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# Analysis of the gym equipment market for the implementation of isometric training plans

Aitor Goti[1,*], Arkaitz Castañeda[1], Iker Lopez[2], Fernando Cortés[1], Ramón Costa[1]

[1*]*University of Deusto, Avda. Universidades 24, Bilbao 48080, Spain; aitor.goti@deusto.es,*
[2]*Kirolene, San Ignacio Auzunea Etxetaldea 5, Durango 48200, Spain.*

**Abstract**

Isometric workouts have been shown to improve muscular mass, strength, balance, and range of motion. Other isometric exercise advantages include stress reduction, increased mental health, injury prevention and overall wellbeing. It is a solution that specially fits injured and elder people, as the risk of injury almost disappears. Nevertheless, the amount of people taking advantage of isometrics at gyms is relatively low. One of the affecting factors in the spread of isometric training could be the lack of knowledge about the existence of specific isometric machinery for gym training. In this context, the purpose of this paper, as main finding, is to present a state of the art of the existing equipment in the field.

**Keywords:** Isometrics; gym equipment; biomechanics

## Introduction

Muscle hypertrophy, strength, balance, and range of motion have all been found to improve with isometric training. Stress reduction, improved mental health, injury avoidance and overall wellbeing are among the other benefits of isometric exercise. It is a solution that is particularly well suited to wounded and elderly individuals, as the possibility of harm is virtually eliminated.

Through muscle training, elderly people improve their motor skills and have enough strength to carry out all day-to-day activities. Sedentary lifestyle in the elderly is a factor that contributes to muscle atrophy, which in turn leads to joint deterioration. This can be combated by encouraging older people to train and lead an active lifestyle. Likewise, life expectancy in Spain is 86.3 for women while 80.7 is for men, 2.6 and 2.5 years respectively higher than the average expectation of the 27 EU countries (Spain, 2021). This translates into the aging of the population if it is analyzed in conjunction with the birth data, which can be seen in the following graph represented as the increase in the average age of the population.

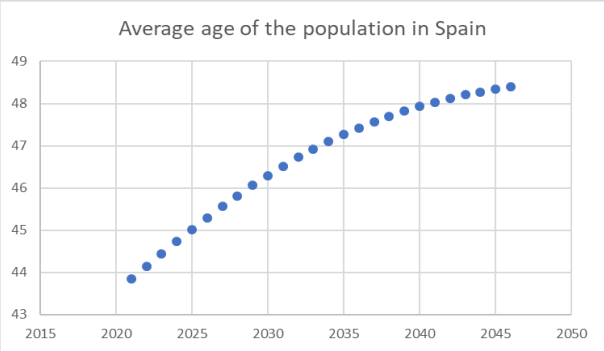


Figure 1. Graph of the projection of the average age in Spain (National Institute of Statistics, Spain, 2021)

Likewise, people who suffer injuries and undergo interventions that involve long periods of rest and inactivity also suffer muscle atrophy due to little or, sometimes, no physical activity. Rehabilitation training is a common practice performed to regain the condition of the muscles and joints after an injury. There are a wide variety of rehabilitation workouts that allows regaining mass muscle, but it is considered that there is no dynamic method that is applicable to all people.

Continuous exercise is essential to maintain a healthy lifestyle and is included within the habits that a person must follow to maintain a healthy life. Within the 17 Sustainable Development Goals (SDGs) proposed by the United Nations (UN) that seek to achieve a sustainable future for the world's population, there is Goal 3, which aims to guarantee the health and well-being of the whole world.

