Chapter 8
Design of Recreational Vehicles for Young and Adult People as an Alternative to Physical Activation in Open Spaces

Mayra Ivette Peña Ontiveros
Autonomous University of Ciudad Juárez, Mexico

Cesar Omar Balderrama Armendáriz
Autonomous University of Ciudad Juárez, Mexico

David Cortés Sáenz
Autonomous University of Ciudad Juárez, Mexico

ABSTRACT

Physical activity is an outstanding factor for daily life since it helps to maintain the physiological functions of the body, granting the possibility of increasing physical and mental health. Recreational vehicles of human propulsion are an alternative for skeletal muscle and cardiovascular system activation with the particularity of improving the system while enjoying the activity. This chapter presents an analysis of the problems of sedentary lifestyle to propose a user-focused alternative that meets the necessary requirements for healthy energy consumption. A prototype was designed and built to verify the metabolic expenditure through a telemetry equipment and another survey was applied to validate functional and user acceptance aspects. The results of the tests showed an average energy consumption of 50.2 kcal/min (Almost 6 METS) placing the prototype in a suitable range to perform physical activation. Finally, the resulting vehicle was cataloged by users as creative and attractive to be used in the future.

DOI: 10.4018/978-1-5225-5234-5.ch008

INTRODUCTION

Physical activity plays an important role in the prevention of chronic diseases such as cardiovascular disease, musculoskeletal disorders, psychological disorders, lung diseases, cancer and metabolic disorders. There is a high percentage of 55% of adolescents and adults who do not perform any productive activity in their leisure time (Heyward, 2008). Besides helping to reduce the risk of these diseases, it also controls body weight, the formation and maintenance of bones, muscles and healthy joints, and creates a sense of psychological wellbeing, among others (Chomistek, Manson et al., 2013; Acero Mora, 2011).

According to the National Institute of Statistics and Geography (INEGI), poor diet, sedentary lifestyle, lack of physical activity are determinants of overweight and obesity, 72% of women and 66% of men over 19 years old suffer from overweight and obesity in Mexico (Olaiz-Fernandez Rivera-Dommarco et al., 2006).

Young and adult people have abandoned open-air activities, due to other activities such as work, school and home activities, video games, social networks, among others; this abandonment generates obesity, stress or depression (Muñoz & Salgado, 2011). This problem is increasingly growing, most of these people are not aware of this problem and do not perform any activity that causes a change (Patino & Marquez, 2009).

The variety of recreational mobility vehicles is scarce; traditional systems are commonly replicated in similar vehicles: bicycles, adapted and modified bicycles and tricycles, these create little expectation to attract the attention of young and adult people; the most attractive recreational systems are motorized, which reduce the possibility of physical activation (Superiores, 2006).

Recreational vehicles for fun and physical activation contribute to a better quality of healthy life, providing numerous advantages for people and society (Acero Mora, 2011). Changes and improvements in recreational vehicles increase the participation in recreational and physical activities, reducing stress levels and consequently preventing health risks (Hurlock, 2010).

The present work aims to demonstrate the importance of physical activation and proposes mobility systems that can be a viable alternative to help prevent diseases caused by sedentary lifestyle, and consequently improve the quality of health of individuals.

Sedentary Lifestyle

Sedentary lifestyle is called physical inactivity, which is a risk factor for cardiovascular diseases (Nosova, Yen et al, 2014); at least 60% of the world population do not perform a physical activity to obtain health benefits, this is due to the increase in the use of passive vehicles of transport and to the reduction of physical activity (WHO, 2010).

From the point of view of the time dedicated to physical activity, a sedentary individual is one who does not perform at least 30 minutes of moderate physical activity during most days of the week; from the point of view of energy expenditure, it can be defined as sedentary or inactive to a person who does not perform vigorous physical activity for at least 20 min, or who does not generate an energy expenditure of at least 3 METS (Metabolic Equivalent of Task) (WHO, 2015). Another definition of sedentary lifestyle is related to the time spent by a person sitting or lying down, also can be called sedentary to the individual who spends less than 1.5 METS per hour (Crespo et al., 2015).

The World Health Organization (WHO, 2010) estimates that sedentary lifestyle is the fourth leading cause of death worldwide, and influences in a major way in the global burden of disease (Lee, Shirona

et al., 2012). Physical inactivity or sedentary lifestyle has been studied in recent years as predictable cause that determines a major number of diseases. It seems that the number of sitting hours has an association with an increased risk of mortality (Patel, Bernstein et al., 2010), the risk is higher in people who simultaneously is less physically active and adopt a sedentary behavior (Stamatakis, Hamer, & Dunstan, 2011).

Inactivity has become one of the worst enemies of physical well-being, 60% of the world's population does not perform the necessary activity to maintain their body in acceptable conditions (WHO, 2010). Figure 1 shows the results of men and women over 18 who are active and inactive, where 38.7% of men and 61.3% of women are inactive (INEGI, 2014).

Physical Activity

Physical activity is considered as the body movement produced by skeletal muscles that require energy expenditure (WHO, 2010). It is a complex and multidimensional behavior and a factor to consider in relation to a healthy lifestyle; the health benefits derived from physical activity are obtained after a regular practice of moderate intensity activity, which involves all the contexts of life, such as: leisure, transportation, work, and home activities (Casado et al., 2015). Studies have highlighted that physical activity reduces the risk of developing chronic, cardiovascular, and neurodegenerative diseases, breast or colon cancer, depression, diabetes and osteoporosis diseases; it also improves cardiorespiratory fitness and cognitive function, and reduces premature mortality (Heyward, 2008). Figure 2 shows a map that relates all these diseases.

