The Normal Foot

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The term “normal foot” has many different interpretations. This article reviews some of the ways in which the word “normal” has been used historically to describe the foot. Also discussed are the problems of attempting to determine what should constitute a normal foot and proposed criteria for distinguishing between the normal and the pathological. (J Am Podiatr Med Assoc 90(7): 342-345, 2000)

“When I use a word,” Humpty Dumpty said in a rather scornful tone, “it means just what I choose it to mean—neither more nor less.”
—Lewis Carroll, Through the Looking Glass

The term “normal foot” has been used in as many different contexts as there are people who have written about it. To each person, the term has a different meaning. This article will address what the word means to different people. It will also consider some ways of approaching the discussion about the meaning of “normal” so as to try to bring many opposing views closer together.

The quest for the “normal” has always pervaded every aspect of life. “Abnormal” has always been viewed as an undesirable state, implying the presence of a defect or deformity. One definition of the word “normal” is “conforming with, adhering to, or constituting a standard.”¹ No matter how it is used, “normal” is always a comparison word. Its precise meaning is determined by what the comparison is. A comparison between normal and abnormal can be seen in an example from ancient biblical times: When Jacob was 130 years old, he stood before Pharaoh and said:

The days of the years of my pilgrimage are a hundred and thirty years: few and evil have the days of the years of my life been, and have not attained unto the days of the years of the life of my fathers in the days of their pilgrimage. (Genesis 47:9)

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If one considered it normal to live more than 130 years, it would mean that nearly everyone who has lived in the past two millennia has lived an abnormally short life.

Comparatively little medical literature pertaining to what should be considered the normal foot exists before the nineteenth century. Some of the oldest arguments about what people thought of the foot go back to modern interpretations of ancient art and sculpture. Hoffman² noted that in classic sculpture, the toes pointed straight ahead and no foot deformities were seen. He also noted that few, if any, toe deformities occur in those who wear sandals or no shoes at all. The low incidence of digital deformities in non–shoe-wearing populations has also been noted by many others³⁻⁵; as a result, many theorists have concluded that shoes indeed create most of the problems in the feet.

This author recently visited a nationally recognized gallery, with the purpose of observing the feet in some of the paintings of the great masters. What was observed was that some of the classic artists of the Renaissance period painted very nice-looking feet and some painted feet with hammer toe and bunion deformities. Few if any of the classic artists showed much variation in the type of feet he painted, although there was significant variation among artists. Since it is often assumed that classic artists painted what they observed, one may conclude that for some artists, a foot with hammer toes and bunions might have represented the average foot. Did these artists consider such a foot normal or abnormal? The answer will probably never be known.

In 1888, Royal Whitman⁶ observed:

I am inclined to think that the frequency of troubles caused by overstraining the arch of the foot is not appreciated, and that the condition is not generally
recognized, because nearly every patient whom I have treated for this affection, many of whom presented the typical appearances of flat-foot, sometimes to an extreme degree, were taking, or had taken for long periods, internal remedies on the supposition that the symptoms were caused by rheumatism.

He then further described the symptoms of a flat foot as

pain especially after long standing or walking, most often about the inside of the ankle; pain sometimes shooting up the inside of the leg or the outside of the ankle; pain in the ball of the foot, the heel or middle of the sole; [the] foot seems heavy and to have lost its spring; stiffness in the foot after sitting for any length of time or on rising in the morning.

He also observed that

the symptoms, too, do not at all correspond with the degree of the deformity. Many persons with complete flat-foot have no trouble, while others who are practically disabled by it show but a slight flattening of the arch.

Since Whitman’s observations, many additional opinions about the correspondence of symptoms with flat foot have been expressed. Lovett and Cotton10 noted,

up to a certain limit, which has not been correctly determined, [pronation of the foot] occurs in the normal foot; beyond this limit it must be regarded as pathological, and is likely to be attended by symptoms of pain and disability.

They concluded that

occurrence of symptoms seems to depend essentially on the reaction to overstrain of ligaments and muscles, and is apparently the result of a degree of pronation such as to bring the burden of support . . . on the ligaments. The necessary degree of pronation varies widely, and would seem to be indicated not so much by the absolute degree of pronation as by the disappearance of the reserve of pronation.

