

ORIGINAL ARTICLE

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Economic impact of localization policies in orthopedic implants in Türkiye: Cost and production analysis for 2014–2023 period

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Abstract

This study aims to assess the economic impact of localization policies in Türkiye by examining changes in orthopedic implant usage from 2014 to 2023. It evaluates how the shift toward domestic production affected import dependency, foreign-exchange exposure, product diversity, and healthcare sustainability. Knee and hip prostheses, intramedullary nails, screw-plate systems, and proximal femoral nails (PFN) were analyzed. Implants were classified according to origin (domestic and imported), and unit costs were compared in Turkish Lira and US Dollars between 2014 and 2023. Product diversity and trends in operational use were also examined. By 2023, domestic production of knee and hip prostheses exceeded 95%, reducing import dependency and foreign-exchange exposure. Product variety and utilization increased. Domestic implants were more cost-effective per unit than imported alternatives. However, intramedullary nails remained largely import-dependent, underscoring the need for greater domestic R&D and manufacturing. Quality improvements strengthened prospects for international competitiveness and exports. Türkiye's localization policies reduced import reliance and costs while fostering industrial growth. This experience may inform other health systems seeking strategic independence. Effective cost management amid an aging population and rising orthopedic demand highlights the broader value of such policies.

Keywords: Orthopedic implants, localization policies, health economics, import dependency, cost analysis

Introduction

Health technology assessment (HTA) helps national health systems decide how to allocate different health technologies or alternatives with limited resources [1]. No country, including developed countries, has sufficient resources to meet all the health needs of the population [2]. Resources must be used effectively to make further progress in health, meet new challenges and address inequity. To achieve this, information is needed on which interventions actually work, how much they cost, their implementation and delivery [3]. Therefore, costs and outcomes should be defined to appropriately assess the added value of new technologies. It provides an important tool for assessing the clinical and cost-effectiveness of healthcare interventions [1,4].

Orthopedic implants are medical devices used in fracture

stabilization, joint replacement and other surgical procedures in modern medical practice and constitute one of the most important cost items in the healthcare sector [5,6]. In Türkiye and worldwide, orthopedic implant costs are considered as a critical factor for the sustainability of healthcare expenditures [7]. High costs impose a great economic burden on the healthcare system, especially due to the widespread use of imported devices [8]. Localization policies implemented in Türkiye in recent years have aimed to reduce this dependency and increase domestic production.

However, the low awareness of healthcare professionals about implant costs has been emphasized in many studies. Okike et al. [9] show that orthopedic surgeons often misestimate implant costs and have limited cost awareness. In a study conducted at seven academic medical centers, only 21% of orthopedic

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specialists and 17% of residents were able to estimate the true cost within a 20% accuracy margin. Although most surgeons recognize that cost is an important factor, confidentiality clauses in contracts with medical supply providers and lack of incentives for surgeons to control costs are the main factors limiting cost awareness.

Similarly, Sorber et al. [10] reported a widespread lack of awareness of the costs of surgical supplies among surgeons, nurses and operating room technicians. In the study, it was observed that the prices of especially low-cost products were often exaggerated and the need for cost education was high. 91% of respondents expressed interest in participating in training programs to increase cost awareness. It is suggested that such education and cost transparency initiatives have the potential to reduce surgical waste and improve decision-making.

Hospital supplies, diagnostic imaging devices, and anesthesia and respiratory equipment represent the majority of medical devices imported into the United States. These imports are particularly susceptible to the proposed U.S. medical device tariffs. With approximately 75% of medical devices sold in the U.S. being manufactured abroad—69% of which are exclusively produced outside the country—the potential for price inflation and reduced accessibility is likely. A significant portion of these devices, 13.6%, are manufactured in China, making the proposed 60% tariffs on Chinese medical device imports a critical factor in supply chain stability. Companies heavily reliant on Chinese manufacturing, such as L&K Biomed, are likely to face severe financial and logistical challenges. In contrast, firms with minimal foreign manufacturing dependency, like Becton Dickinson—producing only 12% of its products overseas—are better equipped to adapt to these changes [11].

