**////Title: Avoiding Injury from Hot Food by Determining the Threshold Contact Temperature**

**////Stand-first**:

Consuming very hot food and beverages poses a risk of oesophageal cancer. Although injury thresholds have been specified in industry standards and guidelines, there remain practical limitations in obtaining an exact measurement of the contact temperature from hot foodstuff in the oral mucosa inside the mouth. Dr Dirk Lachenmeier, a chemist and toxicologist at the Chemical and Veterinary Investigation Agency Karlsruhe, worked in collaboration with his father Dr Walter Lachenmeier, a retired engineer, to develop a new method to estimate the safe surface or consumption temperature of hot food. This has allowed them to make important recommendations.

**////Body text:**

The oesophagus is a muscular tube that connects the mouth to the stomach. To help avoid burning this delicate yet critical component of the digestive system, food portions that are too hot are moved inside the mouth and cooled by the flow of breathing air, only reaching the oesophagus once they have sufficiently cooled.

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Unfortunately, the consumption of very hot drinks may cause cancer of the oesophagus in humans. Although treatment for this form of cancer has improved considerably, survival rates are still low. Based on findings from animal studies, the World Health Organization’s International Agency for Research on Cancer suggested temperatures of less than 65 ◦C for hot beverages to minimise this risk.

However, the associated risks of consuming very hot solid food are less clear cut. Upon contact with hot food, several factors impact the risk of injury, including the contact temperature between the food and body part, the duration of contact, the material, and the surface affected.

It is not feasible to directly measure contact temperature but the researchers have developed a novel approach for its estimation. Their approach is a numerical simulation method based on the physics of heat transfer that can be used to investigate for what period of time a constant temperature is to be expected when eating hot food.

Simulation results for hot solid food show that a constant contact temperature exists for about 10 seconds. The research team determined sample temperatures perceived as tolerable for a well-defined, limited time upon contact with the tongue. The threshold temperatures they obtained (which vary depending on the sample size and the texture of the food), will serve as the input values for the mathematical model that extrapolates the consumption temperatures of any solid food with known substance characteristics. In doing so, this method allows researchers to calculate the optimal serving temperatures of hot food based on the contact temperature.

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In planning their investigations, the researchers took into account that food is only ingested in small portions in the mouth, which quickly cool down due to the heat exchange with breathing air. The temperature of hot food in contact with the oral mucosa remains constant for a limited period. After only a few seconds, the contact temperature drops very quickly because heat is also released from the hot medium into the environment during contact and is dissipated through the film of saliva and the oral mucosa.

Previous attempts by other researchers to directly calculate contact temperature consisted of a device made of silicone rubber with similar thermal properties to human skin, but the suitability of this for measuring the contact temperature of small samples of food under oral conditions has not yet been demonstrated and for various reasons, remains questionable.

Dirk and Walter Lachenmeier developed a sensory technique that uses two parameters for the estimation of the contact temperature via a heat transfer model. The first of the two parameters is the temperature perceived as ‘tolerable’ for any period of time greater than 10 seconds. The second parameter is the threshold temperature, which is perceived as ‘barely bearable’ for limited times of three to ten seconds.

To test the effectiveness of their model, a ‘measuring spoon’ equipped with thermocouples holding a circular PVC sample was developed, which is placed on the tongue of volunteers. During the experiments, the contact temperature of the PVC sample was increased in steps of 1 ⁰C. Other materials tested included cooked potatoes and water. The results of the study were published in 2018.

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Small food samples, such as cooked potatoes in contact with the tongue, resulted in constant contact temperatures of up to 10 seconds before cooling depending on their thickness. Potatoes were chosen because the samples are easy to produce and also retain their molecular structure when heated. Other samples, such as cheese or gelatine were not suitable, since they melt when heated.

This characteristic of melting when heated has a big influence on the duration of the contact temperature. Hot beverages, for example, spread as a thin film, increasing both the contact surface area and the rate of cooling, resulting in higher tolerable temperatures than solid food. The researchers determined the contact temperature of 46.5 ◦C to be comfortable for any period greater than 10 seconds and about 48 ◦C for periods of less than 10 seconds.

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These pilot results demonstrate that the developed procedure is practicable and ready to be validated with larger cohorts of volunteers. Critically, this work has shown that once the contact temperature is defined as a threshold value, the safe surface or consumption temperature for any other food can be calculated, thanks to the mathematical equation that takes into account the physical characteristics of the food samples.

It should be noted that regular consumption of very hot food can lead to a reduction of pain and this should be considered in further investigations. Nonetheless, the researchers are able to recommend that the consumption temperature of food with high water content, such as potatoes, should not exceed 60 ◦C. They further suggest that in addition to the existing minimum serving temperatures to avoid microbiological risks, typically 65 ◦C, the introduction of maximum temperatures should be considered to help reduce the risk of injury to the mouth and oesophagus from burns.

This SciPod is a summary of the paper ‘[Injury Threshold of Oral Contact with Hot Foods and Method for Its Sensory Evaluation](https://www.mdpi.com/2313-576X/4/3/38)’ published in the journal Safety. DOI: <https://doi.org/10.3390/safety4030038>

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