Since then, many other authors and researchers have expressed their opinions on what constitutes the normal arch. Many have noted that fallen arches do not necessarily look flat. After observing the feet of those who habitually wore shoes and those who did not, Hoffman11 concluded that

there is no one type of arch [that can be considered] normal . . . the height and shape of the longitudinal arch are of no value in estimating the strength or usefulness of the foot . . . Normal feet present high, medium and low arches in nearly the same proportions as do feet with weakened arches . . .

weakness of the longitudinal arch rarely results in its depression . . . [and] symptoms . . . are dependent . . . not upon [the arch’s] lowness, except insofar as this lowness is a transition from an original higher condition with concomitant change in the relationship of the tarsal bone.

Anopol12 also noted an inability to correlate the height of the arch with the symptoms that people suffered from. He wrote, “Many weak feet have arches that appear within normal limits as to height. And many are too high.” Blundell Bankart13 also noted that measurement of the height of the arch is not dependent on the development of symptoms and therefore concluded,

People do not suffer from flat foot, but from inability to flatten their feet. With few exceptions, the completely flat foot is painless—because it meets with no resistance and there cannot be strain without resistance.

Henderson14 made a similar statement:

The arch is so often the cause of complaint that the term “fallen arches” has come to be used by the laity for all kinds of foot troubles. There may be no visible lowering of the arch and still a very painful foot exists.

If no correlation can be made between arch height and symptoms, how should the normal foot be defined? Root et al15 defined it as

a set of circumstances whereby the foot will function in a manner which will not create adverse physical or emotional response in the individual. This . . . applies when the lower extremity is used in an average manner and in an average environment, as dictated by the needs of society at the moment.

This is probably one of the broadest definitions that can be applied. It says nothing about what the height of the arch should be, nor does it give any other idea about what any specific anthropologic measurements or morphologies should be. Its wording also allows for a great deal of flexibility and can be almost universally adapted.

Using the Root definition of normal, this author’s first conclusion is that we cannot define “normal” without knowing the needs of society. Do the needs of society demand that a person be able to climb trees, or do they demand that a person be able to stand all day on a concrete floor? Do they demand that a person be able to walk a few city blocks or that a person be able to walk 10 to 12 miles per day? Do they demand that a person wear sandals, or that a person wear a high-heeled shoe? Normal can be defined only in terms of what demands are placed on a
person by a society: the type and amount of work and play demanded of that person, the type of surfaces the society provides the individual to work and play on, and the type of shoe that society demands that a person wear. As can be seen, all of these demands are based on variables that are economically, socially, and emotionally driven. Almost none of the demands are based on the physical capacities of the individuals in that society.

Once the needs of the society are known, the next thing that must be known before one can define “normal” is what constitutes adverse physical or emotional response. This varies widely and is different for each individual. The amount of physical or emotional stress needed to create “pain” is so variable that science still has not arrived at a good definition of “pain.” Certainly, the threshold of pain is different for each person. That alone would be enough to establish the concept of a “normal foot” as being different for each person. If the emotional needs of the person demand that he or she be able to run 100 miles per week, then who can say that the normal foot is not one that can withstand the stress of running that far? If the emotional needs of the person require that the toes look straight in sandals, who can say that a slightly bent toe is not abnormal? On the other hand, if a person is able to perform any activity that his or her psyche desires over a lifetime with no emotional or physical suffering, then no matter how crooked the foot is, who is to say that that foot is not normal?