Implant cost analyses for 2014 and 2023 in Türkiye show that in some orthopedic implant groups, import dependency has decreased significantly and domestic production has reached an important point. For example, in knee and hip prostheses, the domestic production rate has exceeded 90%, but some implant categories such as intramedullary nail are still 100% dependent on imported products. This situation is directly related to the health policies of countries and reveals that domestic production should be encouraged to support economic sustainability [12].

This article aims to evaluate the economic impact of local and imported products by analyzing the cost of orthopedic implants in Türkiye. In the study, cost changes between 2014 and 2023, increase rates of domestic production, import dependency and cost awareness in implant selection will be discussed. Global approaches to optimize implant costs and strategies to increase surgeons' cost awareness will also be discussed [9,10,13]. Finally, policy recommendations will be presented to improve cost-effectiveness and sustainability in Türkiye's orthopedic implant sector.

Material and Methods

This study was reviewed by the Kastamonu University Clinical Research Ethics Committee / Kastamonu Training and Research

Hospital Ethics Committee and received ethical approval under decision number 2025-20. The study was conducted in accordance with the principles of the Declaration of Helsinki. The data in the study was obtained from a medical company specializing in orthopedic products. The firm distributes medical devices for patients with orthopedic problems. The data is how many products were used for operations and patients within the years 2014 and 2023. It was collected from the hospital based on how many of orthopedic implants were used in the operation room.

The data is based on the brands used in 2014 and 2023. The kinds of medical devices used for different kinds of body parts are categorized under different brands. The brands are divided to determine whether the brands are local or imported. Based on the number of imported and local products the rates indicate how many of products are made in Türkiye and how many of them are imported from different countries.

The cost per products shows how much each product is sold in terms of the Turkish Lira (TL). The total cost indicates how much the brand's product is worth in TL and it is converted in US Dollars. Due to the currency in 2014 the exchange rate is 2.32 TL (1 US dollar is worth 2.32 TL). The exchange rate for 2023 is 29.43 TL (1 US dollar is worth 29.43 TL) The number after the decimals are rounded for the exact numbers.

Below are the tables for each part of the body.

Results

Knee

Use of Local and Imported Products

In 2014, all products were imported, while in 2023 the domestic production rate increased to 98%. This indicates a significant increase in domestic production capacity and a decrease in import dependency.

Total Cost (TL and \$)

In 2014, the total cost was 578.655,4 TL and \$249,420, while in 2023 it was 6,080,671 TL and \$206,614. Although the cost in TL terms has increased, the cost in dollar terms has decreased. This indicates that costs are under control with domestic production.

Number of Products

While 175 products were used in 2014, this number increased to 303 in 2023. This indicates an increase in diversity and demand in product supply.

Unit Costs

In 2023, the unit costs of domestic products remained at a lower level compared to imported products. This shows that domestic production provides an economic advantage.

Import Rate

While the import rate was 100% in 2014, it decreased to only 2% in 2023. This shows that the country has greatly reduced its dependence on foreign health technologies.

Knee General Evaluation

These data clearly show the impact of localization policies in the health sector. Between 2014 and 2023, investments in domestic production led to a significant decrease in imports and brought costs under control. Increasing domestic production is important both economically and strategically. The 2023 data points to a great success for sustainability and independence in the health

sector. The decline in the proportion of imported products also shows that domestic products have reached international standards in terms of quality and suitability.

These findings support that health policies are shaped in line with localization targets and that increasing domestic production capacity contributes to the national economy and the health system.

Table 1. Knee

2014 Knee					
Brand	Local	Imported	Cost Per Product (TL)	Total Cost (TL)	Total Cost (\$)
Knee Stryker	0	161	3317	534.037	230.188
Knee Orsem	0	13	3168	41.184	17.752
Implantcast Knee	0	1	3434,4	3434,4	1.480
Total	0	175		578655,40	249.420
Rate	0	100%			

2023 Knee					
Brand	Local	Imported	Cost Per Product (TL)	Total Cost (TL)	Total Cost (\$)
Knee Pasifik	271	0	20199	5.473.929	185.998,26
Knee Ortopro	26	0	19028	494.728	16.810,32
Knee Covision	0	3	20861	62.583	2.126,50
Knee Destiknee	0	3	16477	49.431	1.679,61
Total	297	6		6.080.671	206.614
Rate	98%	2%			

Total Hip

Use of Localand Imported Products

In 2014, the ratio of domestic products was 22.22%, while this ratio increased to 96% in 2023.

