THE ASSOCIATION BETWEEN THE DEGREE OF LEANNESS OR OBESITY IN CHILDREN AND THE DIFFERENCE BETWEEN THEIR AXILLARY AND RECTAL TEMPERATURES

by

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STATEMENT BY AUTHOR

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ABSTRACT

This study was done to explore the question of whether the degree of leanness or obesity in children affects the difference between their rectal and axillary temperatures. The conceptual framework for this study was based on theories of heat production and circulation, heat storage and loss, and body insulation. The sample included 30 female, Caucasian children between the ages of 2 and 23 months who were attending a public health well-baby clinic. The measurement tools used were a room thermometer, measuring tape, skinfold-thickness caliper, arm anthropometry nomogram, electronic thermometer, infant and stand-up scales, and measuring board.

Data analysis at the 0.05 level showed no significant association between degree of leanness or obesity and difference between axillary and rectal temperatures in the sample. However, the trend of the data showed that the thicker the anterior axillary skinfolds, the greater the difference between rectal and axillary temperatures. Also, the data suggested that the axillary method of temperature taking may be unreliable for children in the age group of the sample.

CHAPTER 1

INTRODUCTION

In a hospital pediatric care unit, there is often a question as to whether to take a child's temperature by the rectal or the axillary method when an oral temperature cannot be safely or accurately taken. This is due to a difference of opinion among medical personnel as to whether the axillary method is reliable.

A contributing factor to the reliability or unreliability of the axillary temperature may be temperature-taking technique. Axillary temperature taking takes approximately 10 minutes with a glass thermometer and a busy nurse may not always stay with a child to properly hold the thermometer in place long enough for it to register correctly.

Medical personnel disagree on the amount of discomfort and anxiety they believe rectal temperature taking causes the child. Rectal temperature taking involves invasion of the body by an instrument in a procedure which the child cannot visualize while it is being done. Depending on the perceptions, past experiences, and age of the child, this may be an upsetting experience. There also is a danger of rectal perforation with rectal thermometers when used on newborn and premature babies as reported by Fonkalsrud and Clatworthy (1965), Greenbaum et al. (1969), Smiddy and Benson (1969), and Wolfson (1966).

It has been of interest to this investigator to identify some of those factors that might make the axillary temperature vary from the rectal temperature. After taking many temperatures on many patients, this investigator questions if leanness or obesity of the patient may be one factor that affects the difference between the rectal and axillary temperatures. Looking at the degree of leanness or obesity of children in relation to the difference between their rectal and axillary temperatures has been the focus of this research study.

Statement of the Problem

Is the difference between the axillary and rectal temperatures associated with the degree of leanness or obesity in a child?

Significance of the Problem

Oral temperatures are seldom taken on children under 5 years of age. These young children are often unable to correctly hold oral thermometers in their mouths for as long as is necessary to register accurate temperatures. For children under 5 years of age rectal or axillary temperatures are usually taken. Rectal temperatures may be contraindicated in children who have certain types of gastrointestinal disturbances or gastrointestinal surgery. This leaves only the axillary temperature as a way of temperature taking for children with these problems who are also very young.

Older children also may not be able to have their temperatures taken orally. This may be due to an inability to physically hold the oral thermometers in their mouths because of illness. Also, having various tubes in their noses causing them to mouth breathe negates oral temperatures.

Axillary temperature taking is much more comfortable and less anxiety provoking for the child than rectal temperature taking. In the small baby there also is the danger of rectal perforation when using a rectal thermometer. However, the axillary temperature is more labile than the rectal temperature. Many times when this investigator has compared the axillary and rectal temperatures of a child, there has been as much as 2 to 3°C difference between the two. Nurses need more knowledge about the relationship between rectal and axillary temperatures so that they can use good judgment in choosing temperature-taking methods for children.

If research were to show that the difference between the axillary and rectal temperatures is affected by the degree of leanness or obesity of the child, a nurse could predict the degree of lability of axillary temperature in relation to rectal temperature due to this factor and could better interpret the axillary temperature. For instance, she would know that if the child is thin, his axillary temperature may be much closer to his rectal temperature and if he is obese, his axillary temperature may be less close to his rectal temperature.

Conceptual Framework

The conceptual framework for this study centered on three aspects of the body temperature-regulating system. These were heat production and circulation, heat storage and loss, and body insulation.

Heat Production and Circulation

Selle (1952) reported that the main centers for control of body temperature lie in the hypothalamus. These centers can be affected by direct heat and cold, changes in blood temperature, and impulses from the peripheral temperature receptors. Through the central nervous system and the sympathetic nervous system, blood flow to the peripheral tissues is regulated in response to the changes dictated by the hypothalamus.

Selle (1952) also pointed out that energy comes from the metabolism of carbohydrate, fat, and protein and that in the resting body almost all of the energy released appears as heat. Heat from the inner body is brought to the body surface by conduction through the tissues, tissue fluids, and circulating blood.

It could be postulated that as the arteries get smaller on their way to the peripheral tissues and as heat is conducted from warmer inner body tissues to the more peripheral tissues, the amount of heat conducted decreases the farther to the periphery it travels. It may then follow that the more body tissue there is between the inner body source of heat and the spot where the temperature is taken, the greater the temperature difference. The study by Eichna et al. (1951), described in Chapter 2 of this thesis, tends to support this concept.

Heat Storage and Loss

Brobeck (1973) explained the principles of physics of heat storage and loss. Heat storage varies with body mass. Heat loss varies with surface area. Heat is lost by radiation, convection, conduction, and evaporation. Guyton (1971) wrote that radiation is heat loss by infrared rays. Transfer of heat from the surface of the body to other objects is conduction. Removal of heat from the body by air currents is loss by convection. Evaporation is loss of body heat in the water that escapes from the skin surfaces.

Small bodies have relatively more intense metabolic rates than large bodies. Small bodies store a small fraction of their metabolic rates, whereas large bodies store a larger fraction of theirs. The larger amount of heat stored by large bodies tends to counteract thermal changes. Small bodies have relatively larger surface areas than large bodies making small-body heat loss relatively more. Because small bodies cannot store as much heat and tend to lose relatively more heat through surface area than large bodies, the body temperature of small bodies is relatively more unstable than that of large bodies.

Brobeck (1973) stated that the unstable body temperature of the infant or child, as compared with the adult, reflects the principles of heat storage and loss. There are no inherent differences between child and adult in body temperature-regulating mechanisms.

Using the laws of heat storage and loss, a small, thin child and a tall, thin adult with the same amount of leanness in relation to height, could be compared. The child would not be able to store as much heat as the adult and the child would lose relatively more heat than the adult. This would be because the adult is bigger and has more body mass, and because the child has relatively more surface area. The same laws would apply when comparing two people of the same height, one of whom is obese and the other of whom is thin. The obese person would have better heat storage because of relatively more mass and less heat loss because of relatively less surface area. The temperature of the obese person would be more stable than that of the thin person because the obese person would be better able to counteract thermal changes than the thin person. It seems possible that the skin temperature of the obese person could be altered without affecting his internal temperature as much as the same skin temperature change would alter the internal temperature of the thin person. Again, this would be because the obese person would be better able to counteract thermal changes than the thin person. Therefore, it seems likely that the difference between the rectal and axillary temperatures of the obese person would be more than the difference between the rectal and axillary temperatures of the thin person. This would be because the obese person has more mass and is able to counteract thermal changes easier. His skin temperature would change due to changes in air temperature but his inner body temperature would not be as easily affected. The thin person, because of less mass, does not have the same ability to counteract thermal changes, and therefore a change in air temperature which would change his skin temperature might more readily change his inner body temperature.

Body Insulation

Selle (1952) wrote that when a person is exposed to cold, vasoconstriction of the peripheral blood vessels occurs, shunting the blood to the deeper tissues. He stated that a subcutaneous layer of fat, free from blood flow, has the same amount of insulating power as a layer of cork of the same thickness.

Guyton (1971) pointed out that heat insulation of the body consists of the skin, the subcutaneous tissues, and especially the body fat. Fat conducts heat a quarter as fast as the other tissues. When the blood is being maintained mostly in the heated internal organs, the insulating effectiveness of the tissues of the male body are equal approximately to the insulating properties of three-quarters of an average suit of clothes. Women have better heat insulation than men, due to more fat tissue. From person to person the degree of insulation varies, and it depends greatly on the quantity of fat tissue.

Most of the body heat is produced in the inner portions of the body. Because of this, the insulation under the skin is effective in maintaining the inner body temperature even though it allows skin temperature to approach that of the environment.

An obese person could show more difference between his rectal and axillary temperatures than a thin person. This is because body fat tends to retain inner body warmth. Environmental temperature can influence the skin temperature but cannot easily permeate the fat layers to influence inner body temperature. A thin person without much insulating fat could lose inner body heat more quickly than an obese person. Environmental temperature can perhaps more easily influence his inner body temperature. Therefore, there may be less difference between the rectal and axillary temperatures of a thin person.

