points for the two-tailed test are –Zα / 2 and Zα / 2.

2.4.5. Decision

The decision for the two-way test is to reject H0 and accept Ha, when z <Zα / 2 or z> Zα / 2**.**

3. RESULTS AND DISCUSSION

3.1. Description of Research Data

The data collection technique in this study used the measurement of body temperature in students who were sampled, using an infrared thermometer and a digital thermometer and recorded their body temperature.

The research was carried out by carrying out the standard COVID19 protocol, so that students did not gather, and after each temperature measurement, students were asked to go home. Infrared thermometer measurements are carried out every day, but measurements with a digital thermometer as a comparison are only done once, to avoid being exposed to the Corona Covid19 virus, because there is direct contact between the device and the armpit student body.

The COVID19 protocol procedures carried out at the time of the study were*:* tool operator using Faceshield*;* the appliance operator uses an earloop mask;tool operator using Gloves; spraying the hand sanitizer on the pupils after measuring; infrared thermometer and digital thermometer, before and after measurement sterilized by 70% alcohol.

3.2. Univariate Analysis

Univariate analysis describes the characteristics of the sample based on temperature measurements with an infrared thermometer and a digital thermometer, namely: gender, status of residence, status of residence, size of house, distance from house to school, transportation used to school, status of illness history for the last two months with body heat above normal body temperature. The history of hospital treatment for the last two months and the comfort status were measured by temperature using an infrared thermometer and a digital thermometer.

3.2.1. Gender characteristics

Table 1. Respondent Gender (n=40)

Variable	F	%
Male	19	47,5
Female	21	52,5
Number	40	100

From Table 1, it is obtained data that the characteristics of respondents based on gender, from 40 respondents it was found that the male gender (47.5%) was smaller than the female (52.5%).

3.2.2. Characteristics of Residence Status

Table 2. Status of Residence

Status of residence	F	%
Living with Parents Living together	39	97,5
Grandparents Living together	1	2,5
Relatives	0	0
Number	40	100

From Table 2, it is obtained data that the characteristics of respondents based on their residence status, from 40 respondents it was found that they lived with their parents (97.5%), lived with their grandparents (2.5%)

3.2.3. Characteristics of Residential Status

Tabel 3. Residential Status

Residential Status	F	%
Own house	23	57,5
Rented house	11	27,5
Relative's house	6	15
Number	40	100

From Table 3, it is obtained data that the characteristics of the respondents are based on their residence status, from 40 respondents found their own house (57.5%), rented house (27.5%) and family house (15%).

3.2.4. Residential Size Characteristics

Table 4. Residential Size

Residential Size	F	%
Type 21 House	30	75,0
Type 36 House	9	22,5
Type 45 House	1	2,5
Number	40	100

From Table 4, it is obtained data that the characteristics of respondents based on the size of the residence of the 40 respondents obtained, House Type 21 (75.0%). House Type 36 (22.5%) and House Type 45 (2.5%).

3.2.5. Characteristics of Distance from Home to School

Table 5. Distance from House to School

Distance from House to School	F	%
Less than 1 km	35	87,5
Distance 1-5 km	5	12,5
More than 5 km	0	0
Number	40	100

From Table 5, it is obtained data that the characteristics of respondents based on the size of the distance from the house to the school of 40 respondents obtained, the house is less than 1 km (87.5%). Distance 1-5 km (12.5%) and Distance More than 5 km (0%).

3.2.6. Transportation Characteristics Used

Table 6. Transportation Used

Home distance to school	F	%
Own Vehicle	2	5
Public transport	2	5
On foot	36	90
Number	40	100

From Table 6, it is obtained data that the characteristics of respondents based on the vehicle transportation used to school from 40 respondents are obtained, Own vehicle (5%), public transportation (5%) and walking (90%).

3.2.7. Characteristics Status History of illness in the last 2 months with body heat above normal

Table 7. Status of Pain History with Body Temperature Above Normal Temperature

Pain History Status	F	%
Never	39	97,5
Ever	1	2,5
Rare	0	0
Number	40	100

From Table 7, it is obtained data that the characteristics of the respondents based on the status of illness history for the last 2 months with body heat

above normal from 40 respondents were obtained, Never (97.5%). Ever (2.5%) and Rarely (0%).