In today’s statistically minded world, the word “normal” is often used as a synonym for “average.” A common method of finding a normal foot parameter—such as the normal arch height, the normal resting calcaneal position, the normal rearfoot varus—is to examine a group of young asymptomatic adults and find the statistical average for whatever morphologic variable is being analyzed. A standard deviation from the average is determined, followed by a statement that anyone who falls within 2 standard deviations is considered normal. Seldom do studies analyze the feet of 80-year-old individuals who claim never to have had any foot problems. Seldom do studies attempt to measure the specific parameter in which they are interested in feet that are similar in other parameters. Seldom do studies compare the average parameters of people with a certain symptom and a matched set of people without the symptom. Researchers who have done so have often found tremendous overlap between the symptomatic and asymptomatic groups, sometimes to the point that it becomes very difficult to sort out the symptomatic and asymptomatic groups based on the parameter or parameters being measured.16-18

If foot-care specialists were to accept the idea that the normal foot is the average foot plus or minus 2 standard deviations, then only 5% of people should have foot problems. Indeed, the studies previously referenced have indicated that this may be about the number of people in nonshod populations who are suffering. However, it is evident that foot problems affect much more than 5% of the US population. A large study of self-reported foot problems found that 40% of Americans reported having some type of problem.19 Some researchers may propose that wearing shoes has created the problem, but once again, those who make this claim should note that one criterion of normal is what society demands. To propose a solution that is against societal demands is naive and arrogant. Foot norms can be established only within the confines of other societal norms.

As has been noted for the last 100 years, foot problems vary from person to person. Arches of the same height will function normally in one person and as a weakened structure in another. It is evident that foot norms in a specific society must be based on a wide variety of parameters, not just a few. While Root and colleagues tried, in their book, to discuss the number of parameters to consider, it appears that they did not fully discuss all of the possible parameters in the foot or consider all the varieties of foot types. For this reason, many have tried to discard the Root hypotheses and return to other theories that have as many flaws, if not more.20

Criteria for Defining the “Normal Foot”

So what is the answer to the question of how to define the “normal foot”? For those who need a definition, this author would propose the following:

1) The normal foot should be defined in terms of societal demands, not according to any artificial demands by any one person or group of people. For example, the wearing of shoes is not optional in many societies.

2) The normal foot should be defined as one that creates no adverse effects over a normal lifetime. If the average for people who have lived less than half an average lifetime with no adverse effects is accepted as normal, we will inevitably end up with a distorted perspective and overly broad definitions of normal.

3) Researchers should be very careful about making giant leaps of faith in extrapolating their findings to the population. A classic example of this was the finding in one study of orthoses exacerbating bunion deformities in children.21 The researchers failed to examine and critique their own methodology before making sweeping conclusions about the appropriate
use of such devices. All researchers should be humble and recognize that the perfect research project has yet to be performed.

4) Research must consider all aspects of the foot’s function before taking a stand on one variable. For example, the claim that a pronated foot is a stable foot that can be a rigid lever may be true.\textsuperscript{22, 23} Such a statement, however, is not consistent with facts about the need for supination of the arch in order for the toes to dorsiflex during propulsion.\textsuperscript{24, 25}

5) All theories about what is normal must fit with known principles of mechanics. If they do not, then the theorist must explain why.

6) All theories about what is normal should be built for the lowest common denominator: that is, they should be based on the maximal stress that society may place on that person.

7) Theories about what is normal should try to optimize the sharing of stress by all elements. A theory may explain how to minimize stress on one portion of the foot, but that solution may maximize stress on another portion of the foot.

8) A theory explaining the normal positions and movements for any one individual should be applicable to all shapes and sizes of feet.

9) A universal theory of foot function should include both the static and the dynamic functions of the foot.

10) A theory of foot function should be based on a full understanding of the individual components of the foot, with the result that the sum of the components will equal the final outcomes. It is almost impossible for a final outcome to be measured and therapy to be directed to this final outcome without an understanding of the individual components. Such an attempt will only exacerbate the problems currently encountered in differentiating the normal from the abnormal. Such things as bunions and arch heights should be considered outcomes, not components.

11) Finally, care should be taken before criticizing the work of clinicians who are making honest attempts to fix the abnormal. As noted above, many definitions and criteria exist for the term “normal.” People consult clinicians about conditions they view as abnormal. In making decisions about treatment options, clinicians must use the best research as well as their own experience and judgment and must also consider the goals of the patient. Most of the time, clinicians do not have the luxury of sitting on the sidelines, waiting for additional research to be performed, before making treatment decisions. Therefore, great tolerance and latitude must be provided in areas where differences of opinion still have room to exist.

References