LESSONS FROM HISTORY

Excerpts from: **THE PHYSIOLOGY OF CHANNEL SWIMMERS***

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This paper presents the results of three years' study of some of the factors concerned in the ability to endure immersion in cold water. People showing unusual tolerance of cold have been compared with people showing unusual intolerance.

In 1951 there was a swimming-race across the English Channel in which eighteen of twenty competitors swam from France to England in times ranging from 12 to 20 hours in water at 15.5°C (60°F). This is of great interest because records of shipwreck survivors show that persons immersed in the sea at 60°F usually live only about 5 hours, and seldom more than 6 hours, death being due to hypothermia (Molnar 1946).

The swimmers in the 1951 race all conformed to a certain physical type, very different from that of athletes who cover long distances on land by running, cycling, skiing, or mountain climbing. Some of the swimmers were frankly obese; others were of stocky build and had well-rounded contours concealing the muscular pattern.

Discussion

Partial answers can now be given to the questions asked in the introduction.

Do Channel swimmers tolerate hypothermia better than others? The answer appears to be yes, because the level of rectal temperature measured in two of the cross-Channel swimmers was as low as in G.P. when he was forced to give up swimming in Lake Windermere. It seems unlikely that this tolerance of hypothermia is an important part of the ability to withstand cold. J.Z. could maintain his body-temperature for very long periods when G.P. could not, and it can be suggested that the rectal temperature falls only when the swimmer is becoming fatigued and his expenditure of energy decreases.

The muscular weakness experienced by G.P. when his

rectal temperature fell to 34.5°C (94.1°F) was quite distinct from cramp or fatigue; this phenomenon needs further study.

Is the heat production of Channel swimmers exceptionally high, enabling them to maintain heat balance even in cold water? J.Z., in short practice swims, had an energy expenditure of 350–400 calories per square metre an hour. On longer swims, when the stroke-rate fell, the energy expenditure was possibly about 310–350 calories per square metre an hour. . . . Glaser (1950) reports a value of 365 calories per square metre an hour for “moderately hard swimming” (expired air was collected in a Douglas bag during swimming).

Karpovich and Millman (1944) studied in many subjects the energy expenditure during sprint swimming. They collected the expired air after the subject had swum a distance of 60–120 ft. holding his breath. Very high calorie values were obtained, up to 80 calories a minute. The manner of measuring and the nature of the sprints make it difficult to compare the results with those obtained in the present study, where the swimmers were in a stable state. However, swimming the breast stroke at 1.7 m.p.h. cost 18 calories a minute, which is a little more than the calorie expenditure of J.Z. swimming slightly faster. It is clear that J.Z.'s energy expenditure during swimming is not exceptionally high. If, in this respect, J.Z. is typical of Channel swimmers, the answer to the second question is in the negative. What is remarkable, however, is the total energy expenditure of a Channel swimmer. The time spent in crossing the Channel is 12–20 hours, and the rate of stroke is maintained approximately constant throughout. In the case of J.Z. this means an energy expenditure probably averaging 750 calories an hour—i.e., a total expenditure of 9000–15,000 calories. This makes Channel swimming possibly the greatest feat of endurance in the world of sport.

An important aspect of heat production during swimming concerns the advice to be given to those in danger of shipwreck. Glaser (1950) wrote:

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“Fit men, who are in danger of immersion in cold water, might be advised to swim or struggle as hard as they can for as long as they can. If they try to preserve their strength by clinging to wreckage or floating on their lifebelts, they will die from cold. Perhaps more lives would have been saved in the past if this had been understood.”

The present results do not support this statement. In the case of J.Z. the rate of body-cooling was very low when he lay motionless in a cold bath, and virtually nil while he was swimming. He would probably do equally motionless or swimming. G.P., on the other hand, cooled more rapidly while swimming than while lying still, and he would almost certainly survive longer if he refrained from swimming or struggling.

This finding was confirmed in the other thin subject studied. O.G.E. had a slight fall of rectal temperature in the bath but not when swimming. The water-temperature was relatively high (21.8°C, 71.2°F), and the increase in heat production due to shivering in the water was small compared with the heat production of swimming. The traditional naval advice to cling to wreckage and not to waste energy by swimming is probably correct.

Do Channel swimmers lose heat less rapidly because of their physique? The spreading of grease over the body is common among long-distance swimmers and is relevant to this question. J.Z. used about 2 kg. of lanolin before the Lake Windermere swim. If it is assumed that all the lanolin was spread evenly over the whole body, the thickness of the layer can be calculated as follows:

Surface area of J.Z. = 2.04 sq. m.—i.e., 20,400 sq. cm.

Lanolin = 2000 g. of sp. gr. 0.97

Vol. of lanolin = $\frac{2000}{0.97} = 2060$ ml.

Therefore on each sq. cm. there will be 2060/20,400 of lanolin, about 0.1 ml., giving a thickness of 1 mm.

Larger quantities than 2 kg. (4.4 lb.) were used by some, up to 8 lb. (i.e., about 4000 ml.); so the average thickness in that case could have been up to 2 mm. Even

then the increased insulation due to applied grease would be small, but it might have other useful effects, such as reduction of friction.

Perhaps the most important and certainly the clearest answer was obtained to the question of whether the heat loss in Channel swimmers was diminished owing to their body build. All the Channel swimmers were fat and many of them grossly fat. The increased insulation and the decreased rate of heat loss appear to be the chief factors enabling Channel swimmers to maintain body-temperature in cold water for a long time. Other factors, such as the length and volume of the limbs in relation to the trunk, were also considered. A man with short limbs and a large trunk would cool less quickly than a man of the same surface area but with long slender limbs and a small trunk. Calculations based on measurements on J.Z. and G.P. suggested, however, that only a minor part of J.Z.'s advantage could be explained by this difference. The important factor seemed to be tissue insulation.

This conclusion is similar to that of Scholander et al. (1950), who found no evidence of any difference in the body-temperature of Arctic animals compared with those in temperate or tropical zones, nor any difference in the resting metabolic rate. There was, however, a very large difference in the insulation, due to fur in land animals and to blubber in the water mammals—e.g., seals.

These findings regarding Channel swimmers were admirably summarized by Dr. Sabri when he said: “To be fat is good.”

References

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