3.2.8. Characteristics of Hospital Care History Status, the last 2 months

Table 8. Hospital Treatment History Status, the last 2 months

Pain History Status	F	%
Never	39	97,5
Ever	1	2,5
Rare	0	0
Number	40	100

From Table 8, it is obtained data that the characteristics of the respondents based on the History of Hospital Treatment, in the last 2 months 40 respondents were obtained, Never (97.5%) Ever (2.5%) and Rarely (0%). The characteristics of the comfort status were measured by temperature using an infrared thermometer and a digital thermometer

Table 9. The comfort status was measured by temperature using an infrared thermometer and a digital thermometer

Measurement Convenience Status	F	%
Infrared Thermometer	39	97,5
Digital Thermometer	1	2,5
Neither	0	0
Number	40	100

From Table 9, it was obtained that the characteristics of the respondents based on their comfort status were measured by their body temperature with an infrared thermometer and a digital thermometer for 40 respondents, an infrared thermometer (97.5%), a digital thermometer (2.5%) and not both (0%).

Measuring body temperature is usually carried out in several hospitals or in health care clinics as a procedure to diagnose a disease. The data in this study is in the form of quantitative data which will be processed by statistical analysis, the measurements were carried out for 24 days on 40 students who were included in the sample, so that the measurement data is obtained as much as 806 times the measurement of students and 154 times of students who are not measured, students who are not measured because they do not come. It is stated, if the reason is that sickness is an effort to prevent disease transmission carried out by parents and if the reason is that the permission is because there is no family need, then the body temperature is normal.

From the histogram of Figure 5, it is known that from 806 times the measurement of the student's body temperature using an infrared thermometer as much as 0.744% is the measurement result with a range of 37.46363636 ^{0}C - 37.9 ^{0}C is the result of measuring the student's body temperature above the normal body temperature, and 99.256% is the result of temperature measurement. body with a temperature range of 35.5 ^{0}C - 37.46363636 ^{0}C, is a normal student body temperature.

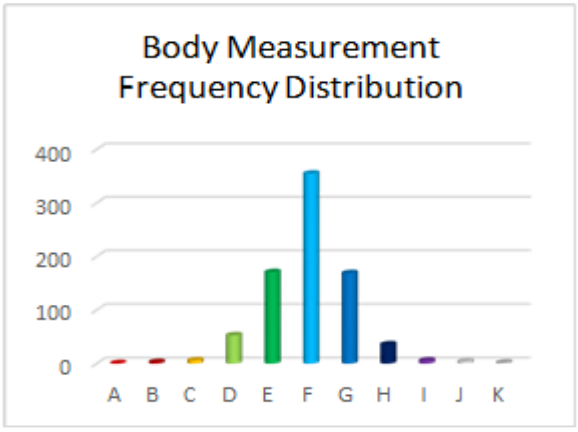

Figure 1. Histogram of temperature measurement components for SDN 089 Babakan Ciparay Class

According to [8], the normal temperature limit is 36 ^{0}C - 37.5 ^{0}C, so that from the research data it was found 4 times the measurement of body temperature with a body temperature above normal.

In the cycle of decreasing infectious diseases, the host factor has an important role so that in this study a limit is made that when 1 student is detected it is measured by an infrared thermometer in a school classroom environment, then there will be disease transmission, so that the limits are made that:

Detected >= 1 student body temperature above normal, indicating that the use of an infrared thermometer is effective in preventing the transmission of infectious diseases to elementary school-aged children

Detected = 0, the student's body temperature is above normal, indicating that the use of an infrared thermometer is not effective in preventing the transmission of infectious diseases to elementary school-aged children

Because in the application of the use of measuring instruments, it is necessary to consider practicality, comfort, and does not cause new problems in terms of transmission of infectious diseases. Data collection in comparing infrared thermometers and

digital thermometers is only done once per sample, because the use of a digital thermometer will occur directly to avoid transmission of infection, from 40 samples measured with infrared thermometers and digital thermometers.