The UN describes the goal of this objective as follows: "Ensuring healthy lives and promoting well-being at all ages is essential for sustainable development"(United Nations, 2015). Within this, 13 goals are collected that allow reaching the global objective with a 2030 deadline, among which is the following goal: "3.4 By 2030, reduce premature mortality from non-communicable diseases by one third through prevention and treatment and promote mental health and well-being" (United Nations, 2015). To meet this goal, the vast majority of the population must adopt a healthy lifestyle through good eating habits and an active life. An active lifestyle involves performing either aerobic or anaerobic sports or physical activity in different degrees of intensity and of different types depending on the age of a person. Incorporating physical activity into our daily lives allows us to prevent and control these types of non-communicable diseases, such as diabetes, cardiovascular diseases, and to maintain a healthy body composition (Organization, 2020). In addition, it not only has beneficial effects for body health, if it does not allow us to improve our mental health. The World Health Organization (WHO) recommends doing activities that strengthen muscles and bones, on average 3 days a week, regardless of age range (Organization, 2020).

For all this, the need is generated to provide options that have been designed with accessibility criteria and that allow all types of people to train

indistinctly. In addition, isometric training allows to simplify workouts by eliminating the movement component, reducing the possibility of injury during training.

Despite this, the number of individuals who do isometrics in gyms is rather modest. One of the problems impeding the spread of isometric training might be a lack of awareness of the presence of particular isometric gym equipment. In this context, the aim of this work is present a market analysis of the currently available equipment in the field.

Thus, the manuscript is structured as follows: section 2 provides the basis of the Isometrics as materials, and the details and scope of the literature review performed for describing the method. Section 3 presents its results. Finally, section 4 summarizes the main findings, confirming that the increase of the visibility of these types of gadgets will help in the spread of the discipline.

## Materials and Methods

*Principles of the isometric training*

Strengthening the muscles is achieved through specific training for each group and trying to achieve the activation of the muscle fibers (Oranchuk et al., 2019). The training methods that exist today are many and varied, but it is worth highlighting the most widely known, which are strength work with resistance. Through the resistances used, muscle contractions can be categorized as follows (ENFERDEP, 2017):

Concentric: in this case, the muscle generates a tension greater than the opposing force and manages to overcome it. An example of a concentric contraction would be when we raise a glass of water to drink our biceps shortens.

Eccentric: the force that the muscle in question is exerting is not capable of overcoming the force it is opposing. In this case, the muscle initially tries to shorten, but ends up lengthening because it exceeds the limit that it can withstand. An example would be trying to support a weight somewhat greater than what we can bear that ends up causing us to give way.

Isometric: in an isometric contraction, as its name suggests, the length of the muscle remains constant, but the muscle itself generates tension since the fibers within it lengthen and shorten. This contraction occurs when the same force that is trying to overcome is performed. The clearest example is when it comes to pushing a wall since force is being exerted, but there is no displacement.

For clarity, the following figure shows a simple analysis of the forces involved in the 3 cases of contraction that have been described.

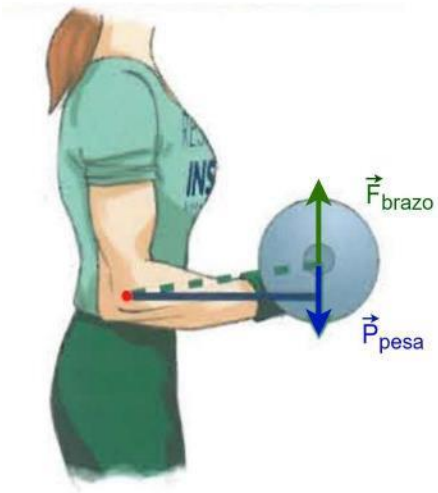


Figure 2. Dynamics of arm movement in bicep curls. Source: Own elaboration

The study of forces following the diagram in illustration 3 is as follows, following the aforementioned numbering:

Concentric: $\vec{F}_{brazo} > \vec{P}_{pesa}$ . Given this condition, there is a movement of rotation in an anti-clockwise direction with respect to the axis of rotation that is located at the elbow (in the illustration, red dot).

Eccentric: $\vec{F}_{brazo} < \vec{P}_{pesa}$. Because the force that the biceps is capable of carrying out is not sufficient to overcome the weight of the dumbbell, there is a clockwise twist with respect to the elbow.

Isometric: $\vec{F}_{brazo} = \vec{P}_{pesa}$. In this case, given that the sum of the forces of the system is zero, there is no movement.

