

Designing and developing a compartment to use the Human Treadmill as a Rat's Treadmill

Alireza Kashef*¹ & Mohammad Ashourifar²

1. Sport engineer and MSc in Exercise Physiology
2. MSc in Mechanical Engineering

ABSTRACT

Purpose: This study aimed to develop a device capable of converting human treadmill for the rat's exercise space on with all the conditions of rodent's treadmills, so that the cost of studies would be reduced.

Technical and Experimental Information:

Specification of the device :1)Running space: 15 × 52 × 10 cm. 2)50 v Shock panel separately for each device. 3) The width of devise is 80 cm. 4) The length of devise is 60 cm. 5) Separate roof for each line. 6) Adjustable to treadmills with different width. Twelve Wistar rats in three groups exercised on this new rodent's treadmill in order to evaluate the performance of the device. To standardize rodent's (or you can always say rat's treadmill) treadmill compartment, the device, in this study, were tested totally for 50 hours and its problems were resolved, and as a result, a rat treadmill compartment was developed. With respect to the novelty of the device and design, researchers registered the device and obtained the invention registry certificate from industrial Intellectual property center of Iran state organization for registration of deeds and properties. (Registry number: 029656 A.89; date: 02.03.2014).

Conclusion: The designed device can be placed on any human treadmill, and it is connected to the body of the treadmill due to the preserving Aluminum base installed on every four corner so the device can stand firm and stable. Based on the width of the device, it can have 3 to 5 lines, each of which benefits from a separate roof and shock panel. All these conditions may provide a standard environment for exercising rat.

Keywords: Rat treadmill, Rat, Design and development, Sport engineering.

Introduction

Many research utilized animals in experimental studies. Achievements of medicine in the last century were greatly dependent to the use of animals. Key events such as cure of diabetes, blood cancer and organ transplantation surgery were among advances achieved by utilizing animals in a scientific manner. Benefits and achievements of using animals in studies and researches justify this increasing usage of animals in research. Animal species are used as a sample [1] where an experiment on a target species is difficult or impossible. Rat is the best experimental animal in experimental researches, since they are not costly, has a small size and some genetic or physiological similarities with human.

The usage of rate has been increased in sport sciences. As a part of the experiments, giving exercise to Rat is conducted in the fields of sport sciences and physiology. Treadmill is considered as exercise equipment used in many sport science studies. Mohammadi et al (2013) investigated the effect of eight weeks resistance exercise with different duration on protein levels of HSP27 among male rats. They exercised 40 male rats for eight weeks on a running treadmill specialized for rodents. The results of the study shows that medium-intensity and duration increased the protein levels of blood plasma's heat shock protein 27 more than short and long duration [3]. By making use of rodent's treadmill, Yaghubi et al (1392) evaluated the effect of one session of continuous exercise on the amount of heat shock protein 72 and antioxidant capacity of rats which were induced diabete by Streptozotocin. Forthy Wistar male rats were examined and they found that the amount of HSP72 plasma was increased following a single exercise session among diabetic rats [4].

Several types of rat treadmills have been developed and produced in USA. However, this rat treadmill wasn't reasonable price and easy to use. In 2005, Gharakhanlou was the first one who designed the first rodent's treadmill in Iran and it was used by many universities however, the production of this device was stopped due to some problems [2]. In 2003, Ghanbari Niakani and colleagues developed a device as a research project. In University of Tabriz, Jafari produced another model of rodent's treadmill in 2008, and Hosseini and Darvishi produced a programmable rodent's treadmill in 2012 [5].

These treadmills are still costly and occupy the space and environment of labs. This study attempts to produce a compartment, so that the human treadmill, which can easily find in physiology labs, can be used for exercising rats. It is a novel device and idea in physiology. In 1995, using an DC electromotor, Rajabi developed a miniature treadmill similar to a human one for his PhD thesis, to investigate the impact of short duration aerobic exercises in an environment contaminated with complete blood count (CBC) on the amount of lipids and lipoprotein in serum and on the running time in experimental rats. He created an exercise area using wood and glass [5,6]. The designed compartment in this study compatible with the most available human treadmills in the market.