In many countries, physical activity does not reach the recommended levels of at least 30 minutes, three times a day physical activity (Merí, 2005). The increase in chronic non-communicable diseases, such as hypertension and type 2 diabetes and others already mentioned, have become one of the main challenges of our health system, these conditions and some other conditions such as sedentary lifestyle, smoking, alcoholism and obesity have become the most important risk factors for the development of cardiovascular and cerebrovascular diseases (CEVECE, 2014).

In Table 1, the MET measure is used to express the intensity of physical activities; a MET is defined as the energy cost of sitting quietly and is equivalent to a consumption of 1 kcal/kg/h; the caloric con-

Figure 1. Physical activity condition
INEGI, 2014.

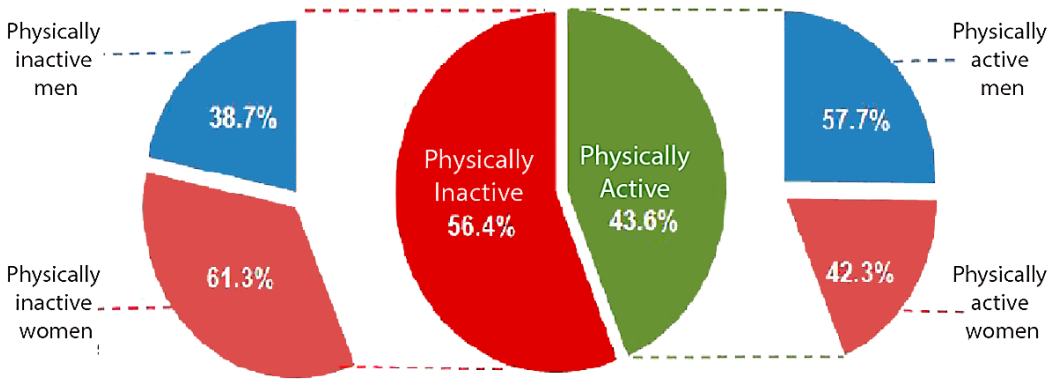
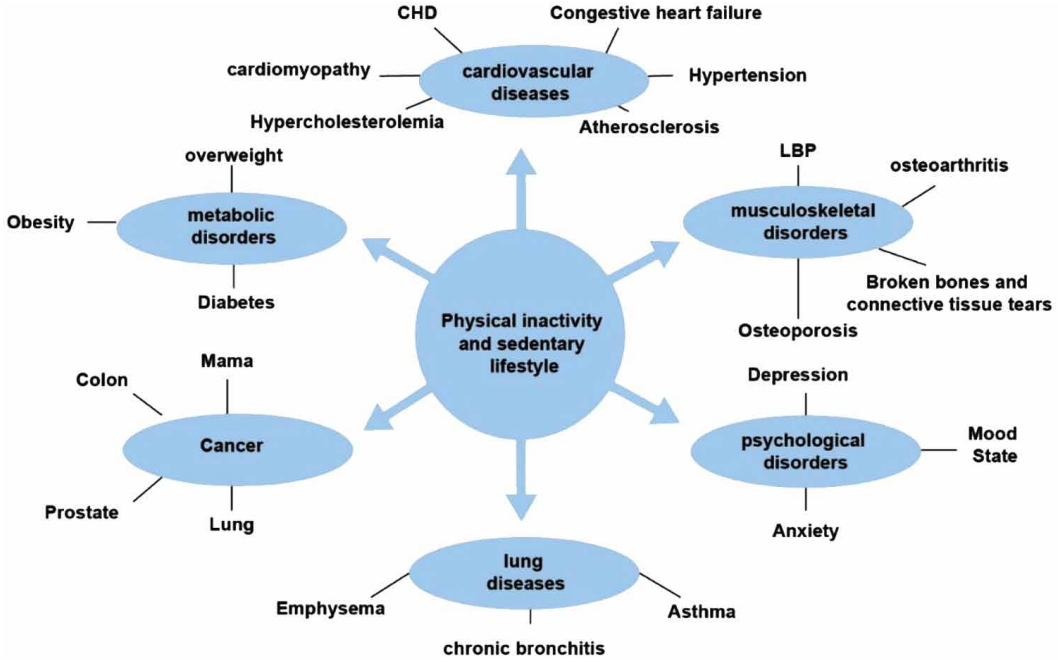


Figure 2. Map of physical activity and related diseases
Heyward, 2008.



sumption is about 3 to 6 times higher (3-6 MET) when a moderate intensity activity is carried out, and more than 6 times higher (> 6 MET) when a vigorous activity is performed (WHO, 2015). The table evidences the need to carry out interactions and programs that promote activity (Casado et al., 2015).

The lack of physical activity or sedentary lifestyle threatens the health of young people considerably, which are less active than in the past, since they spend a lot of time watching television or playing video games. Although some of these activities can be educational and intellectually stimulating, it is important that this segment of the population be physically active to develop and grow healthy (Macarro, Romero and Torres, 2010). Table 2 shows the composition and description of factors of physical activity.

Table 2 shows the physical activity factors. Personal reasons in factor 1 are the dominant components formed by 10 of 15 items. Personal reasons related to time, the person and the interaction with others encourage the abandonment of the practice of physical-sport activity. Factor 2, environmental and social reasons, includes 3 items, which show that the pressure of physical activity, stress and the

Table 1. Level of physical activity

Intensity Level	Range of Activity and Time	Health Benefits
Inactivity.	No physical activity	None
Light	Activities of 1.1 MET to 2.9 MET.	Some
Moderate	Activities of 3.0 to 6 MET.	Substantial
Intense	Activities of 6 MET or more	Additional

WHO, 2010; Services, 2008.