The most common ways of training strength are both concentric and eccentric contractions through the use of gravitational loads, that is, through the use of weights, where only gravity intervenes. In this way, we will work the force trying to overcome the gravitational force that is defined as follows:

$$\vec{F}_{grav,pesa} = m_{pesa} \cdot \vec{g} \quad (1)$$

Where g is the acceleration of gravity and $m_{pesa}$ is the mass of the weight.

On the other hand, elastic loads are also used, which are those in which the force of gravity does not intervene and force is carried out by pulling or compressing an object. The most common is to use elastic bands or cords. Training with this type of load is more complex because it is not easy to know the forces that are being applied at a specific moment quickly. Elastic bodies are those that recover their initial shape at the moment in which forces are no longer applied to themselves (Ruiz & Blanco Díaz, 2015). For the elastic bodies that are used in training, they respond to a linear elastic behavior enunciated by Robert Hooke and which is known today as Hooke's law (Ruiz & Blanco Díaz, 2015). The one-dimensional mathematical statement of this law for a spring is as follows:

$$F_{muelle} = kx \quad (2)$$

Where k is the elastic constant of the spring in question and x is the increase or contraction of its length.

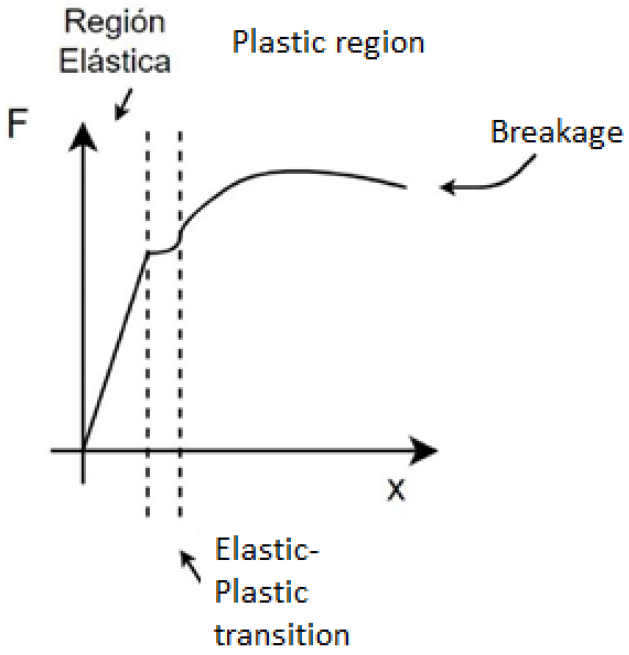


Figure 3. Force - Elongation diagram of a material

For the rest of the solid and elastic bodies that are not springs, the generalized Hooke's law is used, which considers the deformations and stresses at any point of the solid. The elastic elements that are used for training, rubber bands or elastic bands, allow the approximate calculation of the force that is made with the aforementioned Hooke's law, taking into consideration the elastic constant of the material.

Isometric exercise training allows you to train strength and improve the physical conditions of a person without having to perform a movement, which is why it is suitable for anyone regardless of their physical condition. Given these circumstances, it is an ideal type of exercise for elderly people with joint and muscle deterioration, for rehabilitation of injuries, etc. (Noorkõiv et al., 2015). In the article by Noorkõiv et al. It is shown that this type of exercise allows to increase muscle mass, improve strength and force production in a greater range of joint movement (Noorkõiv et al., 2015). In addition, it is shown that there is a notable improvement in the functional mobility of a person in common movements such as getting up from a chair or walking, among others.

On the other hand, the author Arthur Jones, focuses on the importance of technique and position rather than range of motion, to obtain optimal training results (Smith & Bruce-Low, 2004). The lower the speed of movement, the greater the muscle tension, so it is possible to optimize muscle contraction and the benefit of the same training (Smith & Bruce-Low, 2004),(Schilling et al., 2008).