Technical and Experimental Information

With respect to the familiarity with the performance of a standard Rat treadmill and knowledge of technical specifications of common human treadmills, the author attempted to design a compartment which can be compatible with the most available human treadmills in the market. Finally, according to the categorized and collected data, the prototype was designed which was plotted in CATIA software and the general specification were considered. After juxtaposition of the designed parts, the overall view of the device (Figure 1) was depicted. Then, the necessary materials were purchased to build a prototype device.

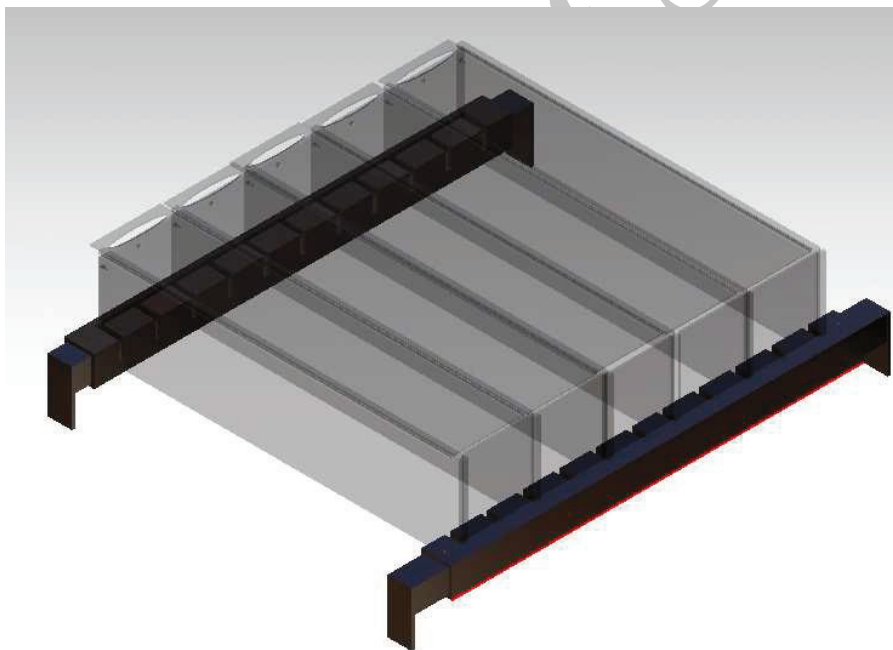


Figure 1. The design of human treadmill compartment to mouse treadmill in CATIA software.

Device Specification

This compartment device includes: separating parts, a preserver, Aluminum base and an electrical shock stimulator panel.

Environmental part

1. **Separator:** in order to create necessary spaces for running rats on the treadmill's running belt, materials with enough transparency and resistance must be implemented. Therefore, Plexiglas mm transparent

Plexiglas® acrylic sheets were used. Walls and roof was made by Plexiglas® acrylic sheets separated chambers were made and each back. Front and back walls of each chamber can easily open for the rat handling.

2. Aluminum base: these parts were designed to support the chambers. With regards to the variety of human treadmills, this Aluminum base must be designed in a way that can have a high variation for different human treadmill with various shapes and width.

To this end, aluminum profiles, which were chosen after calculation of machining, were used.