Purpose of the Study

Relationships between temperatures taken in various parts of the body have continuously been debated. The purpose of this study was to determine if there was an association between the degree of obesity or leanness of children and the difference between their rectal and axillary temperatures. The results of the study may add information to what is known about the factors that affect the relationship between the rectal and axillary temperatures. This information could be important to nurses as they make judgments about when to use either the rectal or the axillary temperature measurements.

CHAPTER 2

SELECTED REVIEW OF THE LITERATURE

This chapter contains a review of the literature on body temperature, the anxiety and discomfort caused by taking rectal temperatures, and the possibility of perforation by rectal thermometers. Additionally, some studies from the literature will be discussed in relation to concepts of heat production and circulation, heat storage and loss, and body insulation.

Body Temperature

Hey (1974) wrote that temperature taking gives information which leads to the promotion of healing and recovery. It also provides, especially in the case of children, a clue to comfort and warmth. Many children cannot tell us when they are uncomfortably warm or cold.

Cranston, Gerbrandy, and Snell (1954) reported that there is no one, single body temperature and that the temperature of different body tissues varies widely. According to Woodman, Parry, and Simms (1967), temperature assessment is based on determining the temperature of the inner body or core temperature. About two-thirds of the body is at core temperature, where one-third is at mean skin temperature.

Sims-Williams (1976) explained that the common sites for temperature taking are the mouth, rectum, axilla, and groin. The temperatures of the mouth and rectum are mucous-membrane temperatures, whereas the temperatures of the axilla and groin are skin temperatures. She stated that in most people the rectal temperature is likely to be higher than the skin temperature and that the difference between rectal and skin temperatures can be only approximately estimated.

Eoff, Meier, and Miller (1974) stated that it is often assumed that the axillary temperature is 1°F lower than the oral temperature and that the oral temperature is 1°F lower than the rectal temperature, with the rectal temperature being considered the most accurate. Earlier, Loudon (1957), Nichols et al. (1966), and Sellars and Yoder (1961) stated that oral, axillary, and rectal temperature measurements are quite variable in their relationships to each other. Blainey (1974), Guyton (1971), and Sims-Williams (1976) all believed that the body's core temperature is more constant than the skin temperature, which varies considerably because of the influence of environmental conditions. Blainey (1974) and Graas (1974) reported that the rectal temperature most accurately reflects the core temperature and that it is the most reliable, being less subject to environmental influences.

A study was conducted by Nichols et al. (1966) to determine relationships between oral and rectal, and oral and axillary temperatures. The sample included 60 adults between the ages of 18 and 50 years. They did not control for age or degree of obesity. The results were as follows:

1. Five per cent of the people had a 1.0°F difference between oral and axillary readings, 57% had less than a 1.0°F difference, and 35% had more than a 1.0°F difference.
2. Eight per cent of the people had a 1.0°F difference between rectal and oral readings, 67% had less than a 1.0°F difference, and 22% had more than a 1.0°F difference.

In summary, this study showed that difference between oral and axillary temperature readings and between rectal and oral temperature readings were not constant.

Anxiety and Discomfort Caused by the Taking of Rectal Temperatures

Even though the rectal temperature is generally considered more accurate and reliable than the axillary temperature (Blainey, 1974; Graas, 1974), taking rectal temperatures causes anxiety for some children. Freud (1952) found that the child is often unable to distinguish between the discomfort of his illness and the discomfort of the procedures imposed upon him to cure his illness. He usually has no choice but to submit to both sets of experiences.

According to McCaffery (1971), it is possible that children can expend enough energy in anxiety over procedures being done to them to adversely affect their recovery. She related that to take a rectal temperature the child is immobilized in a reclining position and unable to observe the intrusive procedure happening to him. This increases the child's anxiety.

Sutton, Falstein, and Judas (1958) studied hospitalized children 6 to 10 years of age who were being subjected to medical procedures. The children expressed greater fears over medical procedures than over their illnesses. One of the most feared procedures was the taking of a rectal swab. This, of course, is similar to taking a rectal temperature. Procedures that could be observed were less objectionable than ones that could not such as rectal swabbing.

Two of the main objections children have to the taking of rectal temperatures are immobilization and not being able to view the procedure. The reports of McCaffery (1971) and Sutton et al. (1958) supported this view.

Perforation by Rectal Thermometers

Rectal temperature taking on newborn and premature infants can be dangerous. Fonkalsrud and Clatworthy (1965) reported statistics gathered from hospitals on an unspecified number of cases that indicated perforation of the gastrointestinal tract in the newborn caused death in three-fourths of the cases. These perforations were thought to be caused by rectal thermometers. Greenbaum et al. (1969) reviewed seven cases of thermometer-induced rectal perforation in newborn and premature babies. Five of the babies died. Fonkalsrud and Clatworthy (1965), Greenbaum et al. (1969), Smiddy and Benson (1969), and Wolfson (1966), in their separate articles, related histories of various infants, totaling six cases, 10 days old and under, who had suffered rectal perforation thought to be due to rectal thermometers. The infants usually developed shock, abdominal distention, peritonitis, and pneumoperitoneum within 24 hours. These children had surgery for the bowel perforations with colostomies which were closed in 2 to 4 weeks, if they survived. Half of the infants survived.

Newborn and premature nursery personnel usually take axillary rather than rectal temperatures because of the danger of rectal perforation. Babies in newborn and premature nurseries are often in infant warmers or isolettes, which control the environment individually. Babies in individually controlled environments probably have more stable axillary temperatures than do older infants and children on regular pediatric wards.

Temperature of Body Parts

The following studies are related to the subject of this research paper. They are concerned with the relationship between axillary and rectal temperatures in newborn babies, bodily effects of thermal applications on dogs, comparison of rectal and axillary temperatures on premature infants, stability of body temperature in babies as related to environmental temperature, and observations of the relationships between temperature measurements in various parts of adult human bodies.

Relationship Between Infant Axillary and Rectal Temperatures

Eoff et al. (1974), using glass thermometers and telethermometers, attempted to determine the difference between axillary and rectal temperatures on infants. The sample consisted of 15 male and 15 female neonates all in good health. They weighed from 4 pounds, 14 ounces to 10 pounds, 3 ounces and were between 1 and 9 days old. The 30 infants were tested in bassinets in the nursery. An axillary and a rectal temperature were taken on each infant within a 15-minute period. A glass thermometer and a telethermometer were used for both for a total of four temperature readings on each infant.

The researchers found rectal temperatures taken with a glass thermometer to average 0.5°F higher than axillary temperatures taken with a glass thermometer. The differences between rectal and axillary temperatures for 14 of the 30 infants ranged from 0.4 to 0.6°F. The correlation between axillary and rectal temperatures was $r = 0.92$, which indicated that the axillary and rectal temperatures varied together. As a result of this study it was recommended that axillary temperatures be taken in this nursery.

Eoff et al. (1974) did not study degree of leanness or obesity in relation to the difference between axillary and rectal temperatures in these infants, but there was a large variation in weight among the babies. Conceptualizing, it might be expected that the larger babies could have had more difference between rectal and axillary temperatures than the smaller babies. The room temperature during each temperature taking was not given. It may be that this nursery had a fairly warm room temperature. If the room were cool, the larger babies would not lose as much inner body heat to the atmosphere as the smaller babies but their skins would reflect the coolness of the room. Therefore, their inner temperatures and skin temperatures would show more difference than would those in the smaller babies. The smaller babies would lose more body heat to the atmosphere than the larger babies causing their inner temperatures and skin temperatures to be closer than would those in the larger babies. In a warm room, the smaller babies would not lose as much inner heat to the atmosphere as they would in a cool room and their inner temperatures and skin temperatures would remain close due to environmental warmth causing skin warmth. In a warm room, the environmental warmth would cause the skin temperatures of the larger babies to more nearly approximate their inner temperatures. Therefore, in a warm room, the difference between the rectal and axillary temperatures in the larger babies would be closer to the difference between the rectal and axillary temperatures of the smaller babies.

Assessment of Local and Systemic Effects of Thermal Applications on Dogs

Dyer and Bagnell (1970) conducted a study on dogs to assess local and systemic effects of hot dry, hot wet, cold dry, and cold wet packs. The ambient temperature was between 72-78°F. The rectal and skin temperatures of the dogs were measured with a telethermometer equipped with thermistor probes and the readings were considered accurate to ± 0.4°F. Some of the dogs' weights were given along with their rectal and skin temperatures, but the relationship between weight and the difference between rectal and skin temperatures was not studied. There was no information given on the structural size of the dogs in relation to their weights.