This type of work not only has improvements in the muscular section, but there are also improvements in the structure of the tendons and in their function if you work with maximum

intensity workouts (Oranchuk et al., 2019). This maximum occurs in contractions at an intensity greater than 70%. Likewise, there is an analgesic effect for patients with tendinopathies or joint pain, which cannot be alleviated in an immediate or very short period of time with some type of intervention (Rio et al., 2015). This is a great benefit, since the quality of life of a person can be improved without having to resort to invasive therapies and perform rehabilitation work that restores the normal state of the tendon tissue. An incorrect functioning of a tendon induces the inhibition of a muscle or its malfunction, which translates into muscle overload or pain (Rio et al., 2015),(Rio et al., 2017).

In conclusion, we can classify an isometric exercise training as the most suitable for people with some type of injury such as rehabilitation work, people with muscular atrophy or sarcopenia, or for sports professionals who need a training alternative. It is also the most indicated for the general population because results are achieved with less time than is necessary in other types of training, because muscle work is focused in less time (Smith & Bruce-Low, 2004).

**Scope of the analysis**

After analysing the benefits, characteristics and adequacy of isometric training for certain cases, this subsection briefly presents the considerations established for determining the scope of the market analysis.

As the analysis is oriented to gym equipment or gym machinery, relatively small and portable devices get out the scope of this analysis. The market is plenty of devices such as Activ5 (Activ5 by Activbody - No Gym Required. – Activbody, Inc., 2019), MicroFET2 (Scientific, 2021), Isometric Exercise Towel and Methods of Isometric Exercise (Al., 2020) that permit the elaboration of some isometric exercises.

State of the art: Gym machines for training isometrics

The products and patents are detailed in the following subsections conform the market analysis performed

Vald Performance: Force Frame (Performance, 2021)

Regarding this product or its technology, no associated industrial protection is apparently available. It is a device that combines sensors and a structure in the form of a gantry that allows exercises for various muscle groups, such as, for example, those of the waist, legs, neck or shoulders, among others of the upper or lower body. With the available sensors, unidirectional measurements of the force applied by the user can be made in the different exercises, because these sensors can be placed in various positions that are graduated. These sensors are arranged on a bar that is adjustable in height thanks to adjustments found in the side profiles of the gantry. Furthermore, this bar is adjustable by rotating it with respect to its own longitudinal axis in 15º increments. The platform on which the structure is anchored allows it to remain rigid and stable when force is applied to it. This machine offers connectivity via bluetooth or USB technology with a device with Windows or iOS / iPadOS operating system.

Figure 4. Product of VALD Performance ForceFrame (Performance, 2021)

*KT360 Testing and Training platform (Kangatech)* (Ltd., 2021)

This machine is the most similar to the one mentioned above. It has a structure similar to that of Vald Performance, except that the vertical profiles through which the horizontal support that contains the sensors runs, have a circular section instead of a square one. The main differences between the previous one and this one are that the sensors are fixed in exact positions and that the grips it has are interchangeable.

Figure 5. Kangatech KT360 Test and Training Platform (Ltd., 2021)

*Viiv Fitness Rx* (Fitness, 2021)

This device has been analyzed by reviewing the photographs and videos that are available of the product to analyze how it works and how it works. way of measuring, because it is not explained on the website. In it appears reference to a patent pending technology called "Torque Frame", which is not available, and which allows to measure forces of up to 3000lbs. It has a seat with a backrest that can regulate its relative position with respect to the vertical support where the different grips that make up the machine are placed. On the opposite side there are two grips and a platform to be able to perform exercises in which the user must be standing. In addition, the machine has a screen that allows you to view the force data it collects.

Figure 6. ViiV Fitness Rx Product (Fitness, 2021)

A figure of the mechanical model of this machine made with the "Working Model" application is illustrated below, for better explaining the working principle of the machine.

