Digital Thermometers: Its Types, Utilities, and Global Trade Prospects for India

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Abstract: Digital thermometer, a developed product from the mercury based aged Clinical thermometer is an apparent device used to sensitize the body temperature with six different latest types of innovation. These are used not only to detect body temperatures of human but also used in animal medicines and industries to check the boiling points. As the world is inching towards alien era, the infusing these thermometers with mobile apps and clouding the data is not a wonder. Understanding the raise of influenzas across the globe triggered biomedical companies to win early global demands and record their presence in global markets. India is also a great player in international demand and supply of biomedical instruments and devices. Government of India, assigned Indian Trade Clarification Harmonized System for digital thermometer. The 8-digit Code allotted is 90251910. This article focuses on the different types of digital thermometer, its utilities and the Indian trade analysis with select countries data.

Key words: Digital thermometer, Resistance Temperature Detector, Portable Electronic Thermometers, Oral Thermometer, Tympanic Thermometer, Forehead Thermometer, App-based thermometer and Pacifier Thermometer.

1. Introduction

“Change is the only constant,” as Heraclitus said, and the global medical industry is primed for dramatic change in medical devices and appliances. Yes, clinical thermometers inspired the invention of digital thermometers. Temperature-sensing instruments with permanent probes and a convenient digital monitor are known as digital thermometers. The type of sensor used in a digital thermometer decides how well it operates. Resistance Temperature Detector (RTD), Thermocouple, and Thermistor are examples of sensor forms. A digital thermometer is used to check that a smart temperature transmitter is operating properly under flowing conditions and that the smart temperature transmitter has been properly calibrated. PETs are small electronic thermometers that use a thermistor or RTD probe to calculate temperature in an RTD-type thermowell.

1.1 Types of Digital Thermometer:

There are six different types of thermometers other than the Clinical Thermometer. They are (1) Digital thermometer: Digital thermometers work by using heat sensors that determine body temperature. They can be used to take temperature readings in the mouth, rectum, or armpit. (2) Oral thermometer: Oral temperature can be taken by either a digital or mercury thermometer. Oral thermometers are most accurate in children over three and in adults.
Digital ear (tympanic) thermometer: Tympanic thermometers measure the temperature inside the ear canal through infrared ray technology. These provide fast and accurate readings and may be preferable to oral or rectal thermometers, especially in children. **(4) Forehead (temporal) thermometer:** The temperature of the superficial temporal artery, a branch of the carotid artery, is measured by forehead thermometers using infrared sensors. Non-contact infrared thermometers are a type of non-contact infrared thermometer. The use of forehead thermometers that do not require physical contact has grown in popularity in places like airports, supermarkets, and stadiums. **(5) App-based thermometer:** Most free phone apps designed to take temperature readings are meant for recording the temperature of environments, not people. Phone apps that help with taking people’s temperatures rely on digital thermometers that link back to the app via Bluetooth connection. **(6) Pacifier thermometer:** The Pacifier Thermometer is a pacifier that has an early-warning system built in. It changes colour from blue, which indicates a normal temperature, to red, which indicates a fever, to let you know when your baby is getting a fever.