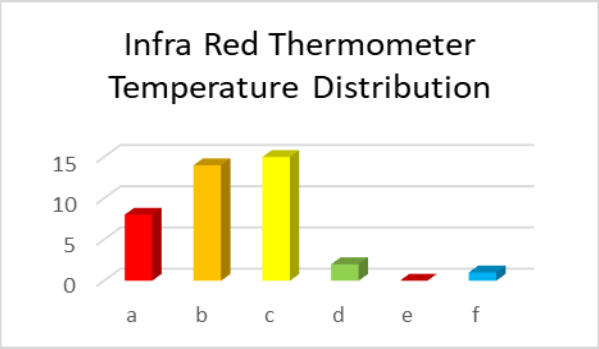

Figure 2. Histogram of Class V Infrared Thermometer Temperature Measurement Components SDN 089 Babakan Ciparay

From the histogram above it is known that from 40 times the measurement of the student's body temperature using an infrared thermometer as much as 38% are the measurement results with a range of 36.73340C - 37.0001 ^{0}C, 35% are the measurement results with a range of 36.46670C - 36.7334 ^{0}C, 20% are the results of measurements with range 36.2^{0}C - 36.4667 ^{0}C, 5% is the measurement result with a range of 37.0001^{0}C - 37.2668 ^{0}C, 3% is the measurement result with a range of 37.5335^{0}C - 37.8002 ^{0}C.

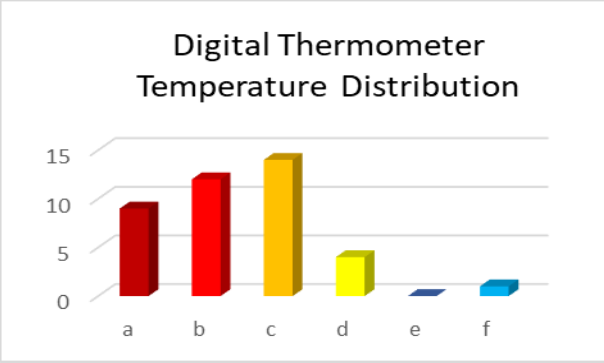

Figure 3. Histogram of Class V Digital Thermometer Temperature Measurement Components SDN 089 Babakan Ciparay.

From the histogram above it is known that from 40 times the measurement of the student's body temperature using a digital thermometer as much as 35% is the measurement result with a range of 36.6^{0}C - 36.85 ^{0}C, 30% is the measurement result with a range of 36.35^{0}C - 36.6 ^{0}C, 23% is the result. Measurement with a range of 36.1^{0}C - 36.35^{0}C, 10% is the measurement result with a range of 36.5^{0}C - 37.1^{0}C, 3% is the result of a measurement with a range of 37.35^{0}C - 37.6 ^{0}C.

Detection of a body temperature above normal body temperature in students, which had previously been screened at home by both parents. This happens because there is an experience when sick that needs healing treatment, when children go to the hospital, they tend to feel uncomfortable and afraid in a very foreign environment [7]. For children who come to the hospital, the feelings that often arise are anxiety, anger, sadness, fear, and guilt, proving that a sick child being taken to the hospital becomes an experience that can cause trauma, both to the child and the parents [7]. Preschoolers perceive hospital visits as a punishment so that the child will feel embarrassed, feel guilty, and fearful. The actions and procedures in the hospital were considered to threaten the integrity of her body. This leads to aggressive reactions with anger, rebellion, refusal to cooperate with nurses, and dependence on parents [7], so that in some cases children are afraid to complain about their own bad health.

The immune factor is influenced by the environment and physical activity, so that when the physical condition decreases due to fatigue, someone will be susceptible to infection disease transmission. In this study 90% of the sample carried out activities from home to school by walking and 5% by public transportation, this allowed the sample to be exposed to infection so that when they entered the school environment they were already infected, which was indicated by an increase in body temperature above normal as well. the response is inflammation due to infection.

In proving statistical research data using SPSS version 23, for decision making and proving the relationship between H0 and Ha. Testing the effectiveness of an infrared thermometer in preventing the transmission of infectious diseases, by measuring the body temperature of the sample, measuring the temperature for prevention of disease transmission is considered effective if it is found that the number of students detected with a body temperature above normal temperature by an infrared thermometer is more than 1 (2.5%) with alpha 5%.