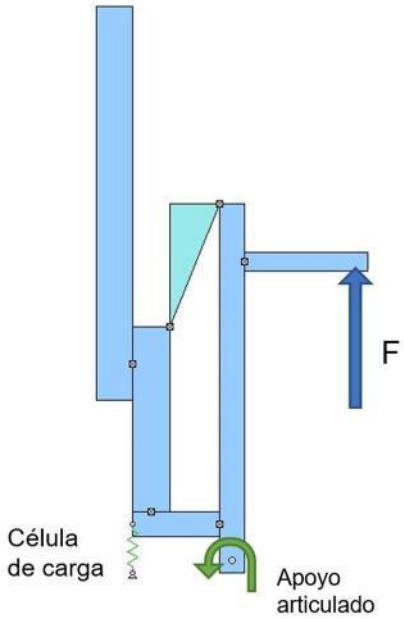


Figure 7. ViiV Fitness Rx mechanical model. Source: Own elaboration

The rigid structure is made up of the rectangular blocks that are joined together by rigid joints, in addition to the triangular block. In this way, the structure can pivot with respect to the articulated

support, which makes it possible to transmit all the forces made to the load cell, represented by a spring in the graph. In this case, all the forces that are carried out with respect to the vertical axis do not vary their moment arm, which allows the force that is applied to be calculated in a simple way. In the case of horizontal forces, the calculation system must be specified what the position is, which results in indirect force measurements.

*PeakFitPro* (PeakFitPro, 2018)

The functional structure of this machine is formed by a gantry with lateral graduation formed by holes in the internal face of the two vertical columns of this gantry. In addition, it consists of a small platform at the base of the gantry where there are sensors that can measure reaction forces made by the user in the direction perpendicular to the plane of this base. The sensors have a measurement precision of one tenth of a pound. A horizontal bench is included in which the user can be arranged to perform the different exercises for which the apparatus is designed. These sensors can be connected to a device via Bluetooth, so that the force data is displayed in a program developed by the company.

Figure 8. PeakFitPro Product (PeakFitPro, 2018)

*1 RepGym* (1RepGym, 2020)

This device consists of a main square profile arranged in a horizontal position with two supports at the ends by means of which the main structure rests on the ground and keeps it stable. On the main profile at one end, there is a seat with a back in which the user is positioned to perform the exercises facing the opposite end of the profile. Through this profile, a force sensor consisting of grips and supports is placed through a guide to measure the forces that are carried out in the direction of this horizontal profile. It also consists of a belt so that the user remains seated and does not separate from the seat. There is a version that has a 5000 lb limit of measurement limit on the sensor. This machine has no connection to any device, it consists of a small LCD screen where the force values that the user is performing at that moment are displayed.


Figure 9. Product 1 RepGym (1RepGym, 2020)

*Ren-ex (several products)* (RenEx, 2019)

A force measurement system was developed that is performed during an exercise session using the Static Pullover machine invented by Ken Hutchins. This system is made up of load cells that measure the force applied to a support on which the arms rest. The person remains seated on a seat and supported by the backrest that incorporates the machine while applying force on the support bar, contracting the abdomen. The sensors are connected to hardware that converts the electrical signal produced by the load cells into a graph that is displayed on a screen through software.


Figure 10. RenEx Product: SuperSlow Pullover (RenEx, 2019)

This machine was the first prototype that led to the development of the "iPOPD machine". For this device, a structure was developed that combines 2 supports with two sensors that make it possible to measure the forces carried out in the pullover and pulldown exercise. The structure consists of profiles arranged on the ground in the shape of a cross with a longer end on which a support is placed for a screen that will show the data obtained on strength during the exercise session. In the other blades of the cross there are three vertical profiles, which, two of which are in the same plane that passes through the center of the cross, will form an arch where the supports will be arranged to perform the exercises, while in the third the seat and back of the machine will be arranged.