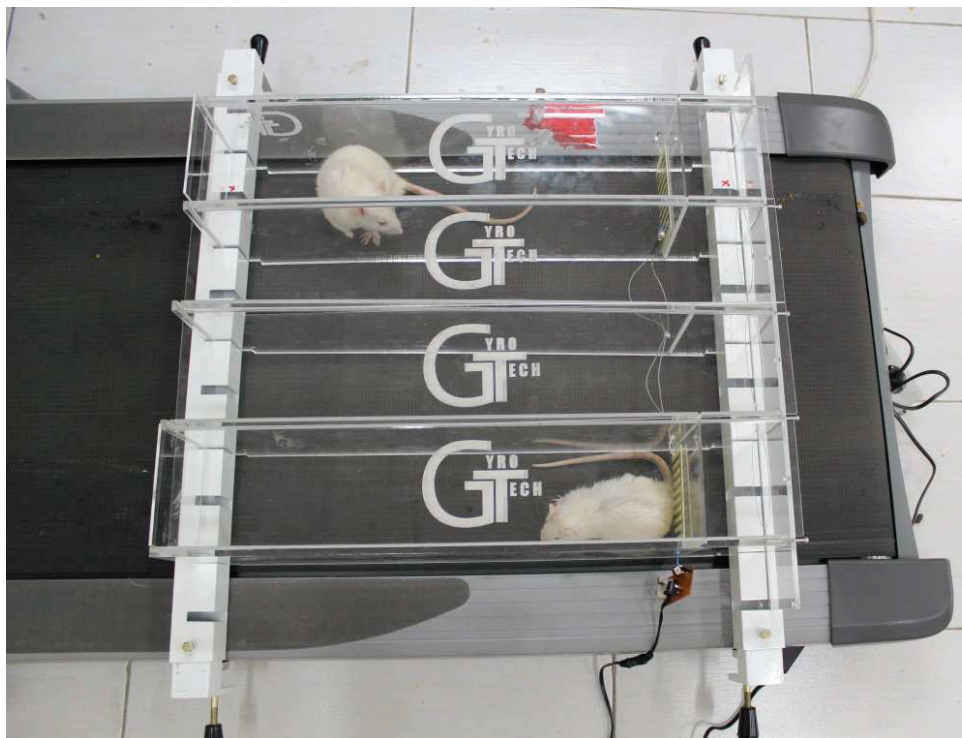


Figure 2. The mouse treadmill compartment on a human treadmill.

B. Shock Systems

1- Shock panel: Electrical shock panel was implemented to push reluctant rats to run. This shock panel is located at the back of the device and produces a shock if they do not run to make the rat run forward. This panel is completely distinct from rodent treadmill and it's a new design. This panel was produced on a electronic Printed Circuit Board (PCB).

2- In order to keep the sock panel at the back of the device, it is necessary to employ a flat and resistant surface. Therefore, a Plexiglas panel with different width is used so that we can create exclusive Plexiglas mm transparent Plexiglas® acrylic sheets.

3. Preserver: In order to keep all the Aluminum base and separates on human treadmills, an L-shaped piece was designed. The top of the piece is pushed into the profile and the bottom part is connected to the treadmill side.

This was the most challenging problem of previous researchers, and they observed a severe injury to the rat during the experiment phases.

Therefore, following several hours of experiment and design of many different geometry of this panel, a design with mentioned conditions was confirmed and used.

Results

Specification of the device

- 1) Running space: $15 \times 52 \times 10$ cm
- 2) 50 v Shock panel separately for each device
- 3) The width of devise is 80 cm
- 4) The length of devise is 60 cm

- 5) Separate roof for each line
- 6) Adjustable to treadmills with different width

Invention register

With respect to the novelty of the device and design, researchers registered the device and obtained the invention registry certificate from industrial Intellectual property center of Iran state organization for registration of deeds and properties. (Registry number: 029656 A.89; date: 02.03.2014).

Validity and device's performance test

Following the production of a prototype, the device was tested in the laboratory of the Faculty of Sport Sciences at the Shahid Rajaei Teacher Training University.

Twelve Wistar rat were exercised for 50 hours at speed between 0.8 km/h to 4.7 km/h and slope of 0 to 10%. All the rats were conditioned with shock panel and they exercise without any problem.

Discussion and Conclusions

Using animal model and limitation in using human model is a known fact in sport sciences, thus, the need for exercise equipment are increasing in these studies. Treadmill is considered as an acceptable device to perform the protocol on experimental rats. Two Iranian and International rat treadmill is available however, it is hard to provide a International one due to international problems, also, the Iranian treadmill is costly and occupies a great deal of space. The idea of developing a compartment is to use equipment available in laboratory to increase productivity.