Besides on the skin and in the rectum, thermistor probes were also placed in the subcutaneous body tissues, muscle, and peritoneal cavity. Observations made from the temperature readings were:

1. After removal of cold, wet packs, inner body temperature went down for 30-50 minutes before warming up.
2. With the application of cold packs, subcutaneous tissue temperature dropped rapidly as much as 22-25°F. However, an hour went by before maximum change was noted in muscle tissue at a depth of 7-8 mm. Temperature changes in the peritoneal cavity (15-16 mm) were never more than 6-7°F.
3. Hot applications were found to raise the skin temperature 10-14°F, subcutaneous temperature 8-11°F, muscle temperature 4-6°F, and peritoneal cavity temperature only a minute amount.

These observations could indicate that the more insulating tissues an animal has separating the inner body from the body surface, the longer it might take for atmospheric temperature to work its way through to the inner body and inner body temperature to work out to the body surface.

Comparison of Axillary and Rectal Temperatures of Premature Infants

Torrance (1968) compared axillary and rectal temperatures recorded over a period of 10 days for 120 premature infants. One aspect of the study was to determine the degree of difference between axillary and rectal readings. In this study, the difference between axillary and rectal readings was not found to be clinically significant.

No difference was found when data were analyzed by sex, race, and weight. Also, there was no significant difference in readings with clothes on or with clothes off. Weights of the babies were not given. Leanness or obesity was not considered as a factor.

Premature babies do not have much body tissue under their skins. Conduction of heat from the inner body to the skin should not take long. Since premature babies in hospital nurseries generally live in warm, controlled atmospheres, there would be less body heat lost to the environment. The range of the temperatures might have been broader if the babies had been in a cooler environment.

Study of the Mean Environmental Temperature
Needed to Keep Body Temperature Stable
in Babies

Hey (1974) studied the mean environmental temperature needed to keep body temperature stable in babies who weighed 1, 2, and 3 kg at birth. The heavier babies did not require as high an environmental temperature to maintain body temperature as did the lighter babies. Leanness or obesity of the babies was not considered.

According to the principles of heat storage and loss, the bigger babies would be able to store more heat than the smaller babies and the larger babies would not lose as much heat from their surface areas as the smaller babies. Therefore, the temperatures of the larger babies would remain more stable.

There could be greater differences between rectal and axillary temperatures of larger babies than of smaller babies. Conceptualizing, the skin temperatures of the larger babies could approach that of the room. Their inner temperatures could stay high. This would be due to their stored heat, less surface area to lose heat through, and possibly more insulating tissue to keep out the cool. The smaller babies would not have as much stored heat, would have more surface area to lose heat through, and would not have as much insulating tissue to keep out the cold. Therefore, their inner temperatures and their skin temperatures could be within a closer range.

Observations of Adult Persons to Determine Temperature in Various Body Parts

Eichna et al. (1951) made observations on 24 afebrile adult human subjects to determine temperatures in various parts of the body. The subjects were hospitalized persons and temperature observations were generally made after fasting overnight or several hours after breakfast. Temperature observations were made with the subjects nude, except for a loin cloth, the atmospheric temperature usually being 77-84°F. Temperatures were measured in the right heart, deep vessels leading to the right heart, femoral artery, femoral vein, rectum, subcutaneous tissues, and the intramuscular tissues 1-1/2 inches below the skin surface of the thigh.

Results of the temperature measurements showed:

1. Temperatures increased in the veins as they approached the heart.
2. Temperatures in the right heart, pulmonary artery, and high in the femoral artery were the same.
3. Rectal temperatures were a little higher than intracardiac and deep intramuscular temperatures.
4. Temperatures in the veins that drained the liver and brain were higher than in the veins into which they drained and were equal to the temperatures in the rectum.
5. The differences between cardiac and rectal temperatures were not clinically significant in afebrile persons.
6. Muscle temperatures were approximately 2°C cooler than rectal temperatures.

Muscle temperature's being cooler than inner body temperature may be due to the insulating power of the muscle tissues.

This study gave the impression that the more distant body tissue was from the inner body, the cooler it was. It could be surmised that the more tissue between the inner body and the skin, the cooler the skin might be as compared to the inner body.

Summary

The material in this chapter discussed body temperature and some of the problems involved with taking axillary and rectal temperatures on children. It also reported on studies from the literature that could be related to the subject of how degree of obesity may affect the difference between rectal and axillary temperatures. The major findings of the studies reviewed were:

1. The difference between axillary and rectal temperatures of a group of newborn infants averaged 0.5°F and the axillary and rectal temperatures of these infants varied together ($r = 0.92$).
2. Hot dry, hot wet, cold dry, and cold wet packs applied to the skins of a group of dogs changed the temperatures of skin and subcutaneous tissues much more quickly and in more degree than they did inner body temperatures.
3. The difference between axillary and rectal temperatures of a group of premature infants was not found to be significant.
4. The mean environmental temperature requirement needed to keep body temperature stable in a group of newborn babies was less for heavier babies than for lighter babies.

5. Temperatures, taken in various body tissues of a group of adult persons, were lower in the peripheral tissues and higher in the inner body tissues.

CHAPTER 3

METHODOLOGY

This chapter includes descriptions of the research design, the setting, the sample, the measurement tools, and the method of data collection. It also discusses the method of data analysis of the study.

Research Design

A descriptive design was used for the study. Thirty children were selected from a public health well-baby clinic to participate in the study. Body measurements taken on each child were an arm circumference; biceps, triceps, subscapular, and anterior axillary skinfold thicknesses; axillary and rectal temperatures; height; and weight. Measurement tools used were an electronic thermometer, measuring board, infant and stand-up scales, room thermometer, fiber glass measuring tape, skinfold-thickness caliper, and an arm anthropometry nomogram.

The Setting

The setting was a public health department well-baby clinic in the southwest. Permission to use the well-baby clinic was obtained from the chief nurse of the public health department by personal interview.

The clinic setting included a large waiting room and many smaller rooms where patients and parents met with the various clinic personnel. The researcher used the waiting room for the initial encounter with the parent and child, which included explaining the study and gaining parental consent. Measurements on the children, with the exception of heights and weights, were done in one of the consultation rooms. In this room were several straight-back chairs and a table. It was free from traffic and drafts. The room where the heights and weights were measured was a short distance across the hall from the consultation room. It contained a table, two chairs, measuring board, infant scale, and stand-up scale. This room was also free from drafts.

The Sample

The sample included 30 children who attended the well-baby clinic. These children also met certain other criteria. The children in the study:

1. Were between 2 months and 2 years of age.
2. Were Caucasian (including Mexican).
3. Were female.
4. Had rectal temperatures between 36.3 and 37.7°C on an electronic thermometer.

The Measurement Tools

The measurement tools used were an electronic thermometer, measuring board, infant and stand-up scales, room thermometer, fiber glass measuring tape, skinfold-thickness caliper, and an arm anthropometry nomogram. They are presented in the order of use.

Room Thermometer

The thermometer used to measure environmental temperature was an Ertco precision mercury thermometer obtained from the Scientific Products Division of the American Hospital Supply Corporation, Tempe, Arizona. The range was minus 30 to plus 120°F. It was marked in 1-degree increments and met all National Bureau of Standards specifications, being accurate within approximately ± 0.5°F. It was calibrated in a warm water bath by the head of the Biology Laboratory of the School of Nursing at The University of Arizona.

Measuring Tape

The arm length and arm circumference were measured with a Miltex fiber glass measuring tape, which measured in both inches and centimeters. This particular type of tape was being used to take various measurements on children in a nutritional study at The University of Arizona (Vargas, 1979). It measured up to 150 cm. This tape was used instead of a steel measuring tape, which was less likely to stretch, because steel tapes are less flexible and thus harder to maneuver around the very small arm of a baby. Also, a steel tape might have been more likely to cut than a fiber glass tape. The fiber glass tape was measured against a centimeter ruler each clinic day before use to verify accuracy.

Skinfold-Thickness Caliper

Skinfold thickness (a measurement of skin and subcutaneous fat) was measured with the Lange skinfold-thickness caliper. Skinfold measurements give a measurement of body fat (Gurney, 1969). McFie and Welbourn (1962) indicated that there was a correlation of $r = 0.66$, significant to the 0.1% level, between the measurement of the triceps skinfold and radiographic measurement of skin and subcutaneous fat. The Lange caliper has been used in many studies where a skinfold-thickness caliper has been needed (Bray et al., 1978; Durnin and Womersley, 1974; Wilmore, Girandola, and Moody, 1970). In a study by Womersley and Durnin (1973), a Lange caliper and two versions of the Harpenden caliper were compared in measuring skinfold thickness on 23 women and 27 men on eight or nine occasions over one month. Biceps, triceps, subscapular, and suprailiac measurements were taken. It was found that the three calipers measured equally well. The Lange caliper has pivoted tips which automatically adjust for skinfold measurements that are parallel. It has spring-loaded levers which provide a substantially constant standard pressure of 10 gm/mm^2 over the operating range (Lindner and Lindner, 1973).