Table 2. Composition and description of factors of physical activity

Factor	Designation	Variance Explained %	Items
1	Personal reasons	35,94	• Don't have time. • It is not fun. • I'm not clever enough • Others are better than me. • Problems with teacher, bosses, family. • Abandonment of classes. • Don't meet my expectation. • Injuries. • Not good at sports. • Unlikely to improve.
2	Environmental and social reasons	10,80	• Because I can't stand the pressure. • Competitive stress. • Work.
3	Attitudinal reasons	7,49	• I prefer doing other activities. • Laziness and unwillingness.

Macarro, Romero, & Torres, 2010.

influence of parents cause the abandonment, and factor 3, attitudinal reasons includes 2 items related to the preferences and the lack of interest (laziness and reluctance) to continue with the physical-sport activity (Macarro, Romero and Torres, 2010).

According to Marquez (2013), it is important to choose an active lifestyle from an early age, since sedentary lifestyle can cause serious diseases in adulthood, that is, encourage habits that allow:

- Stay active to feel good.
- Increase the daily routine in physical activities

The activities of young people in their spare time are not very productive for health. The habits during the spare time of men and women are different, and it is because men, unlike women, prefer to develop activities, such as attending sport events, playing video games, being on the computer; on the other hand, women prefer other activities such as reading, shopping, being with the family; Table 3 shows the preferences of activities of men and women in their spare time (Merlino & Roqué, 2004).

Recreational Transport Mobility

The concept of mobility refers to daily transportation and movement through public spaces (Hannam, Sheller, & Urry, 2006). The vehicle and the experience of visiting green areas, becomes a strong link since one can enjoy roads, landscapes, people; also transport is a form of recreation for people to continue going to parks and perform some activity outside of their daily lifestyle (Hallo, 2009; Veitch, 2013).

The use of recreational vehicle systems increases the motivation to perform healthy activities, involves physical activation and improves the quality of life; the vehicle must be efficient, attractive, interactive, non-polluting, and useful to move from a place to another without complications in smooth territories such as streets or sidewalks (Hurlock, 2010).

Table 3. Activities carried out by young people

Activities	Male	Female
Being with family	76.5%	94.9%
Being outside	70.6%	82.6%
Shopping	43.1%	72.3%
Watch videos	53.1%	68.4%
Eating out	39.8%	58.8%
Read magazines	37.6%	58.1%
Read books	43.7%	55.3%
Surfing the web	54.7%	46.6%
Go out to dance	58.9%	43.5%
Go to the gym	13.7%	26.9%
Go to the movies	35.9%	20.7%
Attending sporting events	37.1%	16%
Playing video games	27.6%	14.7%
Play an instrument	18.9%	4.1%

Merlino & G., 2004.

Some of the characteristics that distinguish this type of vehicles are: (Acero Mora, 2011; Hurlock, 2010):

- A silent, clean, healthy, affordable and sustainable vehicle.
- It is environmentally friendly.
- Improves social cohesion and allows greater independence and freedom.
- It is a very efficient mobility vehicle for medium and short distances.
- Increase leisure, sports and tourism opportunities.
- Improves physical and mental health.

The most outstanding and important example of vehicles for physical activity is the bicycle, which has become one of the favorite recreational sports.

Methods

In order to obtain information that leads to the design of a recreational vehicle that function as a means of physical activation, the characteristics presented in section 1.3 were used (Acero Mora, 2011; Hurlock, 2010). User needs were extracted by means of the survey to obtain necessary attributes of the new design. A non-probabilistic sampling of people aged 18 to 45 years was made to cover the function of the product. Using the image of an innovative recreational vehicle as a contrast, ten questions were asked with four possible answers. These were classified to obtain design requirements and propose innovative graphic alternatives that would provide a solution to the proposal. Subsequently, a design selection was made to meet the requirements.

To test the ergonomics of the device, a 3d simulation of the position and posture of the user regarding the product was made, based on 95, 50 and 5 percentiles simulating the conditions of the designed vehicle in relation to the distances of the pedals and the movements.

In the physical test the energy and the heart rate were measured with a Sunnto telemetric monitoring equipment using a data reception and calculation software called Team Manager (Suunto, Finland) through technology of computation developed by the company Firstbeat Tech., the evaluation was made to 5 people between the ages of 18 and 45, male and female, who were split it into two phases of the evaluation:

Phase One: The equipment to monitor the energy and heart rate was connected to the participant and was asked to remain seated at rest for 3 minutes.

Phase Two: Measurements of the energy expenditure performed on the vehicle during 10 minutes were made using the telemetric equipment. The differences between the two states (rest and activity) were compared and data was obtained on the relevance in the energy consumption when driving the vehicle.

Phase Three: To validate the appearance of the product, a survey was conducted containing the visual aspects of the proposal to 40 men and women between the ages of 18 and 45. It was applied in places with potential use of the product such as parks and recreational school areas. The results of the survey along with the physiological data were considered for the generation of the conclusions.

Results

According to the methodological proposal, data related to: the initial survey, the design proposal, the selection of the best design, ergonomic tests, physical activation tests and appearance tests were obtained. All these are presented below.

Survey Results

Considering the initial data obtained from the survey of potential users (Table 4), the proposed attributes and the design parameters were: 1) the vehicle will be intended for people who practice low physical activity, 2) it will have a design similar to the contrast proposal, 3) the vehicle will be designed for recreational areas, 4) the current design is for individual use, however it is proposed to obtain a version of the design for double use in the future, 5) the design must be different to the traditional vehicles, 6) the finish colors will be bright, 7) preferences on the type of exercise will not be considered, 8) must be comfortable to exercise 9) must be fun, and finally 10) the vehicle will be designed to be used 1 to 2 times a week. The aspects found by Acero Mora (2011) and Hurlock (2010) were also considered.