The rate of imported products decreased from 77.77% to 4%. This shows a significant progress in domestic production.

Total Cost (TL and \$)

While the total cost was 82,432 TL in 2014, it increased to 2.402,170TL in 2023.

In dollar terms, the cost increased from \$35,531.02 to \$81.623,16. One of the main reasons for the increase may be the significant increase in the total number of products and the increase in the unit costs of domestic production.

Number of Products

In 2014, a total of 18 products (4 local, 14 imported) were used, while in 2023 a total of 91 products (87 local, 4 imported) were used. The increase in the number of products is an indicator of demand or changes in treatment methods.

Unit Costs

The unit costs of domestic products were generally lower than those of imported products. For example, in 2023, the unit cost of Tipsan, a domestic product, was 26274 TL, while the unit cost

of Covision, an imported product, was 29083 TL.

Import Rate

While 77.77% in 2014, the import rate decreased to 4% in 2023. This decrease indicates that import dependency has decreased to a great extent and local production has gained importance in the health sector.

Total Hip General Evaluation

Total Hip product data for 2014 and 2023 clearly show that Türkiye's localization policies in the healthcare sector have been successful. By 2023, the domestic production rate has reached 96% and the import rate has fallen to 4%. This shows that the country has succeeded in reducing its dependence on foreign imports in health technologies and has increased its domestic production capacity.

In addition, the increase in the total number of products indicates the expansion of health services and the growing demand for such products in treatment processes. The economic advantage of local products can be considered as a positive development for the sustainability of the health system.

These results underline the economic and strategic importance of localization policies in the health sector. However, continuing to improve the quality of domestic production and ensuring compliance with international standards is critical for sustainable success.

Table 2. Total Hip

2014 Total Hip					
Brand	Local	Imported	Cost Per Product (TL)	Total Cost (TL)	Total Cost (\$)
Hip Ortopro	4	0	3.864,00	15.456	6.662,06
Hip Orsem	0	14	4.784,00	66.976	28.868,96
Total	4	14		82.432	35.531,02
Rate	22,22%	77,77%			
2023 Total Hip					
Brand	Local	Imported	Cost Per Product (TL)	Total Cost (TL)	Total Cost (\$)
Total Hip Tipsan	40	0	26274	1.050.960	35.710,50
Total Hip-Ortopro	47	0	26274	1.234.878	41.959,83
Total Hip Covision	0	4	29083	116.332	3.952,83
Total	87	4		2.402.170	81.623,16
Rate	96%	4%			

Bipolar Hip

Use of Local and Imported Products

For both years, all products were sourced from domestic production (100% local use). No imported products were used.

Total Number of Products

While 63 products were used in 2014, this number increased to 158 in 2023. This shows a significant increase in product demand.

Total Cost (TL and \$)

While in 2014 the total cost was 154,300 TL and \$66.508,61, in 2023 the total cost is 2,959,972 TL and \$ 100,576.69. The increase in the number of products and the rise in unit costs play an important role in the increase in costs in TL terms.

Unit Costs:

In 2014, unit costs ranged between TL 2,408 and TL 2,452, while this cost increased to TL 18,734 in 2023. This indicates an increase in both production costs and economic conditions.

Change in Dollars:

While the total cost in dollar terms was \$66.508,61 in 2014,

it was \$100.576,69 in 2023. The rate of increase is lower than the increase in TL. This reflects the impact of changes in the exchange rate.

Bipolar Hip General Evaluation

The 2014 and 2023 Bipolar Hip data clearly demonstrate the continuity of domestic production and the fact that foreign dependency in the health sector has been reduced to zero. The fact that 100% domestic production was used in both years reveals that domestic production is equivalent to imported products in terms of both quality and capacity.

In 2023, the increase in the number of products indicates the development in the health sector and the increasing need for such products. However, the increase in unit costs is striking and emphasizes the importance of cost management in production processes.

These data reflect the success of localization policies in the health sector. However, the fact that domestic products have quality at international standards can increase export potential and enable these products to take part in the global health market. This continuity in domestic production strengthens Türkiye's economic and strategic independence in the health sector.