Arm Anthropometry Nomogram

An arm anthropometry nomogram (Gurney and Jelliffe, 1973) was used in this study as one way of assessing degree of leanness or obesity. This nomogram is illustrated in Figure 1. Gurney and Jelliffe (1973) reported that the arm anthropometry nomogram is a simple method of finding the calculated arm muscle circumference. Once the calculated arm muscle circumference is obtained, the arm muscle area can be seen on the nomogram. This is subtracted from the total arm area (also shown on the nomogram) and the amount of subcutaneous fat is known. A person is then rated in relation to other people as to how lean or obese he is. Gurney and Jelliffe (1973) reported that the nomogram had been used accurately in a community nutrition survey. Triceps skinfold measurements are used with the nomogram. However, the subcutaneous fat around the arm varies from place to place, the triceps skinfold being the largest. Jelliffe and Jelliffe (1960) suggested that, to get a more accurate measurement of subcutaneous fat folds (skinfolds) for use in calculating muscle circumference, perhaps the biceps skinfold should be used or possibly an average value

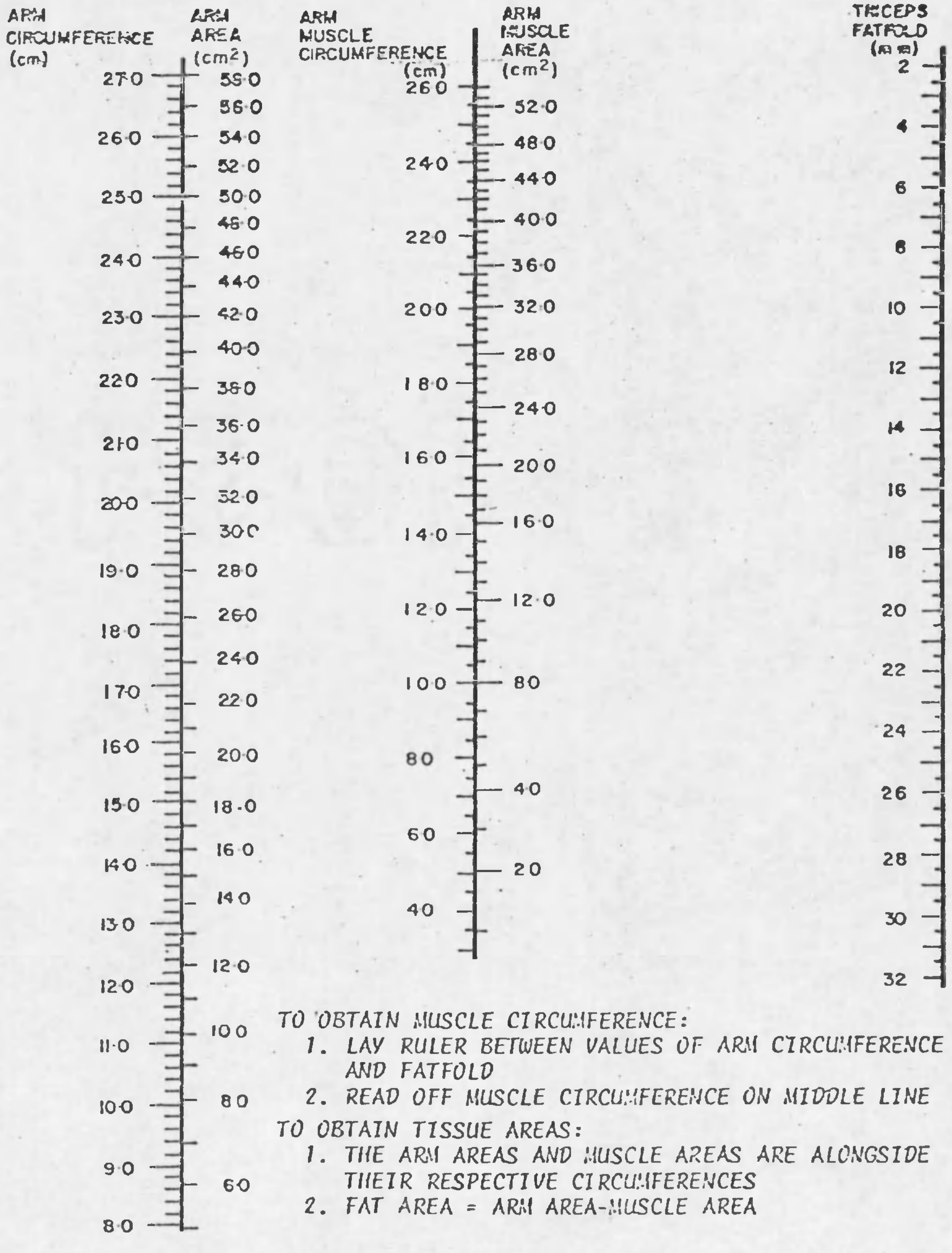

Figure 1. Arm anthropometry nomogram for children -- Source: Gurney and Jelliffe (1973:913).

obtained from biceps, triceps, medial arm, and lateral arm skinfolds. For this study an average of the triceps and biceps skinfolds was used with the nomogram on advice from Harrison (1979).

Electronic Thermometer

A LaBarge battery-operated, electronic thermometer was used to take the rectal and axillary temperatures of the children. It gives readings in approximately 30-45 seconds on a lighted panel. Accuracy of the unit was checked before use by plugging it into a special accuracy-testing module.

Scales

The infant and stand-up scales at the well-baby clinic were used for weighing the children. They were weight and balance type scales and were calibrated to balance at zero before each use. The same heavy book was weighed on both scales to assure that both gave the same reading. The scales weighed in pounds, but weight measurements were converted to kilograms by the investigator. Weights were measured to the nearest ounce on the baby scale and the nearest quarter pound on the stand-up scale.

Measuring Board

The lengths of the children were obtained on a measuring board. It showed measurements of the children in both centimeters and inches. Because the children could be held securely in this measuring device there appeared to be more ease in obtaining accurate measurements than there would have been using a measuring tape. Measurements were made to the nearest tenth of a centimeter.

Method of Data Collection

This section describes how data were collected for the study. The investigator discussed all aspects of data collection, prior to data collection, with the chief nurse of the public health department and permission was given by her to do the study. The researcher attended six well-baby clinic sessions, one per week, from the hours of 7:30 a.m. to 11:30 a.m. She obtained three to six children for the study during each clinic session. Children were admitted to the study as they became available according to the criteria used for selection. All data collection measurements except heights and weights were done by the investigator. Height and weight measurements were taken by clinic personnel as part of their regular routine.

The step by step procedure for data collection that the investigator used at each clinic session follows:

1. Arrived at clinic at 7:30 a.m.
2. Preparation of setting.

a. Set out room thermometer, electronic thermometer, skinfold-thickness caliper, and measuring tape in consultation room.

b. Weighed heavy book on infant and stand-up scales to make sure both scales weighed book the same.

3. Selection of subjects.

a. Sat in waiting room to watch for Caucasian females 2 months to 2 years old.

b. Explained study to parent of prospective subject after parent registered child to be seen at well-baby clinic.

c. Asked parent of prospective subject to read consent form and sign if he wished child to participate in study. (The Subject Consent Form is presented in Appendix A.)

4. Measurement of subject's arm circumference and skinfold thicknesses.

a. Took parent and child to consultation room.

b. Recorded room temperature on data collection sheet (Appendix C).

c. Recorded age of child on data collection sheet.

d. Asked parent to undress child down to one layer of clothing. (Children in the study with one layer of clothing seemed to be comparably dressed.)

e. Obtained left-arm circumference in centimeters by measuring around arm at midpoint between acromium and olecranon processes and recorded measurement on data collection sheet.

f. Obtained biceps and triceps skinfold-thickness measurements at midpoint between acromium and olecranon processes with skinfold-thickness caliper and recorded measurements on data collection sheet.

g. Obtained left subscapular skinfold measurement 1 inch below inferior angle of scapula and recorded measurement.

h. Obtained skinfold measurement on left anterior axillary line at level of xiphoid process and recorded measurement.

5. Measurement of axillary and rectal temperatures.

a. Placed oral probe of electronic thermometer covered with thermometer probe sheath against left chest wall on midaxillary line as high as possible in axilla.

b. Brought arm down over thermometer probe and held arm firmly in place until reading obtained, about 45 seconds.

c. Recorded reading to nearest tenth of a degree centigrade.

d. Inserted rectal probe with clean thermometer probe sheath into electronic thermometer.

e. Lubricated rectal probe and sheath with water soluble lubricant.

f. Inserted probe approximately 1 inch into rectum and held in place until temperature reading obtained, about 45 seconds.

g. Removed thermometer from rectum, threw sheath away, and recorded temperature to nearest tenth of a degree centigrade.