Design Proposals

In relation to the obtained design parameters, proposals were made to respond the user needs. Figure 3 shows a design proposal with circular shapes on the sides which work for displacement and protection, with side handles; in Figure 4 it is a vehicle with 3 wheels, two front and one rear, formed with a case for protection, the seat is at the rear with side handles; Figure 5 shows the third design proposal of two

Table 4. Survey results (2016)

How often do you practice physical activities?					
None	Low	Moderate	Vigorous		Total
10	16	10	4		40
What is your intereston the object shown in the previous picture?					
None	Low	Moderate	High		Total
0	2	14	24		40
What is the interest in using a vehicle of this type in recreational areas?					
None	Low	Moderate	High		Total
0	6	22	12		40
How much would you like to do physical activity accompanied?					
Nothing	Light	Moderate	High		Total
2	9	12	17		40
What recreational vehicle would you like to use in parks or open areas?					
Bicycles	Tricycles	Bicycles of load and improved	New designs		Total
2	0	1	37		40
What kind of colors attract you in a recreational vehicle?					
Bright		Opaque	Neutral		Total
25		2	13		40
What means of exercise do you use?					
Biciycle	Treadmills	Running	Fitness equipment	None	Total
7	3	10	10	11	40
What interest would you have when doing physical activity with a recreational vehicle like the one in the picture?					
None	Low	Moderate	High		Total
0	2	20	18		40
What do you look for in a recreational vehicle?					
Comfort	Exercise	Fun	All		Total
2	1	8	30		40
How much would you use a recreational vehicle that gives you some physical activation?					
Every day	1 or 2 times a week	3 or 5 times a week	Less than 3 times a month		Total
5	18	14	3		40
Comments after regarding the picture					
Big					
Innovative					
Interesting					
Could be more colorful					
Not just a metal structure					
Like					
Different					

continued on following page

Table 4. Continued

Attractive
Creative
It is practical?
Difficulty in the modo of transport
Comfortable and fun
Concern for safety
Curiosity of how it works
How mucho speed it reaches

Figure 3. Recreational vehicle Sketch 1

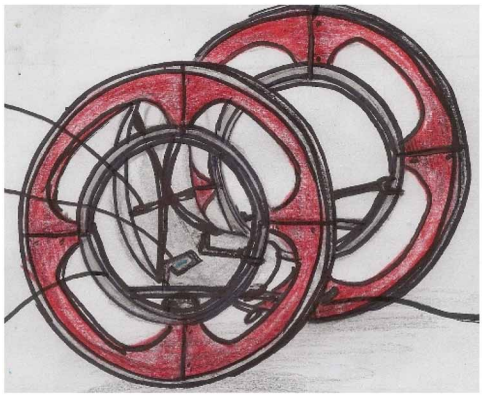


Figure 4. Recreational vehicle Sketch 2

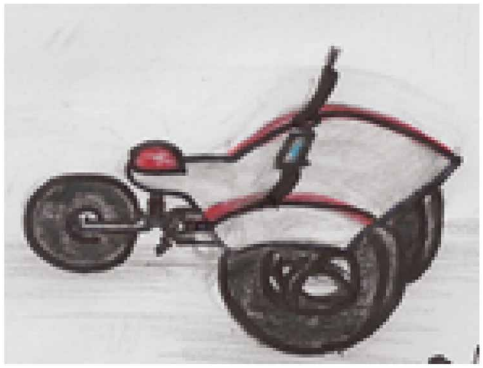
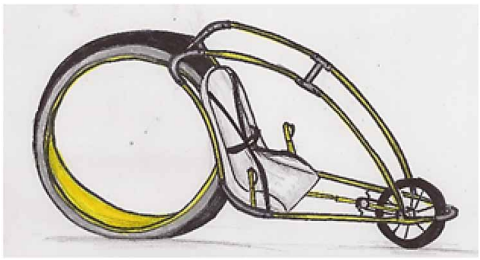


Figure 5. Recreational vehicle Sketch 3



wheels, the rear is a cylinder, the upper part is mobile, the inner part is subject to the central structure and the front wheel the movement is generated for its displacement and its handlebars are lateral.

Design Selection

For the selection of the best proposal a comparative Pugh matrix was made using values associated with the proposal with greater compliance to the design parameters as shown in Table 5.

Subsequently, the results were analyzed, obtaining the proposal with the highest score. The selected design was modified based on color, mechanism and adjustments to make the product viable. Figure 6 shows the 3D model of the final proposal.

Ergonomic Test

A validation of ergonomic tests was carried out in the design, making the adjustments in the distances of 3 mannequins that meet the 95, 50, 5 percentiles, with heights of 1800mm, 1650mm and 1500mm (Figure 7).

Physical Activation

In the evaluation of physical activation, 5 people between the ages of 18 and 45 years were considered; the oxygen and the heart rate that was generated when using the vehicle were measured.

The evaluation was carried out in two phases, the first consisted of measuring the user in a resting state for 3 minutes and the second phase, using the prototype to examine the aerobic load for 10 minutes. We obtained data and graphic representations to show the heart rate and energy consumed in resting (short waves in this case the blue one, Figure 8) and activity (long waves in this case the green) states. Figure 8 shows a representation of the obtained data. In the top part there are two lines of the resting heart rate (blue color or the short one) and activity (green color or the long one). The lower part of figure 8 show, data of the energy consumed at rest (blue color or the short one) and activity (green color or the long one). Differences in energy consumption when using the recreational vehicle and in a resting state are observed.

Figure 9 shows an example of the Team Manager Software information extracted from the activity performed when using the device.