Hypothesis:

H0: Measurement of temperature with an infrared thermometer is effective in preventing the transmission of disease outbreaks if the

detected student temperature above normal body temperature is more than 2.5%; H0: P > P0

Ha: Measurement of temperature with an infrared thermometer is not effective in preventing the transmission of disease outbreaks if the detected student temperature above normal body temperature is less than 2.5%; Ha: P < P0

Term:
Pass the Normality test
Hypothesis:
H0: Normal research data
Ha: Study data are abnormal

If the Sig. value is above 0.05 then accept H0: the research data is normal, because the research data is more than 30, then the Sig value taken is the Kolmogorof Siminov value.

From the results of the SPSS 23 program, the results obtained from each research data have a sig number above 0.05, meaning H0 is accepted and rejected Ha, this states that the research data for measuring body temperature using an infrared thermometer is Normal. Testing research data on the effectiveness of using an Infrared Thermometer in preventing the transmission of infectious diseases is by using the one-sided Z test, with the SPSS version 23 program as follows:

3.2. Testing the Effectiveness of Infrared Thermometers and Digital Thermometers

To find out the comparison of the effectiveness of the Infrared Thermometer with the Digital Thermometer is to use the Z Test, with conditions:

1. Data Must Be Homogeneous,

Hypothesis
H0: Homogeneous research data
Ha: Research data is not homogeneous
Basic decision

If the Sig value is above 0.05 then accept H0: the research data is Homogeneous,

2. Pass the Normality test,

Hypothesis
H0: Homogeneous research data
Ha: Research data is not homogeneous
Basic decision

If the Sig value is above 0.05 then accept H0: the research data is Homogeneous.

The hypothesis is testing the effectiveness with the Z test. Hypothesis:

H_0 = The effectiveness of the measurement results of the IRA thermometer is similar to the effectiveness of the temperature measurement results with a digital thermometer
Ha = The effectiveness of the measurement results of the ira red thermometer is not the same as the effectiveness of the temperature measurement results with a digital thermometer

Sig value> from 0.05 then accept H0 reject Ha
Sig value <than 0.05 then accept Ha, reject H0

The results of the Sig value test on the homogeneity test of body temperature measurements using an infrared thermometer and a digital thermometer for SDN 089 Babakan Ciparay students.

Judging from the Sig value on the Test of Normality on each variable, The Sig value for the infrared thermometer is 0.200 greater than 0.05, so the data is Normal.

Z test results with SPSS 23 to determine whether the effectiveness of the measurement of the Infrared Thermometer is the same as the effectiveness of the Digital Thermometer measurement.

According to [9] the results of measuring body temperature on the skin using an infrared thermometer must be interpreted with caution, because it is based on reports on the limited number of patients. The difference in total measurement results between infrared thermometers and digital thermometers in the research is 0.11 ^{0}C, the difference is more accurate by [10], where the total difference between infrared and digital thermometers is 0.38^{0}C. While the time needed in this study is 1-5 seconds, it has provided an accurate measurement value, compared to a digital thermometer which takes longer, namely 1-2 minutes, and this is in accordance with previous studies (Table 10).

Table 10. Comparison of the effectiveness of using an infrared thermometer with a digital thermometer for measuring body temperature of students at SDN 089 Babakan Ciparay, Bandung.

Information	Infra red Termometer	Digital Termometer
Body contact	No	Yes
Time required	1-5 seconds	1-2 minutes
Risk of transmitting infectious diseases	No	Yes, 5% -15% have nosocomial infections
Comfort	39 students said yes	1 student said yes

4. CONCLUSION

From the results of the Z test using SPSS 23, the Sig (2-tailed) value is 0.127 because the Sig (2-tailed) value is greater than 0.05, so accept the H0 hypothesis and reject the Ha hypothesis, this states that the use of an Infrared Thermometer is effective to prevent the transmission of infectious disease outbreaks to elementary school aged students.

The Sig (2-tailed) value for the Equal variances assumed is 0.105, greater than 0.05, so accept H0, reject Ha. This means that in terms of the results of measuring body temperature between an infrared thermometer and a digital thermometer are the same, but there are other benefits of using an infrared thermometer, namely: Not in contact with the body; the time needed is 1-5 seconds shorter; it provides more comfort for students who have high temperature; and it's easier to operate.

The infrared thermometer is easy to operate and gives students a sense of security and comfort. So that early detection of body temperature with infrared technology for the prevention of endemic outbreaks of infectious diseases in elementary school children is highly recommended.

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