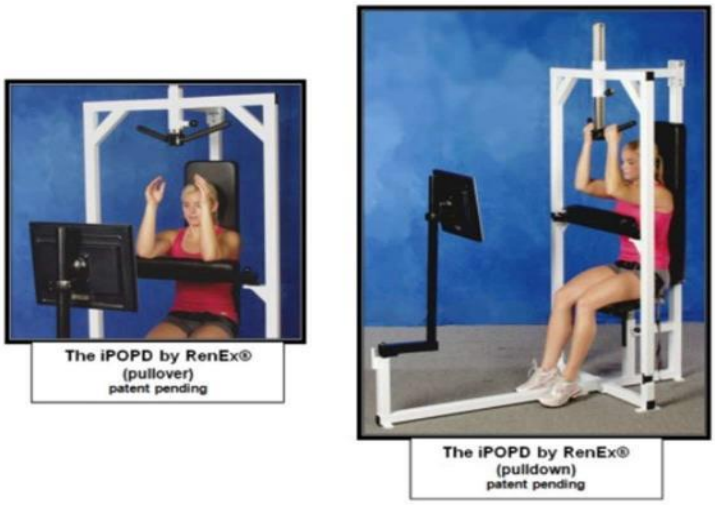


Figure 11. RenEx iPOPD Product. Two pullover and pulldown exercises (RenEx, 2019)

Finally, the latest invention called iMulti is exposed. This device consists of a seat without a backrest and a structure in which two handles are arranged as can be seen in the figure shown below.

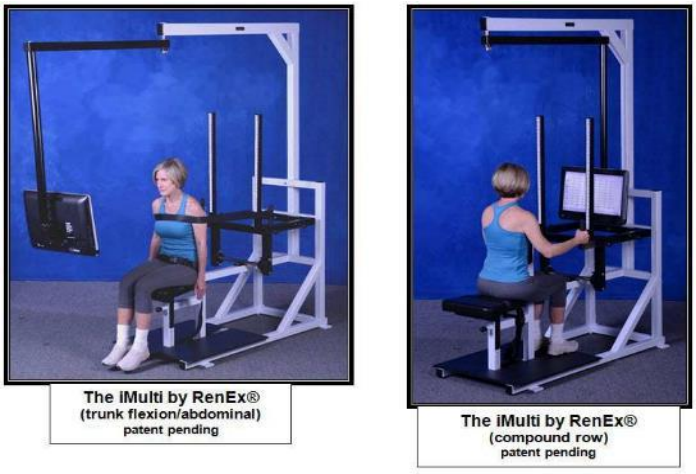


Figure 12. RenEx iMulti product. Abdominal flexion and rowing exercises (RenEx, 2019)

In the image you can see how the structure incorporates a screen that shows the force data that are done during the session. In the same way as the rest of the devices developed by the RenEx brand. This apparatus for adults includes a belt that serves as a grip to perform a trunk flexion exercise to work the abdomen.

*Bullworker Isometric Training Products* (LLC, 2021)

The product is described as a telescopic pole with interchangeable springs inside that allow variable resistance adjustment up to 60 kg. This company is dedicated to distributing a series of products, such as this "bow", that allow you to perform exercises for isometric training. These products do not have any type of sensor that allows to calculate or know the force that the user is applying. They are very simple and straightforward products that only allow you to perform certain specific exercises. It is an example that with simple elements you can perform this type of exercise, on the contrary, it does not allow you to measure or track the exercise.


**Figure 13.** Bullworker Products (LLC, 2021).

*"Isometric exercise device"* (Karapetian, 2017)

This patent describes a device that allows training the muscles of the abdominal and lumbar area. This machine consists of a vertical body attached to a platform at the bottom, constituting its base. In the upper part of the body, in a position parallel to the base of the apparatus, there is an arm attached at its midpoint that will serve as a contact element with the user to perform isometric exercises. This upper arm is adjustable in height and position to allow you to perform different exercises. In addition, it includes sensors to record the force that the user exerts during the exercise session.

*"Isometric exercise apparatus"* (Gala, 1982)

The apparatus described in this patent consists of a vertical support that maintains a grip that can be moved both horizontally and vertically and consists of a load cell that allows measuring the force exerted by the user against the grips. In addition, the device has sensors at the base of the support that also allow the measurement of the force carried out by the user in a direction perpendicular to the plane of the base. The device also has a screen in front of the vertical support that allows displaying the parameters measured by the sensors. In this patent, reference is made to "scales" as the elements that will allow calculating the force exerted by the exercise.