Table 5. Comparison of design proposals in pugh matrix (2016)

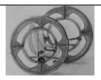
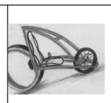
Puhg method. Selection of a recreational vehicle for physical activation.				
Assembly system		+	+	-
Indicators or instructions to arm		+	+	s
Minimum of 12 pieces to assemble		s	+	+
Screws in strategic points to assemble		s	+	+
Identification of functionality		+	+	+
Simple and understandable mechanisms for the user		+	+	+
Parts easy to replace if damaged		s	-	s
Easy maintenance		s	+	+
Adjustable height seat.		+	s	s
Adjustable angle seat.		s	+	s
Softness in the seat materials.		+	+	+
Cushioning		+	+	+
Anatomical design		+	+	+
Anthropometric design		+	+	+
4-point safety belt resistant.		s	s	s
Anti-slip materials in the handlebars.		+	+	+
Light structure		s	+	+
Reliable at a glance.		+	+	s
Resistance to the outside.		+	+	+
Resistance to the weight of a person.		+	+	+
Impact resistant		+	+	+
Physical activation.		+	s	+
Recreation device.		+	s	+
Measurement of energy expenditure		+	+	+
Attractive		s	+	+
Quality finishes		+	+	+
Differentiation of the competition		+	+	+
Long life cycle.		+	+	+
Σ+ (better than, cheaper then, easier than)		20	22	21
Σs (equally satisfies the criterion)		8	4	6
Σ- (worse than, more expensive that, harder to develop than)		0	1	1
	Sum	20	21	20
			strong	

Figure 6. 3D model of the final proposal

Figure 7. Dimensions of the product with respect to the 95, 50 and 5 percentiles (2017)

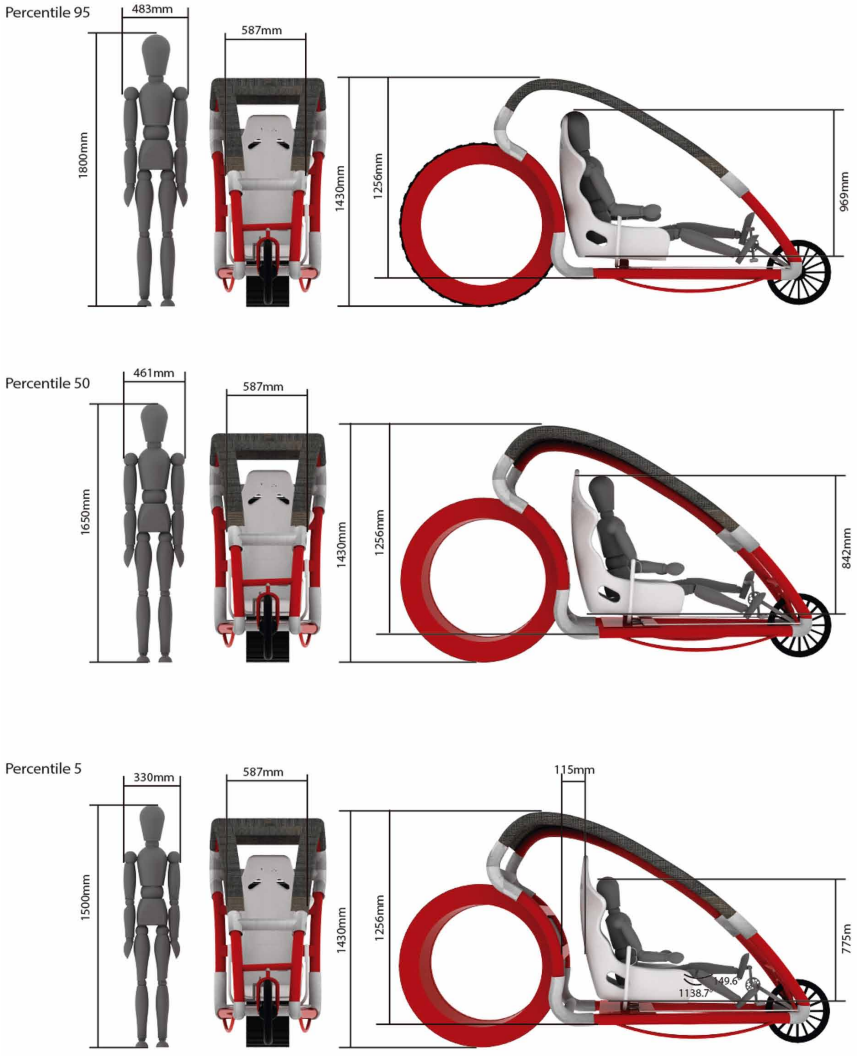


Figure 8. Heart rate and energy in resting and active states (2017)

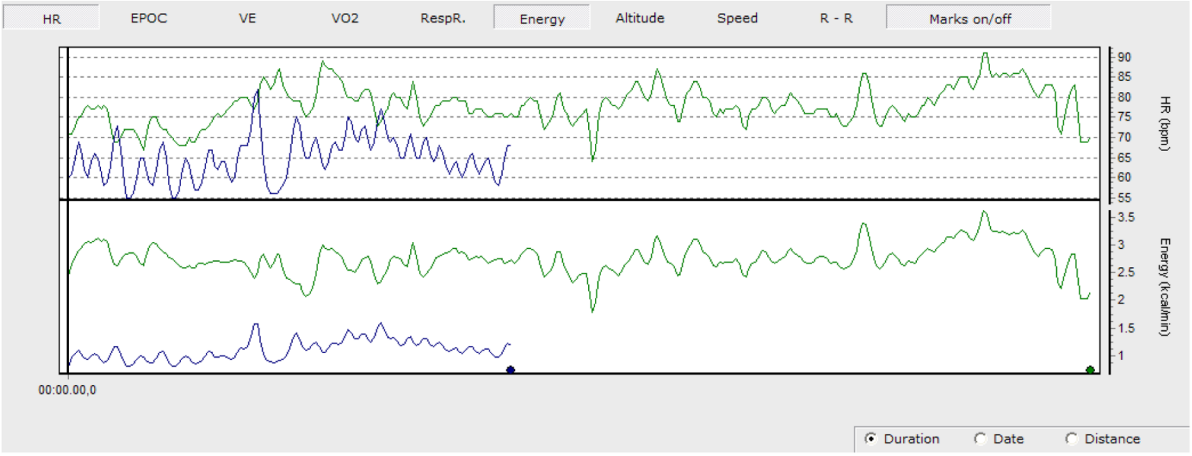


Figure 9. Results presented using the Team Manager software (2017)