Table 3. Bipolar Hip

2014 Total Hip					
Brand	Local	Imported	Cost Per Product (TL)	Total Cost (TL)	Total Cost (\$)
Bipolar Hip Tipsan	59	0	2.452,00	144.668	62.356,89
T2 Tipsan Bipolar Hip	4	0	2.408,00	9.632	4.151,72
Total	63	0		154.300	66.508,61
Rate	100%	0			
2023 Total Hip					
Brand	Local	Imported	Cost Per Product (TL)	Total Cost (TL)	Total Cost (\$)
Bipolar Hip-Ortopro	98	0	18734	1.835.932	62.383,01
Bipolar Hip-Tipsan	60	0	18734	1.124.040	38.193,67
Total	158	0		2.959.972	100.576,69
Rate	100%				

Nail

Use of Local and Imported Products

In both years, all products were imported and no domestic products were used. This shows that local production capacity has not developed in this product category.

Total Number of Products

While 32 products were used in 2014, this number decreased to 26 in 2023. It is observed that there is a decrease in product demand.

Total Cost (TL and \$)

Total cost in TL terms increases from TL 61,696 in 2014 to TL 360,516 in 2023. The main reason for this increase is that the cost per product increases approximately 7 times.

In dollar terms, total cost decreased from \$26,593.10 in 2014 to \$12,249.94 in 2023. This shows that changes in the exchange rate affect the costs of imported products.

Unit Costs

While in 2014 the unit cost was TL 1,928, in 2023 this cost increases to TL 13,866. This increase reflects the significant rise in the prices of imported products.

Product Demand and Cost Relationship

While product demand falls from 32 to 26, the total cost in TL terms increases by about 6 times. This suggests that the cost of imports may become unsustainable over time.

Nail General Evaluation

Data for 2014 and 2023 for nail products show that this product category continues to be completely import-dependent, with no domestic production. Especially the significant increase in unit costs indicates that imported products will become less economically sustainable over time.

In 2023, the decline in product demand suggests that health sector needs or product preference criteria may have changed. However, the increase in import costs reveals the importance of supporting these products with local production in the long term. Increasing domestic production capacity is critical to reduce external dependency and keep costs under control.

In light of these data, increasing domestic production incentives and R&D investments for products in this category should be considered both an economic and strategic priority. Moreover, the development of national policies to reduce dependence on imported products will support sustainability in the healthcare sector.

Table 4. Nail

2014 Nail					
Brand	Local	Imported	Cost Per Product (TL)	Total Cost (TL)	Total Cost (\$)
Nail Smith	0	32	1.928,00	61.696	26.593,10
Total	0	32			
Rate	0	100%			
2023 Nail					
Brand	Local	Imported	Cost Per Product (TL)	Total Cost (TL)	Total Cost (\$)
Nail Smith	0	26	13866	360.516	12.249,94
Total	0	26		360.516	12.249,94
Rate	0	100%			

PFN Hip

Use of Local and Imported Products

In 2014, all products were imported (100% imported), while in 2023, the local product utilization rate reached 96%. This shows a significant progress in domestic production.

Total Number of Products

In 2014, 62 products were used in total, while this number increased to 253 in 2023. This indicates a significant increase in demand for PFN Hip products.

Total Cost (TL and \$)

Total cost in TL terms increases from TL 270.806 in 2014 to TL 3,514,858 in 2023. The increase can be explained by the significant increase in the number of products and the rise in unit

costs. In dollar terms, the total cost decreased from \$116.726,72 in 2014 to \$119,431.12 in 2023. This reflects the impact of changes in the exchange rate.

Unit Costs

In 2014, unit costs ranged between TL 3,310 and TL 4,596 for imported products, while in 2023 they were TL 14,137 for domestic products and TL 7,270 for imported products. It is noteworthy that the unit costs of domestic products are higher than imported products.

Product Demand and Cost Relationship

In 2023, although domestic products were preferred, the increase in costs may indicate that the technical specifications or quality standards of the products may have improved.

PFN Hip General Evaluation

PFN Hip data for 2014 and 2023 show the success of Türkiye's localization policies in the health sector. By 2023, the domestic production rate will reach 96%, indicating that external dependency in health technologies has been significantly reduced. This shows that the national health sector is strengthening both economically and strategically.