2. Review of Literature:

Temperature measurement techniques should be safe, simple to use, non-invasive, cost-effective, and fast, and they should accurately represent core body temperature (Chiappini et Al, 2009 and Paes BF et Al, 2010). Traditionally, older children and adults had their body temperatures taken orally, while babies and young children had theirs taken rectally. Rectal scale, which is the gold standard in young children (Paes BF et al, 2010), is precise and effective in representing the body's core temperature. The treatment, however, is invasive and not well received by both children and parents. As a result, new measurement methods are needed (Chiappini et Al, 2009 and Richardson M et Al, 2007). Axillary measurement is highly reliable in babies younger than 4 weeks (2,4). However, this approach demonstrated variable sensitivity in older children and adults, despite being simple to use and generally well tolerated. Furthermore, considering the fact that an axillary reading is normally 0.5°C lower than a rectal reading, an exact conversion factor cannot be calculated (Chiappini et Al, 2009). Infrared thermometer measurements of tympanic pressure have also been investigated, with mixed results (Craig J V et al, 2002). Based on their study, Naylor et al (2012) found that both tympanic and forehead thermometers measured lower temperatures than readings from rectal thermometers, which often underestimate the body's core temperature. Despite the fact that both devices had high specificity and positive predictive values, their sensitivity was low, and their negative predictive values were weak. The forehead thermometer displayed obvious inconsistency, with a range of almost 3°C between the limits of agreement. While the tympanic thermometer had a marginally better agreement, its range of nearly 2°C was clinically in apprising. Furthermore, the current findings suggest that forehead measurements are sensitive to the use of a radiant warmer, explaining at least part of their lack of precision and supporting the conclusion that these instruments are not ideal for use in a private paediatric practice (Naylor et Al, 2012). In his study, Mohammed Fadzil (2010) discovered that the optical thermometer has the best agreement with the mercury in glass thermometer. For the uncooperative patient, the infrared tympanic thermometer might be preferable, and the liquid crystal forehead thermometer is better used at home, he added. Roberta Areas (2006) compared human body temperature rhythmic parameters calculated with digital thermometers and thermistors with memory. They suggested that the use of a thermistor with memory in the
wrist can be used as an alternative methodology to studies of human body temperature rhythmicity, particularly for long temporal sequence, based on their data. Ricardo Villamarin et al. (2013) looked at and evaluated the use of over-the-counter sales data to predict influenza H1N1 incidence. Miller et al. used data from smartphone-connected thermometers to reliably predict real-time influenza activity at a national level in their study (Miller AC et. al, 2018). According to related studies, such "smart thermometers" can be used to predict influenza activity in China (Hswen Y et. al, 2017). These instruments have been shown to capture specific features of disease such as biphasic fever patterns, transmission events, illness length, and diurnal temperature patterns, in comparison to previous alternative indicators of disease activity (Miller AC et al, 2018).

In the early 1990s, ear thermometers were introduced in Japan as a medical specialist's instrument. It was officially approved as a medical device for general use in 1996, and it went on the market. The number of ear thermometers produced and sold in Japan increased rapidly, reaching about one million per year in just a few years. The manufacturers had high hopes for this new innovative product that appeared in the clinical thermometer market that had matured since the development of clinical electronic thermometer about a quarter of a century ago, owing to the fact that new ear thermometer fulfilled used demands and that the manufacturers had high hopes for this new innovative product that appeared in the clinical thermometer market that had matured since the development of clinical electronic thermometer about a quarter of a century ago (JMIR, 199).

When the Severe Acute Respiratory Syndrome (SARS) outbreak hit Asia in 2003, the research's standard facility for ear thermometer calibration was given to national standard institutions in Asian countries, which helped to prevent the spread of infection (Nikkei Business Daily, 2003). The signal is amplified to achieve minimum Limits of Detection (LOD) and Limits of Quantification (LOQ).

3. Research Methods:

The object behind this article is to analyze the trade prospects of various digital thermometers in India perspective. Secondary data was used in this research article. Statistics like Simple Percentage and Ranking was performed to analyze the data using Tableau. The results were diagrammatically represented using Tableau.

4. Analysis and Interpretation

Table 1 depicts the Percentage of total export broken down by country, population and year is shown in the table. Upon analysing the last 5 year data, India’s digital thermometer exports to Canada (with a total population of 37,589,260) were high during 2017-2018 with 26.95 percent. India’s exports to 57 million populated Singapore recorded 97.46 percent during 2019 to 2020. During 2020-2021 India’s digital thermometer export to Singapore was 77.84 percent. This shows Singapore imported a greater number of digital thermometers during covid-19 from India. Interestingly India exported more digital thermometer before covid-2019 to United States i.e., during 2015 -16 with 85.64 %, 2016-2017 with 76.48%, and in 2017-2018 with 62.66%. There is steady decrease with the exports to USA.
Table 1: Country-wise and Year-wise Percentage of Total Digital Thermometer Exports made by India with respect to countries population from the year 2015 to 2021

| Year       | CANADA | ITALY | KENYA | RUSSIA | SINGAPORE | TANZANIA | UNITED ARAB | UNITED STATES |
|------------|--------|-------|-------|--------|-----------|----------|-------------|---------------|
| 2015-2016  | 4.03%  | 0.06% | 9.30% | 0.09%  | 0.88%     | 5.55%    | 85.64%      |               |
| 2016-2017  | 26.9%  | 0.19% | 15.72%| 0.09%  | 1.87%     | 5.39%    | 76.48%      |               |
| 2017-2018  | 26.9%  | 0.09% | 5.09% | 0.09%  | 0.53%     | 4.19%    | 62.66%      |               |
| 2018-2019  | 0.0%   | 0.09% | 3.06% | 0.09%  | 35.71%    | 47.68%   | 2.70%       |               |
| 2019-2020  | 0.0%   | 0.09% | 0.59% | 0.09%  | 97.46%    | 1.71%    | 0.07%       |               |
| 2020-2021  | 2.59%  | 0.06% | 0.16% | 0.01%  | 77.64%    | 0.28%    | 8.62%       | 10.44%        |