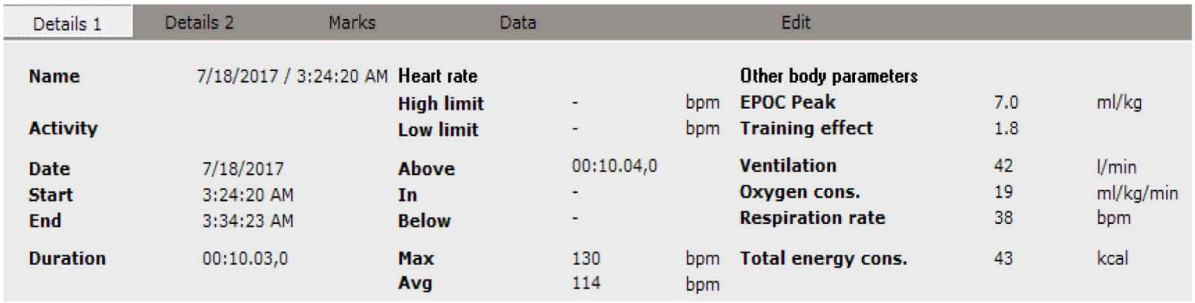


Table 6 shows the comparisons of oxygen, energy consumed, and heart rate of the people who performed the evaluations. A notorious difference can be observed in the energy consumption of the activity monitoring against the rest state (Graphics in Table 6).

Table 7 shows the comparison of average of energy consumption in kcal/min, the oxygen consumed in ml/kg/min and the heart rate in bmp; it is observed that the energy of 8.6 kcal/min was raised to 50.2 kcal/min (Almost 6 METS of difference), so it presents a physical activation when using the recreational vehicle.

Physical Appearance of the Vehicle

In the evaluation of the physical aspect, the survey results were analyzed. Figure 10 shows a graph of three questions based on: design, physical activity and recreational use. The results showed that most people were very attracted to the design; it seemed a vehicle which they would regularly use as a tool for physical activity. In addition, it was considered as a very recreational vehicle.

Figure 11 shows a graph of the results about the perception of the vehicle, users rated it as a fun product to use, they were also very attracted to the colors and shapes in the design.

Table 6. Comparison of oxygen, heart rate, and energy consumed of five users (2017)

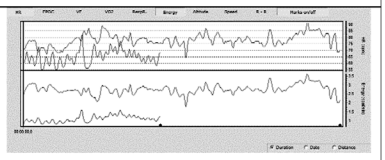
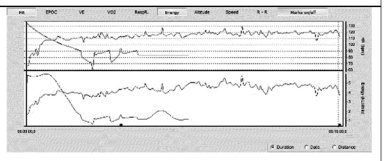
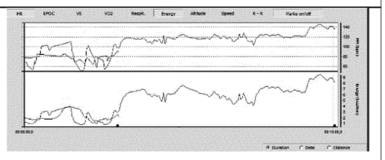
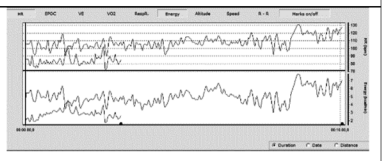
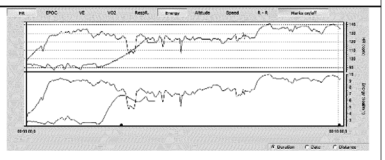
Gender	Age	Rest	Active	Graphic
Male	24 years	Oxygen: 4 ml/kg/min Energy: 1 kcal/min Heart rate: 62 bpm	Oxygen: 11 ml/kg/min Energy: 3 kcal/min Heart rate: 80 bpm	
Female	28 years	Oxygen: 20 ml/kg/min Energy: 12 kcal/min Heart rate: 87 bpm	Oxygen: 27 ml/kg/min Energy: 65 kcal/min Heart rate: 119 bpm	
Male	31 years	Oxygen: 11 ml/kg/min Energy: 6 kcal/min Heart rate: 84 bpm	Oxygen: 28 ml/kg/min Energy: 52 kcal/min Heart rate: 142 bpm	
Male	19 years	Oxygen: 14 ml/kg/min Energy: 8 kcal/min Heart rate: 83 bpm	Oxygen: 24 ml/kg/min Energy: 50 kcal/min Heart rate: 125 bpm	
Male	44 years	Oxygen: 17 ml/kg/min Energy: 16 kcal/min Heart rate: 96 bpm	Oxygen: 26 ml/kg/min Energy: 81 kcal/min Heart rate: 135 bpm	

Table 7. Comparison table of average oxygen and energy consumption (2017)

	Average Oxygen Consumption	Average Heart Rate	Average Energy Consumption
Rest	13.2 ml/kg/min	82.4 bmp	8.6 kcal/min
Using the vehicle	23.2 ml/kg/min	120.0 bmp	50.2 kcal/min

Figure 10. Results of the evaluation of physical appearance of the vehicle 1 (2017)