However, the increase in unit costs is noteworthy. The higher cost of domestic production compared to imported products suggests

that advanced standards in quality and production processes may have been adopted. Optimizing domestic production costs can increase the competitiveness of the national health sector.

These results emphasize the importance of increasing domestic production for sustainability and independence in the healthcare sector. The success of localization in PFN HIP products provides a model that can be applied to other health technologies. Moreover, quality improvement and compliance with international standards to increase the export potential of local products are critical for long-term success.

Table 5. PFN Hip

2014 PFN Hip					
Brand	Local	Imported	Cost (Per Product)	Total Cost (TL)	Total Cost (\$)
PFN Orthofix	0	51	4.596,00	234.396	101.032,75
PFN Smith	0	11	3.310,00	36.410	15.693,96
Total	0	62		270.806	116.726,72
Rate		100%			
2023 PFN Hip					
Brand	Local	Imported	Cost (Per Product)	Total Cost (TL)	Total Cost (\$)
PFN-IMD Manyetix	105	0	14137	1.484.385	50.437,81
PFN-Özova Distalock	139	0	14137	1.965.043	66.770,06
PFN-Smith	0	9	7270	65.430	2.223,24
Total	244	9		3.514.858	119.431,12
Rate	96%	4%			

Plate Screw

Use of Local and Imported Products

In both years, all products were sourced from local production. The use of 100% domestic production demonstrates the success of domestic production in this product category.

Total Number of Products

While 96 products were used in 2014, this number increased to 341 in 2023. This approximately 3.5-time increase in product demand shows that there is an increasing demand for the use of Plate screw in the healthcare sector.

Total Cost (TL and \$)

Total cost in TL terms increased from 177,600 TL in 2014 to 3,191,760 TL in 2023. The main reasons for this increase are the increase in the number of products and the significant rise in unit costs. In dollar terms, total cost increased from \$76,551.72 in 2014 to \$108,452.59 in 2023. The increase in cost in currency terms is more limited and reflects the impact of changes in the exchange rate.

Unit Costs

In 2014, the unit cost was 1,850 TL, while in 2023 this cost increases to 9,360 TL. This increase in unit cost indicates that

domestic production costs may have increased and the impact of economic factors such as inflation.

Product Demand and Cost Relationship

The preference for domestic production despite the increase in product demand indicates that domestic production capacity is sufficiently developed to meet this increase. However, the increase in costs points to the need to increase the economic sustainability of domestic production.

Plate Screw General Evaluation

Plate screw data for 2014 and 2023 show that in this product category, a supply strategy based entirely on domestic production is being pursued and dependence on imported products has been completely eliminated. This shows that localization policies in the healthcare sector have been successful and domestic production capacity has been increased.

The nearly 3.5-time increase in product demand shows that the healthcare sector is expanding and the need for products such as plate screw is increasing. However, the increase in unit costs highlights the importance of cost optimization of domestic production. Reducing production costs and developing more efficient production processes are critical both to meet the needs of the domestic market more economically and to take advantage of potential export opportunities.

Table 6. Plate Screw

2014 Plate Screw					
Brand	Local	Imported	Cost (Per Product)	Total Cost (TL)	Total Cost (\$)
Plate Screw	96	0	1.850,00	177.600	76.551,72
Total	96	0			
Rate	100%				

2023 Plate Screw					
Brand	Local	Imported	Cost (Per Product)	Total Cost (TL)	Total Cost (\$)
Plate Screw	341	0	9360	3.191.760	108,452,59
Total	341	0			
Rate	100%	0			

This picture sets a fundamental example for a sustainable domestic production model in the healthcare sector. A well-developed domestic production capacity capable of meeting high demand and provides a strategic advantage in terms of economic independence. However, bringing domestic production costs to internationally competitive levels is critical for long-term success.

Overall, the total number of units purchased in 2014 and 2023 for each category, broken down by local and imported, is shown in the histogram below.