6. Measurement of subject's height and weight.

a. Went with child and parent across hall to have child's height and weight measured, if clinic personnel were ready, or had parent dress child and returned child and parent to waiting room until clinic personnel were ready.

b. Went with child and parent to weighing and measuring room when clinic personnel were ready.

c. Observed balancing of scale before weight was measured.

d. Observed weight and height measurements to make sure they were being done correctly.

e. Recorded height and weight of each child.

f. Thanked parent and child for participation in study and left them for clinic personnel to direct their further clinical activities.

The investigator then returned to the waiting room to wait for another child who might be appropriate for the study. When the investigator obtained six subjects, or if she found she could not obtain any more subjects on a certain day, she packed her equipment and left.

Control Variables

The control variables for this study were age, sex, race, and range of rectal temperature. The children who participated in the study were to be 2 months to 2 years old. This was to narrow the influence physical growth might have on body structure. Only girls were admitted to the study because of possible sexual differences in body composition even at an early age. The study included only Caucasian (including Mexican) children. Kroska (1968) indicated that there were variances in body composition due to race. Children whose rectal temperatures were not between 36.3 and 37.7°C were not included in the study to rule out the effect, if any, of abnormally high or low rectal temperatures on the difference between rectal and axillary temperatures.

Data Analysis

The purpose of the data analysis was to determine if there was an association in children between degree of leanness or obesity and difference between axillary and rectal temperatures. Degree of leanness or obesity was measured in four different ways, each of which was looked at during data analysis in relation to the difference between axillary and rectal temperatures.

The weight of each child in kilograms was divided by his length or height in centimeters, the quotient being carried out to two decimal places, to obtain a weight-height ratio in kg/cm. The higher the weight-height ratio, the more body weight a child had in relation to his height or length. The difference in degrees centigrade between the rectal and axillary temperatures of each child and his weight-height ratio was listed on a table to see the trend of the data collected.

Averages of the biceps and triceps skinfold measurements and the arm circumference of each child were used with the arm anthropometric nomogram to calculate amount of subcutaneous fat for each child. The amount of subcutaneous fat of each child and the difference between his rectal and axillary temperatures was listed on a table to see if there was an association between the two.

The biceps, triceps, subscapular, and anterior axillary skinfold measurements of each child were summed and that sum was placed in a table of data along with the difference between his axillary and rectal temperatures. It was then seen if there was an association between those two values.

The anterior axillary skinfold measurement of each child was placed in a table of data along with the difference between his rectal and axillary temperatures. The investigator examined the data for an association.

Room temperature did not vary more than 5°F during data collection. Therefore, it did not seem necessary to analyze the data in relation to room temperature.

In this study four sets of data were used to determine degree of leanness or obesity in a sample of children. These were weight-height ratio, amount of subcutaneous fat, sum of skinfold measurements, and measurement of the anterior axillary skinfold alone. During data analysis the degree of obesity or leanness of the children, as determined by these data, were analyzed in relation to the difference between their rectal and axillary temperatures. The level of significance for this study was $p = 0.05$.

Human Rights

Permission to do this study was given by the Human Subjects Committee of The University of Arizona. A copy of the Human Subjects Committee letter of approval is contained in Appendix B.

CHAPTER 4

PRESENTATION AND ANALYSIS OF DATA

The data from the study are presented in this chapter. The demographic characteristics of the sample of 30 subjects are presented first. The second part of the chapter discusses the relationship between the difference between rectal and axillary temperatures of the subjects and the subjects' weight-height ratios, amounts of subcutaneous fat, summed skinfold thicknesses, and anterior axillary skinfold measurements alone.

Characteristics of the Sample

The sample population for the study consisted of 30 female, Caucasian children, who, at the time of data collection, were being seen for health care at a public health well-baby clinic. All subjects met the preestablished criteria for the study.

A distribution of the subjects by age in months by 6-month intervals is shown in Table 1. The age range was from 2 to 23 months with a mean age of 10.1 months. Seventeen subjects were younger than the mean age of 10.1 months and 13 were older.

As shown in Table 2, the heights of the subjects ranged from 56.1 to 87.0 cm. The mean height of the

Table 1. Distribution of Subjects by Age

	Age, in months				
	0-6	7-12	13-18	19-24	Total
Number	11	9	7	3	30
Per Cent	37	30	23	10	100

Mean age = 10.1 months

Table 2. Distribution of Subjects' Heights

	Height, in centimeters		
	56.1-71.5	71.6-87.0	Total
Number	16	14	30
Per Cent	53	47	100

Mean height = 71.5 cm

subjects was 71.5 cm with 16 of the subjects having heights equal to or below the mean height and 14 of the subjects having heights above the mean height.

The weights of the subjects in relation to the mean weight of the subjects are presented in Table 3. Weights ranged from 5.07 to 12.57 kg with a mean weight of 8.50 kg. Fifteen of the subjects' weights were equal to or below the mean and 15 of the weights were above the mean.

Table 3. Distribution of Subjects by Weight

	Weight, in kilograms		
	5.07-8.50	8.51-12.57	Total
Number	15	15	30
Per Cent	50	50	100
Mean weight = 8.50 kg			

Additional measurements taken on the subjects during the study included rectal temperatures which ranged from 36.3 to 37.7°C with a mean of 37.0°C. The mean axillary temperature was 35.8°C and axillary temperatures ranged from 35.2 to 36.5°C. Arm circumferences ranged from 12.0 to 17.0 cm with a mean of 14.9 cm. Biceps skinfold measurements ranged from 3.0 to 7.0 mm, and the mean was 4.7 mm. Triceps skinfold measurements ranged from 6.00 to

12.00 mm with a mean of 8.63 mm. Averages of combined biceps and triceps skinfold measurements were calculated and these measurements ranged from 5.00 to 8.75 mm with a mean of 6.72 mm. Subscapular skinfold measurements ranged from 3.75 to 10.00 mm with a mean of 6.88 mm.

The mean values of all measurements taken on the subjects during the study for each of four 6-month age groups are presented in Table 4. These data show that:

1. The means of height, weight, and kilograms of weight per centimeter of height all increased with age from the 0-6 month to the 19-24 month age groups. Mean height increased from 64.6 to 84.3 cm, mean weight from 6.73 to 10.95 kg, and mean weight-height ratio from 0.10 to 0.13 kg/cm.
2. The only measurement that decreased with age from the 0-6 month to the 19-24 month age groups was the mean subscapular skinfold measurement, which decreased from 7.50 to 4.58 mm.
3. The mean rectal and mean axillary temperatures varied only slightly among the age groups and did not vary in any pattern with age. The mean rectal temperature ranged from 36.8 to 37.2°C and the mean axillary temperature ranged from 35.7 to 35.9°C.
4. The mean anterior axillary skinfold measurement and the mean difference between rectal and axillary temperatures varied together from one age group to

Table 4. Mean Values of All Study Measurements for Each of Four Age Groups of Subjects -- N = 30.

	Age groups of children, in months			
	0-6 (n=11)	7-12 (n=9)	13-18 (n=7)	19-24 (n=3)
Arm circumference, in cm	14.0	15.5	15.2	15.3
Biceps skinfold, in mm	4.7	3.7	5.2	3.9
Average of biceps and triceps skinfold thicknesses, in mm	6.64	6.92	6.93	5.92
Triceps skinfold thickness, in mm	8.55	9.05	8.57	7.83
Fat, in cm^2	4.14	5.11	6.14	4.17
Subscapular skinfold, in mm	7.50	7.33	6.32	4.58
Sum of skinfold thicknesses, in mm	26.73	27.67	26.18	20.50
Anterior axillary skinfold thickness, in mm	6.02	5.53	6.11	4.25
Rectal temperature, in °C	37.2	36.8	37.0	36.8
Difference between axillary and rectal temperatures, in °C	1.2	1.0	1.4	1.0
Axillary temperatures, in °C	35.9	35.9	35.7	35.8
Height, in cm	64.6	70.7	78.1	84.3
Kg of weight per cm of height	0.10	0.12	0.12	0.13
Weight, in kg	6.73	8.60	9.71	10.95

another. They both decreased from the 0-6 month to the 7-12 month age groups, increased in the 13-18 month age group, and then decreased in the 19-24 month age group.

Weight-Height Ratios and Difference Between Rectal and Axillary Temperatures

The difference between the rectal and axillary temperatures and the weight-height ratios for each subject are presented in Table 5. The difference between rectal and axillary temperatures ranged from 0.3 to 2.4°C with a mean of 1.1°C. Seventeen subjects (57%) had a difference between their rectal and axillary temperatures equal to or less than the mean and 13 subjects (43%) had a difference more than the mean. The weight-height ratios ranged from 0.09 to 0.14 kg/cm with a mean of 0.12 kg/cm. Twenty-one subjects (70%) had weight-height ratios equal to or less than the mean and 9 subjects (30%) had weight-height ratios more than the mean.