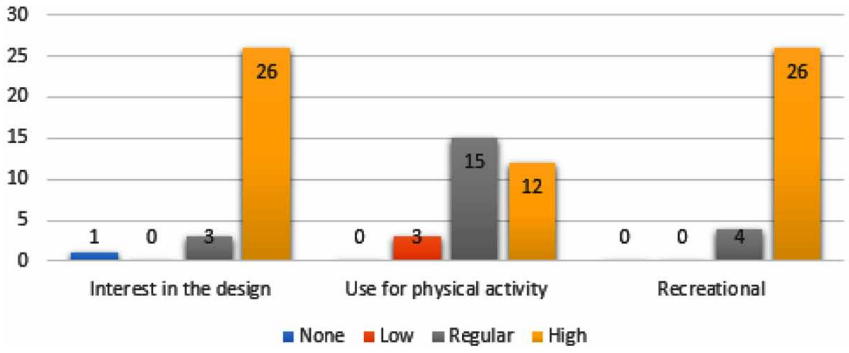
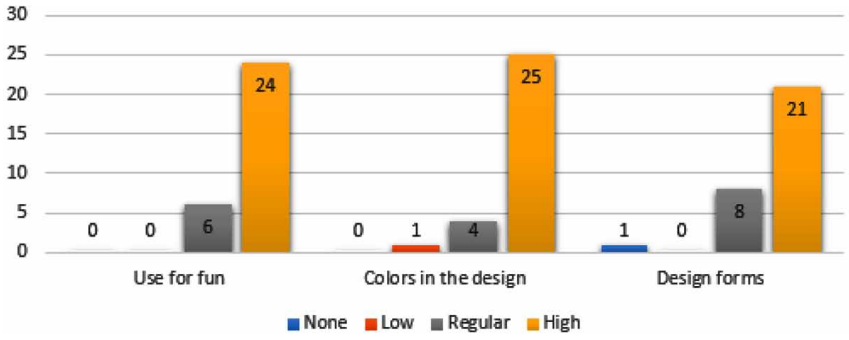


Figure 11. Results of the evaluation of physical appearance of the vehicle 2 (2017)

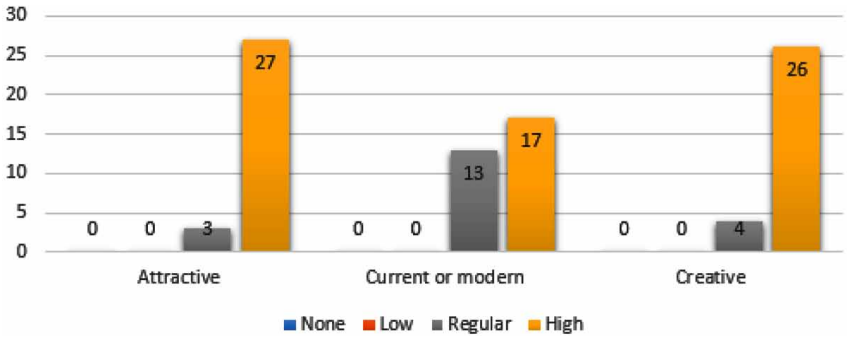


The results in Figure 12 show a graph that the vehicle was considered a very attractive, modern and creative design.

CONCLUSION

It is important to propose alternatives to reduce and prevent the consequences caused by the lack of physical activity. The result of the literature review and the surveys revealed the need to have attractive and different vehicles for practicing outdoor activities. The present work exposes an alternative to encourage people to carry out physical activity in a fun and healthy way.

Figure 12. Results of the evaluation of physical appearance of the vehicle 3 (2017)



The proposal showed the potential to function as a recreational physical activation vehicle, demonstrating that new devices can be developed to have the necessary attributes to please users and at the same time serve as a means to preserve and promote health.

The use of design techniques oriented to ergonomic adaptation and preferences over an attractive appearance, are a means of putting in development of high level products of human value.

FUTURE RESEARCH DIRECTIONS

To obtain a more accurate research it is recommended to make some changes in the prototype and add research for greater accuracy in results; the changes and proposals are:

- Adjustments in the structure of the prototype for better mobility in its displacement, likewise perform a complete physical study on the properties and resistances of materials.
- Biomechanical study to avoid that the user applies the higher force to use the product
- Analysis of movement of all the interactions that the human body has when using the vehicle.
- Design a digital device that is incorporated in the vehicle, that it is possible to measure and observe the time, energy, heart rate, forces and METs that are generated in the use of the prototype.

REFERENCES

Acero Mora, J. (2011). *Los sistemas de bicicleta pública vistos desde la relación servicio - producto.* Bogota: UNC.

Carmichael, C., & Burke, E. (1997). *BICICLETA. Salud y ejercicio*. Ed Paidotribo.

Casado, C., Hernández, V., Jiménez, R., Fernández, C., Carrasco, P., & Palacios, D. (2015). Actividad física en población adulta trabajadora española: Resultados de la Encuesta Europea de Salud en España. *Atencion Primaria*, *1*(5), 10.

CEVECE. (2014). *Factores De Riesgo De Enfermedad Cardiovascular En Adultos Mayores*. Retrieved MARZO, 2015, from http://salud.edomex.gob.mx/cevece/doc/Documentos/Facriesgo_cardio_amayores.pdf

Chomistek, A., Manson, J., Stefanick, M., Lu, B., Sands-Lincoln, M., Going, S., & Eaton, C. (2013). Relationship of Sedentary Behavior and Physical Activity to Incident Cardiovascular Disease. *Journal of the American College of Cardiology*, *61*(23), 9. doi:10.1016/j.jacc.2013.03.031 PMID:23583242

Crespo, J. J., Delgado, J. L., Blanco, O., & Aldecoa, S. (2015). Guía básica de detección del sedentarismo y recomendaciones de actividad física en atención primaria. *Atencion Primaria*, *47*(3), 9.

González, J. M. (2003). *Actividad física, deporte y vida: beneficios, perjuicios y sentido de la actividad física y del deporte. Cuerpo y espíritu*. Basauri, España: Etor-Ostoa.