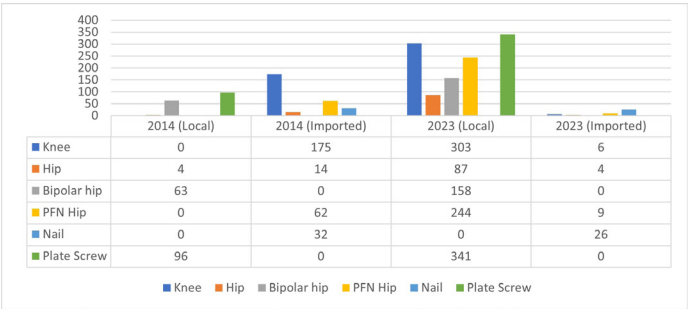


Figure 1. 2014-2023 Local and Imported Totals by Category

Here, it shows a clear shift toward localization during the 2014–2023 period: knee (2014: all imported → 2023: 297 local / 6 imported, ≈98% local), hip (4/14 → 87/4, ≈96% local), bipolar hip (63/0 → 158/0, 100% local), PFN hip (0/62 → 244/9, ≈96% local) and plate-screw (96/0 → 341/0, 100% local) categories have seen a dramatic increase in the local share. In contrast, intramedullary nails appear to be completely dependent on imports in 2023 (0 local / 26 imported). The findings show that import dependency is rapidly decreasing in many categories.

Discussion

The use and costs of orthopedic implants in Türkiye have changed significantly in recent years. Due to the localization policies and domestic production incentives, import dependency has decreased and domestic production capacity has increased since 2014. In this process, the share of domestic producers has gradually grown, especially in high-cost medical devices such as orthopedic implants. While in 2014, a large portion of orthopedic implants were imported, by 2023, this ratio had fallen significantly and domestic production was able to meet a significant portion of total utilization. This change can be

considered a major step forward in terms of the sustainability of health expenditures. This is the first study to compare the cost-effectiveness of widely used orthopedic implants with the change in the country's economy and localization policies over the years.

In Türkiye, the domestic production rate for knee implants increased from 100% imports to 98% local production between 2014 and 2023. During this period, although the total cost in TL terms increased, a decrease in dollar costs was observed. This suggests that domestic production contributes to cost control and reduces import dependency. Moreover, when medical data in Kastamonu city are analyzed, the number of knee prostheses increased from 175 in 2014 to 303 in 2023 and the unit costs of domestic products remained lower compared to imported products. These data reveal that Türkiye has taken important steps towards creating a sustainable health system by reducing its dependence on imports in health technologies.

On the other hand, more than 100,000 TKAs (total knee arthroplasty) are performed in the UK (United Kingdom) each year, at a total cost of approximately £550 million [14]. Although the NHS national tariff cost for a TKA in 2018/2019 was set at £6651, the true financial cost of the procedure has not been fully calculated [17]. The number of TKAs in the UK is expected to double by 2050 [15,16], which could put significant pressure on healthcare expenditure. Localization policies and increased domestic production in Türkiye could serve as a model for countries like the UK. Increasing local production and controlling costs are critical for the sustainability of health systems, both economically and strategically.

Although primary total hip arthroplasty (THA) is considered a highly cost-effective intervention to relieve pain and improve functionality in individuals suffering from debilitating hip conditions [18,19], it accounts for a significant (and increasing) portion of healthcare expenditures in the United States. For example, total hospital costs associated with hip and knee arthroplasties exceeded US\$19 billion in the United States in 2010 [20]. Demand for primary THA is expected to increase by 174%, reaching approximately 572,000 procedures per year by 2030 [21]. As a result, initiatives aimed at cost containment are becoming increasingly important. In this context, developments in countries with localization policies in the healthcare sector are

noteworthy. Especially in Türkiye, Total Hip and Bipolar Hip product data for 2014 and 2023 clearly show that localization policies have been successful. By 2023, the domestic production rate in Total Hip products reached 96%, while the import rate dropped to 4%. The fact that 100% domestic production was used in Bipolar Hip products for both years reveals that local production has become equivalent to imported products in terms of both quality and capacity, and that foreign dependency in the health sector has been reduced to almost zero.