Data analysis, using the Pearson correlation coefficient, showed no significant association ($r = -0.07$) between weight-height ratio and difference between rectal and axillary temperatures.

Table 5. Difference Between Rectal and Axillary Temperatures and Weight-Height Ratio -- N = 30.

Subject number	Difference between rectal and axillary temperatures (°C)	Weight-height ratio (kg/cm)
1	0.9	0.12
2	1.5	0.13
3	1.4	0.12
4	1.1	0.10
5	1.5	0.12
6	2.1	0.09
7	1.4	0.09
8	0.7	0.13
9	1.0	0.14
10	0.9	0.11
11	1.6	0.09
12	0.8	0.10
13	0.9	0.12
14	1.8	0.14
15	0.4	0.10
16	1.1	0.13
17	0.6	0.09
18	0.3	0.12
19	0.7	0.11
20	1.4	0.12
21	0.7	0.11
22	1.0	0.11
23	0.7	0.14
24	2.4	0.10
25	1.4	0.14
26	0.7	0.10
27	2.0	0.11
28	1.7	0.13
29	1.2	0.12
30	0.3	0.14

Mean difference between rectal and axillary temperatures = 1.1°C.

Amounts of Subcutaneous Fat Determined by Nomogram and Difference Between Rectal and Axillary Temperatures

The amounts of subjects' subcutaneous fat were determined by using their arm circumference measurements and averages of biceps and triceps skinfold measurements with an arm anthropometry nomogram for children. This showed square centimeters of fat for each subject.

The difference between the rectal and axillary temperatures of the subjects and the square centimeters of subcutaneous fat for each subject as determined by the nomogram are presented in Table 6. The measurement of fat ranged from 2.00 to 10.50 cm^2 with a mean of 4.90 cm^2. Fifteen subjects (50%) had square centimeters of fat equal to or less than the mean and 15 subjects (50%) had more square centimeters of fat than the mean.

The Pearson correlation coefficient was used to analyze the data. No significant association was found ($r = 0.03$) between amounts of subcutaneous fat as determined by nomogran and difference between rectal and axillary temperatures.

Sums of Skinfold Measurements and Difference Between Rectal and Axillary Temperatures

The data presented in Table 7 show the sum of the biceps, triceps, subscapular, and anterior axillary skinfold measurements of each subject along with the difference between his rectal and axillary temperatures. The range of

Table 6. Difference Between Rectal and Axillary Temperatures and Amounts of Subcutaneous Fat by Nomogram -- N = 30.

Subject number	Difference between rectal and axillary temperatures (°C)	Subcutaneous fat as determined by nomogram (cm^2)
1	0.9	6.00
2	1.5	5.00
3	1.4	5.50
4	1.1	3.25
5	1.5	5.00
6	2.1	2.00
7	1.4	4.00
8	0.7	4.50
9	1.0	5.00
10	0.9	4.00
11	1.6	3.00
12	0.8	4.00
13	0.9	3.50
14	1.8	10.50
15	0.4	8.50
16	1.1	4.50
17	0.6	3.25
18	0.3	3.50
19	0.7	3.50
20	1.4	6.00
21	0.7	5.50
22	1.0	4.50
23	0.7	5.50
24	2.4	5.50
25	1.4	4.50
26	0.7	5.00
27	2.0	3.00
28	1.7	7.00
29	1.2	7.00
30	0.3	5.00

Mean amount of fat = 4.90 cm^2.

Table 7. Difference Between Rectal and Axillary Temperatures and Sums of Skinfold Thicknesses -- N = 30.

Subject number	Difference between rectal and axillary temperatures (°C)	Sums of skinfold thicknesses (mm)
1	0.9	31.50
2	1.5	24.75
3	1.4	29.25
4	1.1	23.50
5	1.5	25.25
6	2.1	21.25
7	1.4	30.75
8	0.7	21.00
9	1.0	24.75
10	0.9	23.75
11	1.6	27.25
12	0.8	26.00
13	0.9	20.75
14	1.8	36.25
15	0.4	25.50
16	1.1	27.25
17	0.6	28.50
18	0.3	20.25
19	0.7	24.00
20	1.4	24.75
21	0.7	32.00
22	1.0	28.75
23	0.7	26.25
24	2.4	26.50
25	1.4	19.75
26	0.7	28.00
27	2.0	22.00
28	1.7	35.75
29	1.2	30.50
30	0.3	22.00

Mean sum of skinfold thicknesses = 26.26 mm.

the sums of the skinfolds was from 19.75 to 36.25 mm with a mean of 26.26 mm. Seventeen subjects (57%) had summed skinfold measurements equal to or below the mean measurement and 13 subjects (43%) had summed skinfold measurements with a value above the mean.

No significant association was found ($r = 0.18$) between the sums of the skinfold measurements and difference between rectal and axillary temperatures. The Pearson correlation coefficient was used.

Anterior Axillary Skinfold Measurements and Difference Between Rectal and Axillary Temperatures

As seen in Table 8, the subjects' anterior axillary skinfold measurements ranged from 3.75 to 10.00 mm with a mean of 6.05 mm. Seventeen subjects (57%) had anterior axillary skinfold measurements equal to or less than the mean and 13 subjects (43%) had measurements more than the mean.

Analysis of the data concerning the relationship between the difference between the rectal and axillary temperatures and the measurement values of the anterior axillary skinfolds showed $r = 0.34$ and was not significant at $p = 0.06$. Those findings indicated that in this study there was no significant association between the difference between the rectal and axillary temperatures and the measurement values of the anterior axillary skinfolds.

Table 8. Difference Between Rectal and Axillary Temperatures and Anterior Axillary Skinfold Measurements -- N = 30.

Subject number	Difference between rectal and axillary temperatures (°C)	Anterior axillary skinfold measurements (mm)
1	0.9	4.00
2	1.5	6.00
3	1.4	7.00
4	1.1	4.25
5	1.5	5.00
6	2.1	5.00
7	1.4	8.75
8	0.7	3.75
9	1.0	7.00
10	0.9	5.00
11	1.6	8.00
12	0.8	5.00
13	0.9	5.00
14	1.8	10.00
15	0.4	4.00
16	1.1	6.25
17	0.6	8.25
18	0.3	4.00
19	0.7	8.00
20	1.4	4.75
21	0.7	7.00
22	1.0	7.75
23	0.7	6.00
24	2.4	6.25
25	1.4	4.00
26	0.7	5.00
27	2.0	6.00
28	1.7	10.00
29	1.2	6.50
30	0.3	4.00

Mean axillary skinfold measurement = 6.05 mm.

However, the trend of the data showed that the thicker the anterior axillary skinfolds, the greater the difference between the rectal and axillary temperatures.

Summary

A sample of 30 children was studied to see if there was any association between how lean or obese they were and the difference between their rectal and axillary temperatures. The Pearson correlation coefficient was used to determine if there was an association. Degree of leanness or obesity was determined by calculating weight-height ratios; using arm circumferences and averages of biceps and triceps skinfold measurements with an arm anthropometry nomogram; summing biceps, triceps, subscapular, and anterior axillary skinfold measurements; and using the values of anterior axillary skinfold measurements alone. No significant association was found between the difference between the rectal and axillary temperatures and degree of leanness or obesity.

CHAPTER 5

DISCUSSION OF FINDINGS, CONCLUSIONS, RECOMMENDATIONS, AND SUMMARY

This was a descriptive study that addressed the problem of whether the amount of difference between the axillary and rectal temperatures of a child was associated with his degree of leanness or obesity. The findings of the study as related to the conceptual framework and the review of the literature are discussed in this chapter. The conclusions about the study and its significance to nursing are also discussed. Recommendations are made for further study.

Discussion of Findings

The study sample comprised 30 subjects from 2 months to 23 months of age. An electronic thermometer was used to measure rectal and axillary temperatures. The difference between rectal and axillary temperatures was studied in relation to weight-height ratios; amounts of subcutaneous fat; sums of biceps, triceps, subscapular, and anterior axillary skinfold measurements; and anterior axillary skinfold measurements alone. A room thermometer was used to measure room temperature. Weights of the subjects were measured on infant and stand-up scales. Heights were obtained from a measuring board. Amounts of subcutaneous fat were determined by taking arm circumferences with a measuring tape and using those values along with averages of biceps and triceps skinfold measurements on an arm anthropometry nomogram for children. Skinfold measurements were taken with a skinfold-thickness caliper.

The conceptual framework considered several aspects of the body temperature regulating system. Those were heat production and circulation, heat storage and loss, and body insulation.