Source: Computed from the data published in dgft.gov.in

Table 2 & Figure 1: Country wise Ranking of Indian Exports of Digital Thermometers

A ranking is a relationship between a group of items in which the first item is either "ranked higher than," "ranked lower than," or "ranked equal to" the second. The rankings are in no particular order. Rankings make it possible to evaluate complex knowledge according to certain criteria by reducing complicated steps to a series of ordinal numbers. From Table 2, it is clearly seen that countries like Singapore during the years 2019-2020 & 2020-2021, Tanzania in the year 2018-2019 and United States during the periods 2015-2016, 2016-2017 and 2017-2018 stands first among India’s exporting nations. It was closely followed by Canada in the year 2017-2018, Kenya in the year 2015-2016 and 2016-2017, Tanzania in the year 2019-2020 and United states in the year 2018 -2019 and 2020-2021 and these countries attain rank 2 in India’s export of Digital Thermometer. Canada in the year 2015-2016, Kenya in the year 2017 -2018 & 2019-2021 and Singapore in the year 2018-2019, United Arab Emirates during the periods 2016-2017 and 2020-2021 attained third position among world digital thermometer buyers from India. Surprisingly, our natural friend nation, Russia was ranked 8th during the year 2015-2016 in India’s digital thermometer exports.
Figure 2: Countries with population and their Digital Thermometer Imports from India

Source: Computed from the Secondary data

Figure 3: Percentage of total import and population

Table 3 and Figure 2 depict the percentage of total import towards countries total population. During the period 2015-2016, India’s import of digital thermometer from China was 7.26 percent whose population is 83.82 percent with the select countries taken for analysis. India imported this device Hongkong during year 2015-16 with a 21.92 percent share and from Singapore with a share of 67.99 percent during in the year 2015-2016.
Table 3: Country-wise and Year-wise Percentage of Total Digital Thermometer Imports made by India with respect to countries population from the year 2015 to 2021

In the year 2016-2017 India’s import of digital thermometer from China exponentially grown to a 94.42 percent and with a 5.33 percent share, Singapore’s digital thermometer sales to India decreased. In the year 2017-2018, India imported 96.59 percent of digital thermometers from china and from Singapore it was as low as 2.36 percent. Other countries like Germany, Hong Kong, Japan and Taiwan recorded a low export to India with 0.01 percent, 0.59 percent, 0.38 percent and 0.07 percent respectively.

In the year 2018-2019 China played a major role in India’s import of digital thermometer with a 94.21 percent share. Singapore, Germany, Hong Kong, Japan and Taiwan yet again recorded a low import share with India with 4.46 percent, 0.06 percent, 1.08 percent, 0.02
percent, and 0.17 percent respectively. During the period 2019-2020, India’s import from China recorded a 93.80 percent followed by Singapore, Germany, Hong Kong, and Taiwan with 4.23 percent, 0.29 Percent, 1.23 percent, and 0.44 percent, respectively. During 2020-21, India’s digital thermometer import recorded 81.55 percent with China followed by Hong Kong, Singapore, and Taiwan with percentages of 16.97, 1.25 and 0.14, respectively.

5. Findings and Conclusion:

The above analysis clearly shows that India’s role in dealing with both imports and exports of digital thermometer is impeccable. India as an exporting country of digital thermometer does well with underdeveloped economies like Kenya and Tanzania. It is also seen very clearly that India’s major supplier or importing nation for digital thermometer is China followed by Chinese dominated countries like Singapore, Hong Kong, Taiwan. With the shift from clinical thermometer to digital thermometer, counting the different global epidemic, there is a potential market for digital thermometer. In this study, the statistics clearly shows that there is a sudden five times increase in the imports of digital thermometer made by India from China just a couple of years before Covid-19 pandemic leaving a raised eyebrow of suspicion.

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