*"Isometric exercise apparatus and storage rack therefore"* (Thorpe, 2009)

This device consists of a flat surface and a wall assembled from one side, forming an angle of 90º to each other. It contains a support arm that keeps the user's body static during exercises. This clamping arm is connected to another that pivots on the base and can be kept static in certain positions that are adjusted with different angles with respect to the horizontal base. It also includes some grip accessories to perform different exercises that the holding arm does not allow, which are **an**chored to the body of the device. There is also a trademark that sells this patent under the name Isophit.

**Analysis of the market gym equipment for isometric exercises**

Being all of them properly designed and fantastic products for some specific cases, after reviewing

the market gym equipment for isometric exercises, it is worth mentioning that it was possible to find some use limitation of the previously detailed models. These limitations are discussed in the following lines:

*Vald Performance: Force Frame and KT360 Testing* and *Training platform (Kangatech)*
• They do not include a bench or element on which the user can sit. This limits the type of user to which it is directed.
• Elements that ensure the correct positioning of the user to carry out the different exercises are not included.
• These sensors can only measure force in the direction of the sensor and not in other directions. In addition, it only has one type of contact point or grip for measuring the force.

*Viiv Fitness Rx*
• Elements that ensure the correct positioning of the user to carry out the different exercises, such as belts or harnesses, are not included.
• Sensors can only measure force in the direction of the sensor and not in other directions. In addition, only one type of grip is available

*1 RepGym*
• It does not allow the measurements of the different sessions to be stored on a mobile device or computer, or to have graphs that can give the user more information on the parameters reached in each session. No comparison among sessions and users possible.
• It is limited to a series of exercises involving only and exclusively pulling or pushing movements.
• It only consists of a belt that allows the user to be fixed around the waist. It is necessary more elements like this to be able to guarantee a correct positioning for all the exercises, or it is necessary to have the support of qualified personnel to ensure right placing.
• It does not have different types of grips depending on the type of exercise.

*Ren-ex (Various products)*
• With these machines you can only perform a specific type of exercise per machine.
• In this case, sensors that make specific force measurements at the point where the force is applied are also not used. It also does not allow triaxial force measurements.

A common limitation among the devices studied has been that it was not possible to find their medical validation studies, the studies giving ethical and medical proofs of their positive effects. As indicated in the materials and methods section, isometrics are for sure beneficial for health. As the equipment presented herein is valid for performing isometric exercise, it can be assumed that this equipment as well improves health parameters. Nevertheless, it is not possible to establish to what extent they do it. Thus, a common limitation detected could be that this equipment is lacking of studies with hypotheses, objectives, study design, subjects, variables, data collection and analysis, study limitations and ethical considerations, and contingency plan. These studies would help in gaining trustworthiness and visibility of both the equipment and the isometric exercise typology, and should be considered as a future step for equipment sellers not performing them.

## Conclusion

Muscle hypertrophy, strength, balance, and range of motion have all been found to improve with isometric training. Other benefits such as, e.g. stress reduction, improved mental health, injury avoidance and overall wellbeing are associated to isometric exercise as well. It is a proper solution for injured and elderly individuals, as the possibility of injury is practically null. Despite this, the number of people who do isometrics in gyms is relatively modest. One of the problems affecting the spread of isometric training seemed to be a lack of awareness of the presence of specific isometric gym equipment.
With this context, the aim of the article has been to provide a market analysis of the currently available equipment in the field. Ten devices have been analyzed within the context of the research, remarking each one's differential characteristics. Thus, we firmly believe that this review will increase the visibility of these types of devices and the benefits of isometrics.

## Supplementary Materials:

In the following link it is possible to see an animation of the mechanical model showing the movement of the device of Figure 7: https://drive.google.com/file/d/1pdztQl4wnWtSP_oZWUBKZAeGRkEff95F/view?usp=sharing


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## Conflicts of Interest:

The authors declare no conflict of interest.

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