The review of the literature considered the body temperature, the anxiety and discomfort caused by the taking of rectal temperatures, and the possibility of rectal perforation by rectal thermometers. Some studies from the literature were related to concepts of heat production and circulation, heat storage and loss, and body insulation.

Findings Related to the Conceptual Framework

Selle (1952) reported that blood flow to the peripheral tissues is regulated by centers in the hypothalamus and that heat from the inner body is brought to the body surface by conduction through the tissues, tissue fluids, and circulating blood. Brobeck (1973) explained that heat storage varies with body mass and that heat loss varies with surface area. Larger bodies store more heat than smaller bodies and smaller bodies, due to relatively more surface area, lose more heat than larger bodies. Guyton (1971) and Selle (1952) stated that subcutaneous fat acts as an insulator to keep inner body heat in and environmental cold out.

It was hypothesized by the investigator that an obese child might show more difference between axillary and rectal temperatures than would a thin child. This would be because the obese child would have more tissue for inner body heat to traverse before reaching the body surface to affect surface temperature and also more tissue for environmental cold to penetrate before affecting inner body temperature. Also, an obese child might retain his inner body heat easier, thereby showing more difference between his inner and surface temperatures, whereas a thin child might lose his body heat faster, causing his inner and surface temperatures to more closely approximate each other. Lastly, an obese child would have more insulating fat than a thin child to keep inner heat in and environmental cold out. This might cause more of a difference between the inner and surface temperatures with an obese child than there might be with a thin child.

In this study, the difference between the rectal and axillary temperatures of 30 subjects were compared with how lean or obese they were. Estimations of leanness or obesity were accomplished in four ways: calculating weight-height ratios; using arm circumferences and averages of biceps and triceps skinfold measurements with an arm anthropometry nomogram for children; summing the biceps, triceps, subscapular, and anterior axillary skinfold measurements; and using the anterior axillary skinfold measurements alone. Data analyses of these four comparisons showed no significant associations between difference between axillary and rectal temperatures and degree of leanness or obesity in these children.

There was a nonsignificant trend of the data that suggested that the thicker the anterior axillary skinfold, the more difference between the rectal and axillary temperatures. This would go along with that this investigator postulated from the reports of Guyton (1971) and Selle (1952).

Findings Related to the Review of the Literature

Loudon (1957), Nichols et al. (1966), and Sellars and Yoder (1961) reported in their writings that oral, axillary, and rectal temperature measurements were quite variable in their relationships to each other. Eoff et al. (1974) related that it has often been assumed that the axillary temperature was 1°F lower than the oral temperature and that the oral temperature was 1°F lower than the rectal temperature. Based on what Eoff et al. (1974) reported, it could be assumed that the axillary temperature would be 2°F cooler than the rectal temperature. In the study for this thesis, the axillary temperatures varied erratically from the rectal temperatures. The smallest difference between a rectal and an axillary temperature was 0.3°C (0.56°F), the largest difference 2.4°C (4.44°F), and the mean difference was 1.1°C (2.03°F). The findings of this study support the findings reported by earlier authors that there is no set rule as to how much the axillary temperature will vary from the rectal temperature. The results of this study would also indicate that the axillary temperature may be an unreliable measurement in children 2 to 23 months of age.

The purpose of this study was to see if the degree of leanness or obesity of a child would affect the difference between his rectal and axillary temperatures. No studies from the literature could be found that related precisely to this subject. Eoff et al. (1974) attempted to determine relationships between axillary and rectal temperature readings on infants in a newborn nursery, and found a correlation of 0.92. Dyer and Bagnell (1970) conducted a study on dogs to assess local and systemic effects of hot dry, hot wet, cold dry, and cold wet packs and found that it took varying amounts of time for these packs to affect the inner temperatures of the dogs but surface tissue temperatures were changed more rapidly and markedly. Torrance (1968) compared axillary and rectal temperature determinations on premature infants and found that the difference between the axillary and rectal readings was not clinically significant. Hey (1974) studied the mean environmental temperature needed to keep body temperature stable in babies weighing 1, 2, and 3 kg at birth. The heavier babies did not require as high an environmental temperature to maintain body temperature as did the lighter babies. Eichna et al. (1951) made observations on 24 afebrile, adult, human subjects to determine temperature readings in various parts of the body. Temperatures were found to be cooler in the tissues more distant from the inner body.

The investigators of the above studies did not use leanness or obesity as a factor in their research. Therefore, their studies cannot be contrasted with this investigator's study in which measurement of leanness or obesity was a main factor. However, these studies tended to support the concept of an association between the difference between the rectal and axillary temperatures of a child and how lean or obese the child is.

Findings Related to the Control Variables

The control variables for this study were age, sex, race, and range of rectal temperature. The subjects in the sample were to be between the ages of 2 and 24 months of age, female, and Caucasian, with rectal temperatures between 36.3 and 37.7°C on an electronic thermometer. There were no significant findings relating difference between rectal and axillary temperatures to degree of leanness or obesity in the study sample, using these control variables. If the study were to be done again, an attempt should perhaps be made to have in the sample a number of subjects in each of varying categories of obesity.

Conclusions

This section presents the conclusions of the research related to the purpose of the study and to the significance of the study for nursing. No particular problems related to the logistics of the study were encountered during the research.

Conclusions Related to the Purpose of the Study

The purpose of this study was to see if there was an association between degree of leanness or obesity in children and the difference between their rectal and axillary temperatures. In this study no statistically significant association was found. The data suggested a nonsignificant positive association between thickness of the anterior axillary skinfold and difference between rectal and axillary temperatures. Looking at measurements of anterior axillary skinfolds in relation to difference between rectal and axillary temperatures in a group of children in which it has been purposefully attempted to have varied degrees of leanness and obesity might prove interesting for further research.

Conclusions Related to the Significance of the Study to Nursing

In this study, difference between the rectal and axillary temperatures of the children who participated varied widely even under controlled conditions. There are probably many factors we do not yet realize that affect the difference between the rectal and axillary temperatures. The data of the study suggest to this investigator that the axillary method of temperature taking may be unreliable for children in the age group of the sample. More research needs to be done to identify factors that might affect the difference between the rectal and axillary temperatures.

Recommendations

Based on the findings of the study, the investigator recommends repeating the study, in particular, that part of the study having to do with the size of the anterior axillary skinfold and the difference between the rectal and axillary temperatures. It is recommended that this be done with a group of children who have been carefully chosen so as to have widely varying degrees of leanness or obesity in the group.

Summary

This was a descriptive study to determine if there was any association between the difference of the axillary and rectal temperatures of a child and his degree of leanness or obesity. The study was based on concepts of heat production and circulation, heat storage and loss, and body insulation. It was postulated that an obese child would have more subcutaneous tissue than a thin child for inner body heat to circulate through to the body surface and for environmental cold to circulate through to reach the inner body. Also, it was postulated that an obese child would retain heat better and lose less heat than a thin child and that an obese child would have more fat as insulating material than a thin child. Therefore, it was conceptualized that an obese child would show more difference between his rectal and axillary temperatures than would a thin child.

The sample included 30 children who attended a well-baby clinic. They were between 2 and 23 months of age, Caucasian, and female. Also, they had rectal temperatures of 36.3 to 37.7°C on an electronic thermometer.

Measurements taken on the subjects were arm circumferences; biceps, triceps, subscapular, and anterior axillary skinfold thicknesses; heights; weights; and rectal and axillary temperatures. Measurement tools used were a room thermometer, measuring tape, skinfold-thickness caliper, arm anthropometry nomogram, electronic thermometer, infant and stand-up scales, and measuring board.

The analysis of the data showed no statistically significant association between the difference between the axillary and rectal temperatures of the subjects and their degree of leanness or obesity. The Pearson correlation coefficient was used to analyze the data.

The findings of the study should help increase understanding that the axillary temperature is much more labile than the rectal temperature and that there are probably many factors that affect it. Therefore, nurses should be cautious and exercise extreme good judgment in its use.

APPENDIX A

SUBJECT CONSENT FORM

I agree to have my child participate in a research project entitled "The Association Between the Degree of Leanness or Obesity in Children and the Difference Between Their Axillary and Rectal Temperatures." The purpose of this study is to add information to what is known about the factors which affect the relationship between the rectal and axillary (underarm) temperatures.

I understand that this morning, here in the clinic, my child will have the size of his upper arm measured, have four skinfold thickness measurements taken with a skinfold thickness measuring tool, and have both rectal and axillary temperatures taken. His height, weight, and age will also be recorded. These measurements will be taken by experienced personnel educated in proper technique and involve minimal risk, taking about 10 minutes of time.

I understand that the information taken about my child for the study is completely confidential and will be used anonymously in the study.

The study will cost me nothing nor will I be paid for participation and I understand that the results may add to present information about body temperature in children.