The advantages of this device include: low price, standard (training area dimensions, voltage of shock panels), ease of use, and space efficient.

Generally, the performance of the device was in a good state however, the following defects were identified and resolved.

- 1- The height of the Plexi Shock is crucial. If it is very close to the belt surface, it may hurt the rat's tail, and if the height is very high, the rat is able to turn back to the of Plexi panel. Therefore, after many experiments and assessments, the exact height of Plexi panel was calculated and examined so that no harm could reach to the rat.
- 2- The prototype of shock panel was identified with a small likelihood of contact, thus, it was modified and tested again, and as a result, the likelihood of getting shocked was increased.

After some adjustment, the device was given to Shahid Rajaei Teacher Training University, Faculty of Sport Sciences, and it has been employed since then.

It worth noting that this device with a low price and high performance can play a significant role on the qualitative and quantitative advancement of sport sciences researches of the country.

The importance of the device is manifested through ease of use, small size, and more importantly, comparability with all the available treadmills in the market.

This device is produced by Nedaye Mohandesi-e-Varzesh Pars Company under the brand name, Gyrotech.

After-sale services are considered as one the main pillars of the product quality. All the after-sale services were conducted by the above mentioned company.

Also, this company produces other equipments for exercising rodents.

With respect to these equipments, it is to be hoped that the studies in the field of the sport physiology experience gain a tremendous growth.

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Corresponding Author: Alireza Kashef, No 4, Azizi Dd end, Jomhouri St, Tehran, Iran. 1313916967, Phone:(+98) 9121323154. Email: kashefalireza@gmail.com

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چکیده فارسی

طراحی و بهینه‌سازی یک مبدل برای تبدیل ترمیل انسان به ترمیل رت

علیرضا کاشف و محمد آشوری‌فر

زمینه و هدف: هدف از اجرای این تحقیق ساخت دستگاهی جهت تبدیل کردن ترمیل انسان به ترمیل موش و ایجاد فضای تمرین دادن موش بر روی ترمیل انسان با تمامی شرایط ترمیل‌های مخصوص جوندگان بود که بتوان هزینه‌های پژوهش‌ها را با خرید تجهیزات آزمایشگاهی با کیفیت بالا کاهش داد. **روش تحقیق:** مبدل ترمیل موش با این مشخصات تهیه شد. ۱- فضای دویدن : $10 \times 52 \times 15$ سانتیمتر ۲- صفحه شوک با ولتاژ ۵۰ ولت به صورت مجزا برای هر لاین ۳- عرض دستگاه هفتاد تا ۸۰ سانتیمتر ۴- طول دستگاه ۶۰ سانتیمتر. با توجه به جدید بودن ایده و طرح، محققین اقدام به ثبت اختراع دستگاه نموده‌اند و موفق به اخذ گواهی ثبت اختراع از اداره‌ی مالکیت صنعتی سازمان ثبت اسناد و املاک کشور قوه قضائیه با شماره ثبت ۰۲۹۶۵۶ الف/۸۹ در تاریخ ۹۲/۱۱/۱۴ شدند.

نتیجه‌گیری: این دستگاه طراحی شده بر روی انواع ترمیل انسان قرار می‌گیرد و با پایه‌های نگهدارنده‌ای که در چهار گوشه آن تعبیه گردیده است، به بدنه ترمیل متصل شده و کل دستگاه را ثابت نگه می‌دارد. بر اساس عرض ترمیل این دستگاه می‌تواند از ۳ تا ۵ لاین داشته باشد، که هر لاین دارای سقف و پنل شوک مجزا می‌باشد. تمامی این شرایط می‌تواند محیط استاندارد برای تمرین دادن موش را فراهم آورد.

واژه‌های کلیدی: ترمیل موش، موش صحرائی، طراحی و ساخت، مهندسی ورزش.