The increase in the total number of products indicates that healthcare services are expanding and the demand for such products in treatment processes is increasing. The economic advantages provided by domestic products can be considered as a positive development for the sustainability of the healthcare system. However, the increase in unit costs of Bipolar Hip products emphasizes the importance of cost management in production processes. Continuing to improve the quality of domestic production and ensuring compliance with international standards is critical for sustainable success. This may increase the export potential of local products and enable them to gain a competitive position in the global healthcare market. These results highlight the importance of localization policies in the health sector not only from an economic but also a strategic perspective. This continuity in domestic production can strengthen Türkiye's health independence and set an example for global health systems in terms of cost control and technological independence.

Intramedullary nails (IMNs) are considered the current gold standard treatment for long bone diaphyseal and selected metaphyseal fractures. The design of IMNs has undergone many revisions since their invention in the 16th century, and recent years have seen a significant increase in new designs aimed at further improving intramedullary fixation techniques [22]. However, intramedullary nailing treatment is still not universally accessible, especially in Low and Middle Income Countries (LMICs). To alleviate this situation, SIGN Fracture Care International, a US-based NGO, began manufacturing and donating intramedullary nails that can be used in resource-limited settings without the need for fluoroscopy or other power tools in 1999 [23]. However, despite these efforts, access to this treatment modality is still limited, especially in public hospitals. Economic evaluation of health interventions plays a critical role in informing policy decisions in resource-limited settings. For example, available data on the costs of surgery for femoral shaft fractures are both sparse and methodologically inconsistent [24,25,26], making it difficult to develop cost-effective solutions.

The data on intramedullary nail products for 2014 and 2023 reveal that this category continues to be completely import-dependent and that domestic production is not being realized. In particular, the significant increase in unit costs indicates that imported products are becoming less economically sustainable over time. In 2023, the decline in product demand suggests that

health sector needs or product preference criteria may have changed. However, the increase in import costs emphasizes the importance of supporting these products with domestic production in the long term. Increasing domestic production capacity should be considered as a critical step to reduce external dependency and keep costs under control. In light of these data, increasing domestic production incentives and R&D investments in the Nail products category has become both an economic and strategic priority. Moreover, the development of national policies to reduce dependence on imported products will support sustainability in the healthcare sector and ensure more efficient use of resources. Such steps can also contribute to global efforts to improve the accessibility and quality of healthcare services, especially in resource-limited settings.

Between 2015 and 2050, the proportion of the world population aged 60 years and older is projected to double from 12 percent to nearly 22 percent [27]. This demographic change, together with an aging population and an increase in life expectancy, will lead to a significant increase in the incidence of hip fractures in Türkiye and the world. Aging-related problems such as decreased physical capacity, weakened reflexes, vision and hearing loss weaken the functions of protection and escape from environmental hazards. Furthermore, the decrease in bone density with age significantly increases the risk of fractures [28]. Musculoskeletal diseases account for approximately 30% of the global burden of disease and place an increasingly heavy economic burden on health systems, especially with an aging population [29]. While 1.6 million hip fractures occurred globally in 1990, this number is expected to increase to over 6 million by 2050 [30]. Although Türkiye has one of the lowest hip fracture incidence rates in Europe, a significant increase has been observed in recent years. The FRACTURK study predicts that the estimated number of hip fractures in Türkiye will increase from 24,000 in 2009 to 64,000 in 2035 [31]. This represents a serious burden in terms of both health loss and social and health care costs.

Thus, the success of localization policies in the healthcare sector is particularly evident in PFN Hip products used in hip fracture treatment. The 2014 and 2023 PFN Hip data show that Türkiye has significantly reduced its dependence on imports in this field. By 2023, the domestic production rate will reach 96%, indicating that the national healthcare sector is strengthening both economically and strategically. However, the increase in unit costs is noteworthy, suggesting that domestic production may be more costly than imported products. This cost increase may be related to the adoption of advanced standards in quality and production processes. Optimizing domestic production costs can increase the competitiveness of the national health sector and support its sustainability.

These results highlight the importance of indigenization policies in the healthcare sector not only from an economic but also from a strategic perspective. The localization success achieved in PFN Hip products provides a model that can be applied to

other health technologies. Moreover, quality improvement and compliance with international standards, which will increase the export potential of local products, are critical for long-term success. Such steps can play an important role in meeting the growing health needs of an aging population and supporting the sustainability of global health systems.