I also understand that this consent form will be filed in an area designated by the Human Subjects Committee with access restricted to the principal investigator or authorized representatives of the College of Nursing. A copy of the consent form is available to me upon request.

I have read the above "Subject's Consent" and agree to it. The nature, demands, risks, and benefits of the project have been explained to me. I understand that I may ask questions and that I am free to withdraw my child from the study at any time without incurring ill will (or affecting my child's medical care).

Parent or Guardian:______________________ Date:__________

Witness:______________________ Date:__________

Researcher:______________________ Date:__________

APPENDIX B

HUMAN SUBJECTS COMMITTEE LETTER OF APPROVAL

THE UNIVERSITY OF ARIZONA
TUCSON, ARIZONA 85724
HUMAN SUBJECTS COMMITTEE
ARIZONA HEALTH SCIENCES CENTER 2305

TELEPHONE: 626-6721 OR 626-7575

26 February 1980

Ms. Glenda Jordon
2000 E. River Road
Apartment A-3
Tucson, AZ 85718

Dear Ms. Jordon:

We are in receipt of your project entitled, "The Association Between the Degree of Leanness or Obesity in Children and the Difference Between Their Axillary and Rectal Temperatures", which was submitted to the Human Subjects Committee and concur with the opinion of the Departmental Review Committee's examination and recommendation of this minimal risk project. Therefore, approval is granted effective 26 February 1980.

Approval is granted with the understanding that no changes will be made in the procedures followed or the consent form used (copies of which we have on file) without the knowledge and approval of the Human Subjects Committee and the Departmental Review Committee. Any physical or psychological harm to any subject must also be reported to each committee.

A university-wide policy requires that all signed consent forms be kept in a permanent file in the Departmental Office to assure their accessibility in the event that university officials or investigators require the information and the principal investigator is no longer on the staff or unavailable for some other reason.

Sincerely yours,

Milan Novak

Milan Novak, M.D., Ph.D.
Chairman
Human Subjects Committee

MN/jm

cc: Ada Sue Hinshaw
Departmental Review Committee

APPENDIX C

DATA COLLECTION SHEET

Child Identifying Symbol	Room Temperature	Age	Arm Circumference	Biceps Skinfold	Triceps Skinfold	Subscapular Skinfold	Anterior Axillary Skinfold	Rectal Temperature	Axillary Temperature	Height	Weight

REFERENCES

Blainey, Carol Gohrke. "Site Selection in Taking Body Temperature," American Journal of Nursing, 74:1859-1861, October, 1974.

Bray, George A., Frank L. Greenway, Mark E. Molitch, William T. Dahms, Richard L. Atkinson, and Karen Hamilton. "Use of Anthropometric Measures to Assess Weight Loss," The American Journal of Clinical Nutrition, 31:769-773, May, 1978.

Brobeck, John R., ed. Best and Taylor's Physiological Basis of Medical Practice. 9th ed. Baltimore: The Williams and Wilkins Company, 1973.

Cranston, W. I., J. Gerbrandy, and E. S. Snell. "Oral, Rectal, and Oesophageal Temperatures and Some Factors Affecting Them in Man," Journal of Physiology, 126:347-358, November, 1954.

Durnin, J. V. G. A., and J. Womersley. "Body Fat Assessed from Total Body Density and Its Estimation from Skinfold Thickness: Measurements on 481 Men and Women Aged from 16 to 72 Years," British Journal of Nutrition, 32:77-97, July, 1974.

Dyer, Elaine D., and Howard K. Bagnell. "Local Tissue and General Temperature Changes in Dogs Produced by Temperature Applications," Nursing Research, 19: 37-41, January-February, 1970.

Eichna, Ludwig W., Adolph R. Berger, Bertha Rader, and William H. Becker. "Comparison of Intracardiac and Intravascular Temperatures with Rectal Temperatures in Man," Journal of Clinical Investigation, 30:353-359, April, 1951.

Eoff, Mary Jo Fike, Robert S. Meier, and Carol Miller. "Temperature Measurement in Infants," Nursing Research, 23:457-460, November-December, 1974.

Fonkalsrud, Eric W., and H. William Clatworthy. "Accidental Perforation of the Colon and Rectum in Newborn Infants," The New England Journal of Medicine, 272: 1097-1100, May, 1965.

Freud, Anna. "The Role of Bodily Illness in the Mental Life of Children," The Psychoanalytic Study of the Child, 7:69-81, 1952.

Graas, Suzanne. "Thermometer Sites and Oxygen," American Journal of Nursing, 74:1862-1863, October, 1974.

Greenbaum, Edward I., Merle Carson, William N. Kincannon, and Bernard O'Loughlin. "Rectal Thermometer-Induced Pneumoperitoneum in the Newborn," Pediatrics, 44: 539-542, October, 1969.

Gurney, J. Michael. "Field Experience in Abeokuta, Nigeria," Journal of Tropical Pediatrics, 15:225-232, December, 1969.

Gurney, J. Michael, and Derrick B. Jelliffe. "Arm Anthropometry in Nutritional Assessment: Nomogram for Rapid Calculation of Muscle Circumference and Cross-Sectional Muscle and Fat Areas," The American Journal of Clinical Nutrition, 26:912-915, September, 1973.

Guyton, Arthur C. Textbook of Medical Physiology. 4th ed. Philadelphia, London, Toronto: W. B. Saunders Company, 1971.

Harrison, Gail. Associate Professor, Department of Family and Community Medicine, The University of Arizona Health Sciences Center, personal communication, 1979.

Hey, Edmund. "Keeping Babies Warm," Nursing Mirror, 139: 62-64, July, 1974.

Jelliffe, D. B., and Patricia Jelliffe. "Prevalence of Protein-Calorie Malnutrition in Haitian Preschool Children," American Journal of Public Health, 50: 1355-1366, September, 1960.

Kroska, Rita A. "Comparative Appraisal of Bone, Fat, and Muscle Development of Minnesota White and Indian School Children," Journal of the Minnesota Academy of Science, 35(1):51-56, 1968.

Lindner, Peter, and Daisy Lindner. How to Assess Degrees of Fatness, a Working Manual. Cambridge, Maryland: Cambridge Scientific Industries, 1973.

Loudon, I. S. "On Taking the Temperature in the Mouth and the Axilla," The Lancet, 2:233-235, July-August, 1957.

McCaffery, Margo. "Children's Responses to Rectal Temperatures: An Exploratory Study," Nursing Research, 20: 32-45, January-February, 1971.

McFie, John, and Hebe F. Welbourn. "Effect of Malnutrition in Infancy on the Development of Bone, Muscle, and Fat," Journal of Nutrition, 76:97-105, February, 1962.

Nichols, Glennadee A., Margaret M. Ruskin, Beverly A. Glor, and Willie H. Kelly. "Oral, Axillary, and Rectal Temperature Determinations and Relationships," Nursing Research, 15:307-310, Fall, 1966.

Sellars, Jacqueline H., and Ann E. Yoder. "A Comparative Study of Temperature Readings," Nursing Research, 10:43-45, Winter, 1961.

Selle, W. A. Body Temperature: Its Changes with Environment, Disease, and Therapy. Springfield, Illinois: Charles C. Thomas, 1952.

Sims-Williams, Alice J. "Temperature Taking with Glass Thermometers: a Review," Journal of Advanced Nursing, 1:481-493, November, 1976.

Smiddy, F. G., and E. A. Benson. "Rectal Perforation by Thermometer," Lancet, 2:805-806, Ocrober, 1969.

Sutton, Helen A., Eugene I. Falstein, and Ilse Judas. "Emotional Reactions to Medical Procedures and Illnesses in a Hospital Child Psychiatry Unit," American Journal of Ortho Psychiatry, 28:180-187, January, 1958.

Torrance, Jane T. "Temperature Readings of Premature Infants," Nursing Research, 17:312-320, July-August, 1968.

Vargas, Margaret. Research Assistant, Department of Family and Community Medicine, The University of Arizona Health Sciences Center, personal communication, 1979.

Wilmore, Robert N., Robert N. Girandola, and Dorothy L. Moody. "Validity of Skinfold and Girth Assessment for Predicting Alterations in Body Composition," Journal of Applied Physiology, 29(3):313-317, September, 1970.

Wolfson, Justin J. "Rectal Perforation in Infant by Thermometer," American Journal of Diseases of Children, 3:197-200, February, 1966.

Womersley, J., and J. V. G. A. Durnin. "An Experimental Study on Variability of Measurements of Skinfold Thickness on Young Adults," Human Biology, 45(2): 281-292, May, 1973.

Woodman, Ellen A., Susan McConnell Parry, and Lillian Simms. "Sources of Unreliability in Oral Temperatures," Nursing Research, 16:276-279, Summer, 1967.