Hallo, J., & Manning, R. (2009). Transportation and recreation: A case study of visitors driving for pleasure at Acadia National Park. *Journal of Transport Geography*, *17*(6), 9. doi:10.1016/j.jtrangeo.2008.10.001

Hannam, K., Sheller, M., & Urry, J. (2006). *Mobilities.* Ed M.i.a. moorings.

Heyward, V. (2008). *Evaluación de la aptitud física y prescripción del ejercicio* (Vol. 5). Madrid: Médica Panamericana.

Hurlock, E. (2010). Interés y actividades recreativas. Cambios en los intereses. In Paidos (Ed.), Interés y actividades recreativas (pp. 51 - 55). Academic Press.

INEGI. (2014). *Módulo de Práctica Deportiva y Ejercicio Físico*. Instituto Nacional de Estadística y Geografía. Retrieved Abril, 2015, from http://www.inegi.org.mx/est/contenidos/proyectos/accesomicrodatos/encuestas/hogares/modulos/mopradef/?_file=/est/contenidos/proyectos/encuestas/hogares/modulos/mopradef/doc/resultados_mopradef_feb_2014.pdf

Lee, I., Shirona, E., Lobelo, F., Puska, P., Blair, S., & Katzmaryk, P. (2012). Effect of physical inactivity on major non-communicable diseases worldwide: An analysis of burden of disease and life expectancy. *Lancet*, *380*(9838), 10. doi:10.1016/S0140-6736(12)61031-9 PMID:22818936

Macarro, J., Romero, C., & Torres, J. (2010). Motivos de abandono de la práctica de actividad físico-deportiva en los estudiantes de Bachillerato de la provincia de Granada. *Review of Education*, *353*, 25.

Márquez, S. (2013). *Actividad física y salud* (E. D. d. Santos, Ed.). Ediciones Díaz de Santos.

Merí, Á. (2005). Fundamentos de fisiología de la actividad física y el deporte (E. M. Panamericana, Ed.). Academic Press.

Merlino, A., & Roqué, G. (2004). *Los nuevos jóvenes. Un estudio psicográfico de sus actitudes y estilos de vida*. Ed Brujas. Córdova.

Muñoz, I., & Salgado, P. (2011). Ocupaciones de tiempo libre: Una aproximación desde la perspectiva de los jóvenes. *Universidad de Chile*, *1*, 10.

Nosova, E., Yen, P., Chong, K., Alley, H., Stock, E., Quinn, A., & Grenon, M. (2014). Short-term physical inactivity impairs vascular function. *The Journal of Surgical Research*, *190*(2), 11. doi:10.1016/j.jss.2014.02.001 PMID:24630521

Olaiz-Fernández, J., Rivera-Dommarco, J., Shamah-Levy, T., Rojas, R., Villalpando-Hernández, S., & Hernández-Ávila, M. (Eds.). (2006). INEG. *Instituto nacional de estadística y geografía*. Retrieved from http://www.inegi.org.mx/

OMS. (2010). *Inactividad física: un problema de salud pública mundial*. Retrieved MARZO, 2015, from http://www.who.int/dietphysicalactivity/factsheet_inactivity/es/

OMS. (2015). *Estrategia mundial sobre régimen alimentario, actividad física y salud*. Retrieved Abril, 2015, from http://www.who.int/dietphysicalactivity/physical_activity_intensity/es/

Patel, A., Bernstein, L., Deka, A., Feigelson, H., Campbell, P., Gapstur, S., & Thun, M. (2010). Leisure Time Spent Sitting in Relation to Total Mortality in a Prospective Cohort of US Adults. *American Journal of Epidemiology*, *172*(4), 10. doi:10.1093/aje/kwq155 PMID:20650954

Patiño, A., & Márquez, J. (2009). *Actividad Física y Ejercicio Físico en salud: retos en un contexto globalizado.* Fúnambulos ed.

Sevices., D. o. H. H. (2008). *2008 Physical Activity Guidelines for Americans*. Retrieved 04, 20015, from http://www.health.gov/paguidelines/pdf/paguide.pdf

Stamatakis, E., Hamer, M., & Dunstan, D. (2011). Screen-Based Entertainment Time, All-Cause Mortality, and Cardiovascular Events: Population-Based Study with Ongoing Mortality and Hospital Events Follow-Up. *Journal of the American College of Cardiology*, *57*(3), 8. doi:10.1016/j.jacc.2010.05.065 PMID:21232666

Superiores, I. T. (2006). Movilidad: Una visión estratégica (ITESO Ed. ITESO ed.). Guadalajara, México: ITESO.

Valero, A., Gómez, M., Gavala, J., & Ruiz, F. (2007). Porque no se realiza actividad fisco-deportivo en el tiempo libre. *FEADEF, 12*(5).

Veitch, J., Ball, K., Crawford, D., Abbott, G., & Salmon, J. (2013). Is park visitation associated with leisure-time and transportation physical activity? *Preventive Medicine*, *57*(3). PMID:23933224

KEY TERMS AND DEFINITIONS

Anatomical Design: Which is built to suit the shape of the human body.

Design Parameters: Aspects of a component that are needed to make something. It decides cost, design, materials, and risk.

METS: Used to express physical intensity and are the ratio between the metabolism of the person during the performance of a job and their basal metabolism.

Non-Probabilistic: Sampling technique where the samples are gathered in a process that does not give all the individuals in the population equal chances of being selected.

Percentile: Each of the 100 equal groups into which a population can be divided according to the distribution of values of a particular variable.

Prototype: A first, typical, or preliminary model of something, especially a machine, from which other forms are developed.

Recreational: Relating to or denoting activity done for enjoyment when no one is working.