In modern fracture fixation, locking plate/screw systems, in which the screw head is mechanically prevented from rotating at the plate interface, are widely used [32,33]. These systems are particularly preferred in clinical indications such as the presence of osteoporotic bone and stabilization of short metaphyseal segments [34-36]. However, there are a limited number of studies in the literature on the cost-effectiveness or cost-benefit analysis of locking plates [37-39]. In this context, plate-screw production data between 2014 and 2023 show that a procurement strategy based entirely on domestic production has been adopted in this product category and the dependence on imported products has been eliminated. This demonstrates the success of the localization policies implemented in the health sector and the increase in domestic production capacity.

The approximately 3.5-time increase in product demand indicates that the need for medical products such as plate screws has increased in parallel with the expansion of the healthcare sector. However, the rise in unit costs once again highlights the importance of cost optimization in domestic production. Reducing production costs and developing more efficient production processes are critical both to meet the needs of the domestic market more economically and to be competitive in the international market. These developments set a fundamental example for the creation of a sustainable domestic production model in the healthcare sector. While an advanced domestic production capacity capable of meeting high demand provides a strategic advantage in terms of economic independence, long-term success requires bringing domestic production costs down to internationally competitive levels. This process is crucial to ensure the sustainability of domestic production both in the domestic and global markets.

This comparison shows how effective localization policies can be in terms of cost control and reducing external dependency in health services. Türkiye's success provides an important reference point for other countries to implement similar strategies.

Limitations

The limitation of the study is the years as 2014 and 2023 was given. However the exchange rate difference over the past 9 years clearly shows how much the costs have differed. The products have changed and some imported products have completely changed into local products. The product data was obtained from a hospital that has an orthopedics department. For future studies the years could be expanded and include more hospitals in different regions or multiple hospitals in the country. Furthermore, this study is limited to data obtained from a single center (a hospital)

and no adjustments have been made for inflation. Future studies could increase the scope and generalizability of the analysis by including tax advantages, R&D incentives, and export data.

Conclusion

The results emphasize Türkiye's remarkable achievement in diminishing reliance on imports and augmenting cost-effectiveness in orthopedic implants through comprehensive localization strategies. By emphasizing domestic manufacturing, Türkiye accomplished extraordinary feats, exemplified by the elevation of knee and hip implant indigenization to over 95% by 2023, which significantly reduced dollar-denominated expenses despite inflationary pressures within the local currency. These initiatives not only bolstered the sustainability of healthcare but also established Türkiye as an exemplary model for nations facing escalating procedure volumes and expenditures, such as the United Kingdom and the United States. Nonetheless, obstacles persist in sectors such as intramedullary nails, where dependence on imports remains substantial, underscoring the necessity for focused research and development investments alongside cost-optimization methodologies. With aging demographics propelling global demand for orthopedic services, Türkiye's experience illustrates the combined economic and strategic advantages of localization; however, enduring success is contingent upon upholding quality standards, enhancing production efficiency, and broadening export competitiveness. These insights are vital for the establishment of resilient and equitable healthcare systems on a global scale.

While Türkiye has achieved over 95% localization in knee and hip implants, categories like intramedullary nails (IMNs) remain 100% import-dependent. The government could launch specific public-private R&D grant programs targeting underdeveloped orthopedic segments such as nails. The goal is to build a local technical capacity and reduce vulnerability to external supply shocks and price changes.

A national orthopedic technology innovation program could be established and universities, hospitals, local manufacturers could be linked in order to accelerate developments that meet international standards and enhance export potential.

Offering tax incentives, technical support, and fast-track approval pathways for companies investing in quality improvements and obtaining international certifications could pave the way to unlock export markets and elevate Turkish medical devices to global competitiveness.

Surgeons could receive cost awareness training to understand the economic significance of implants. This is to ensure professional development and to make economically informed decisions without compromising care quality.

Conflict of Interests

The authors declare that there is no conflict of interest in the study.

Financial Disclosure

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Ethical Approval

This study was reviewed by the Kastamonu University Clinical Research Ethics Committee / Kastamonu Education and Research Hospital Ethics Committee and received ethical approval with application number 2025-20. The study was conducted in accordance with the principles of the Declaration of Helsinki.

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